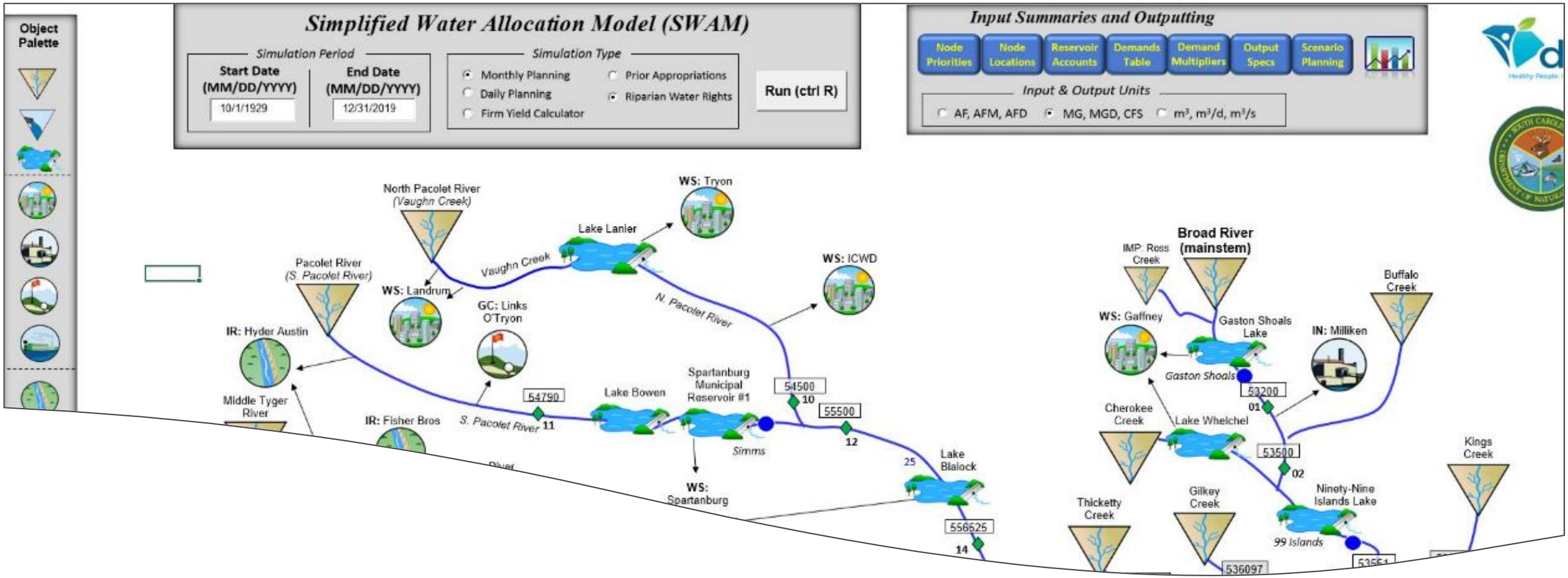


Surface Water Availability Modeling Results of Planning Scenarios

Agenda Item 6

River Basin Planning Process

Phase 2	- **Evaluate current and future water availability issues** - Identify and quantify shortages, select surface water conditions, reaches of interest and groundwater areas of concerns
Phase 3	- Develop and evaluate **water management strategies** - Recommend and prioritize strategies

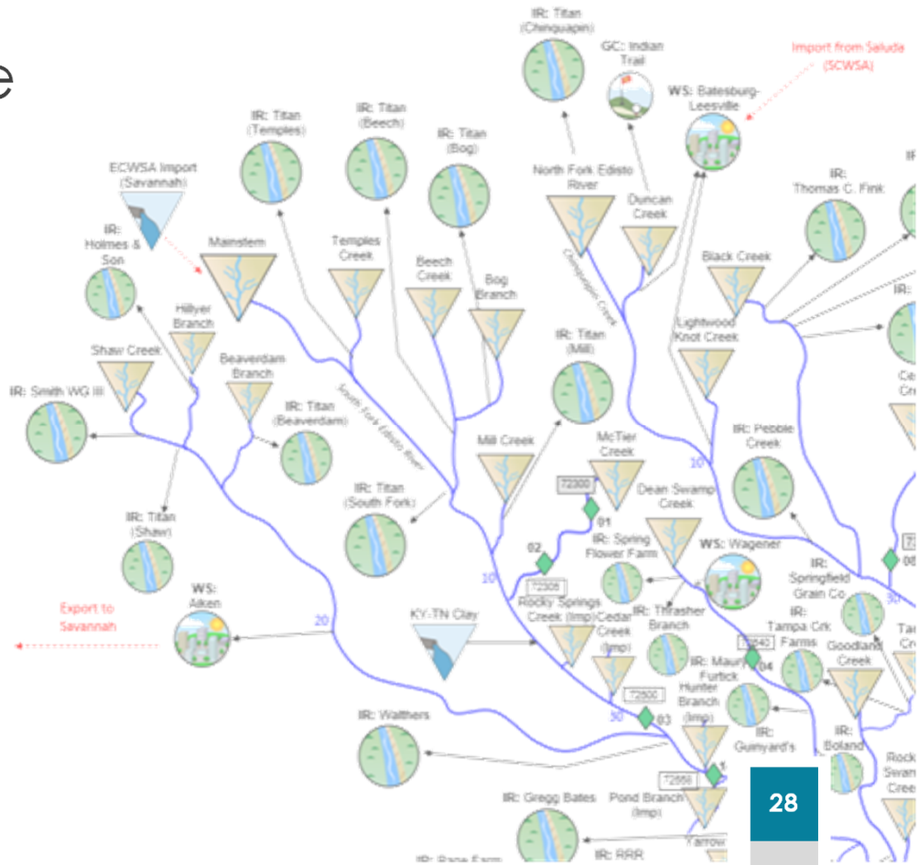
Definitions

- **Physically Available Surface Water Supply** – maximum amount of water occurring 100% of the time at a location on a surface water body, with no defined conditions applied on the surface water body.
- **Surface Water Condition** – a physical limitation on the amount of water that can be withdrawn from a surface water source and is independent of water demand.
- **Surface Water Supply** – maximum amount of water available for withdrawal 100% of the time at a location on a surface water body without violating any applied *Surface Water Conditions* on the surface water source and considering upstream demands.
- **Surface Water Shortage** – occurs when the water demand exceeds the *Surface Water Supply* for any water user in the basin.
- **Reaches of Interest** – specific stream reaches that may have no identified Surface Water Shortage but experience undesired impacts, environmental or otherwise, determined from current or future water-demand scenarios or proposed water management strategies.

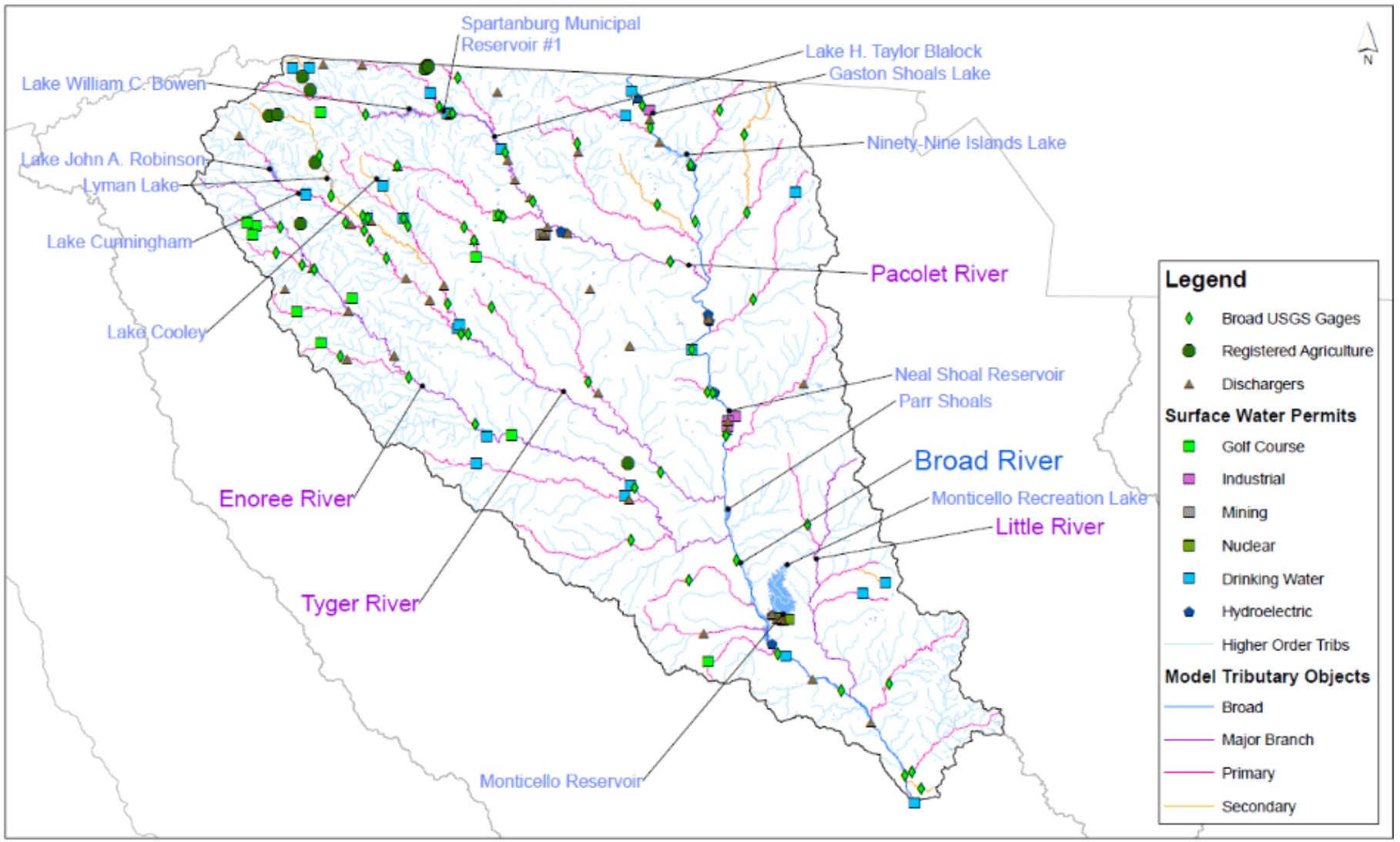
Broad Basin Surface Water Model Overview

Water Allocation Modeling ***is***:

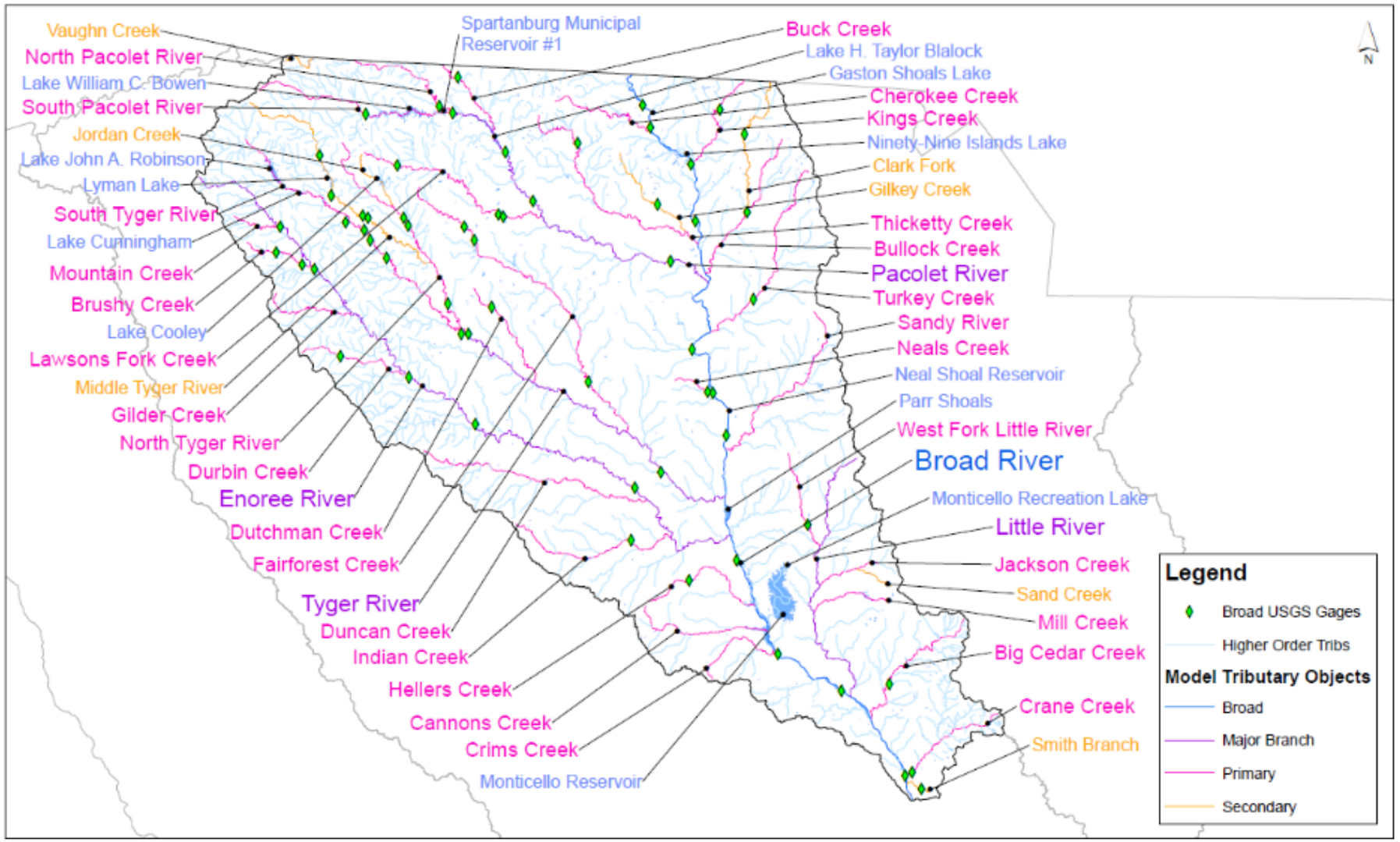
- Water balance calculations of physical flow
- Water rights calculations of legally available flow
- Demands, withdrawals, and return flows
- Reservoir storage
- Stream networks, multiple “nodes”
- Data intensive



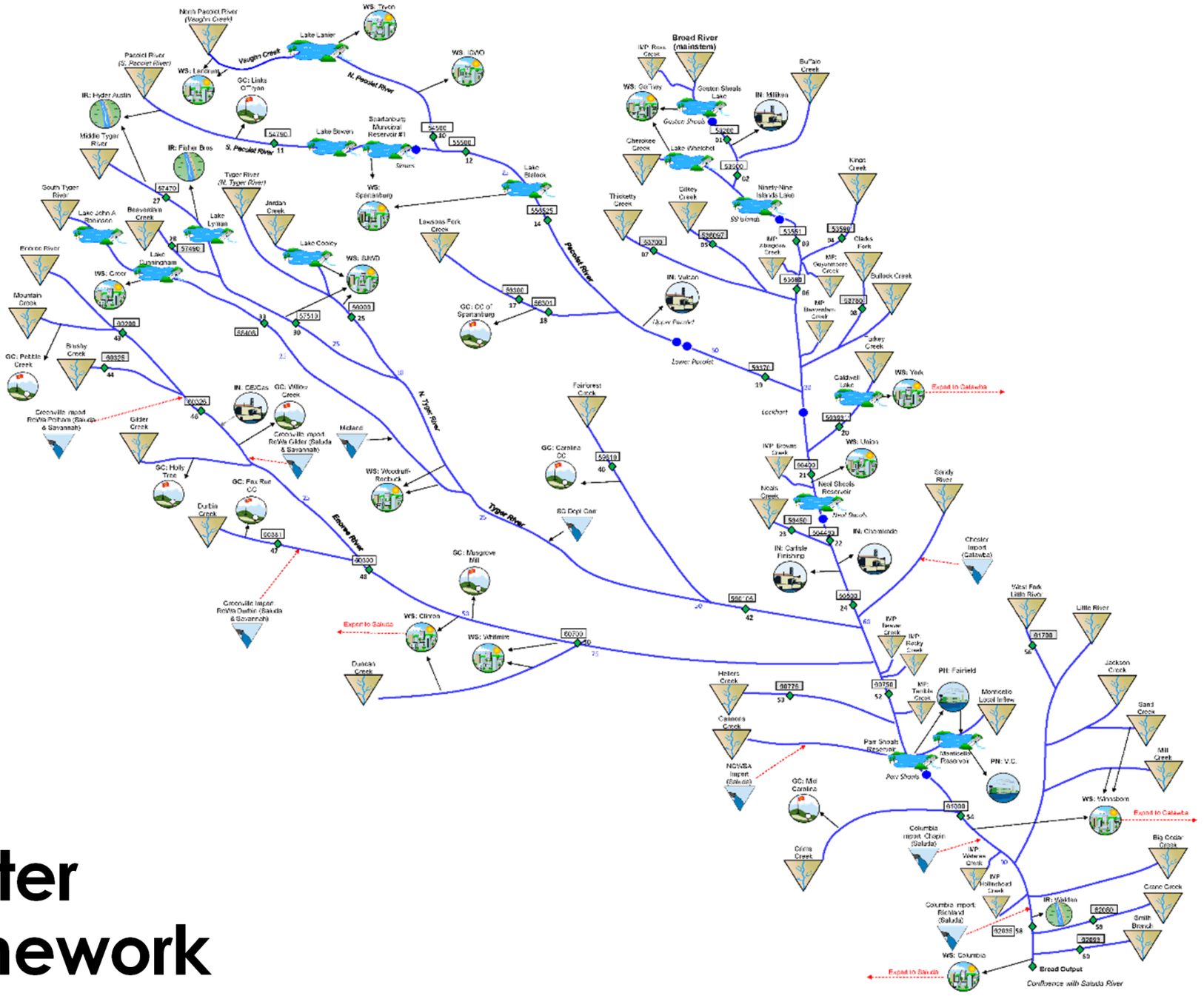
Main Stem and Major Branches



Primary Tributaries



Broad River Surface Water Model Framework

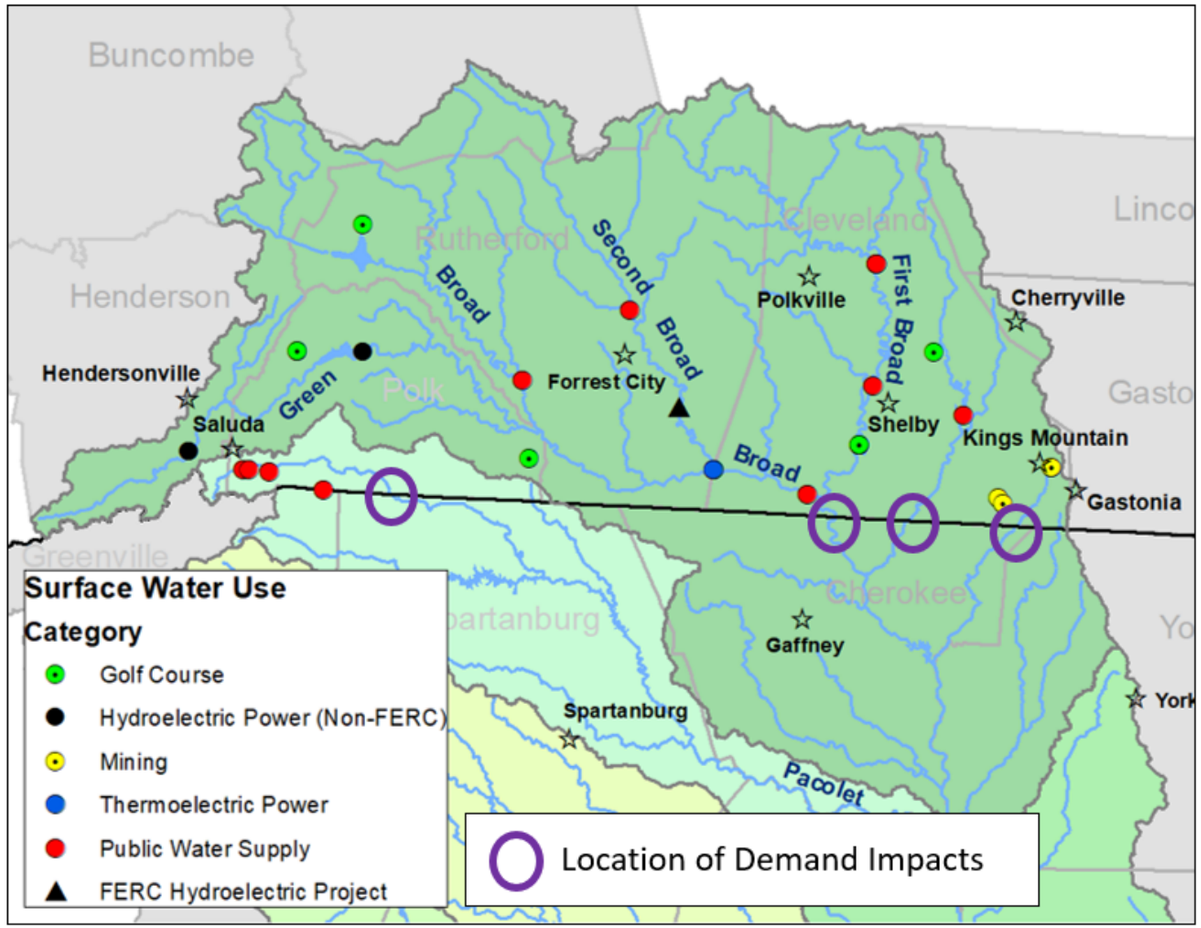


Surface Water Scenarios

Base Scenarios

- Current Surface Water Use Scenario
  - *Uses most recent 10-yr average withdrawals (as reported by month)*
- Permitted and Registered Surface Water Use Scenario
  - *Uses current fully-permitted and registered amounts*
- Moderate Water Demand Projection Scenario
  - *Future water demand projection based on moderate growth and normal climate*
- High Water Demand Projection Scenario
  - *Future water demand projection based on high growth and hot/dry climate*

North Carolina Demands-
4 Subbasins Cross the State Border

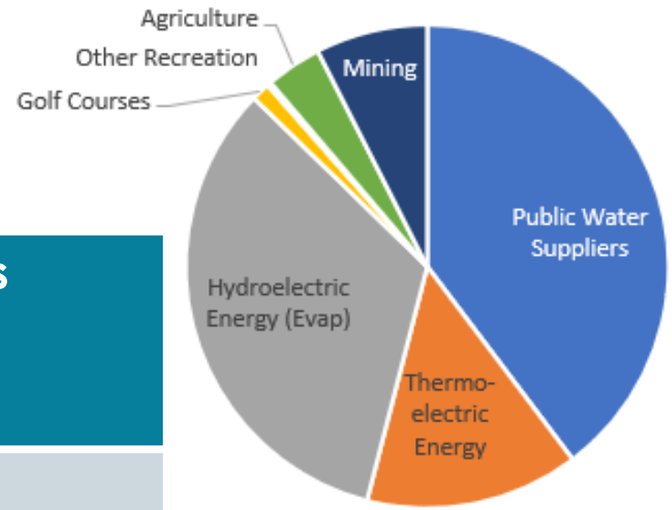


Unimpaired Flow Data Sets

River	1929-2009	2010-2019
North Pacolet	Unimpaired SWAM boundary flow with current use data	
Broad River	Oasis Model	Unimpaired SWAM boundary flow with current use data
Buffalo Creek	Oasis Model	
Kings Creek	Unimpaired SWAM boundary flow with current use data	

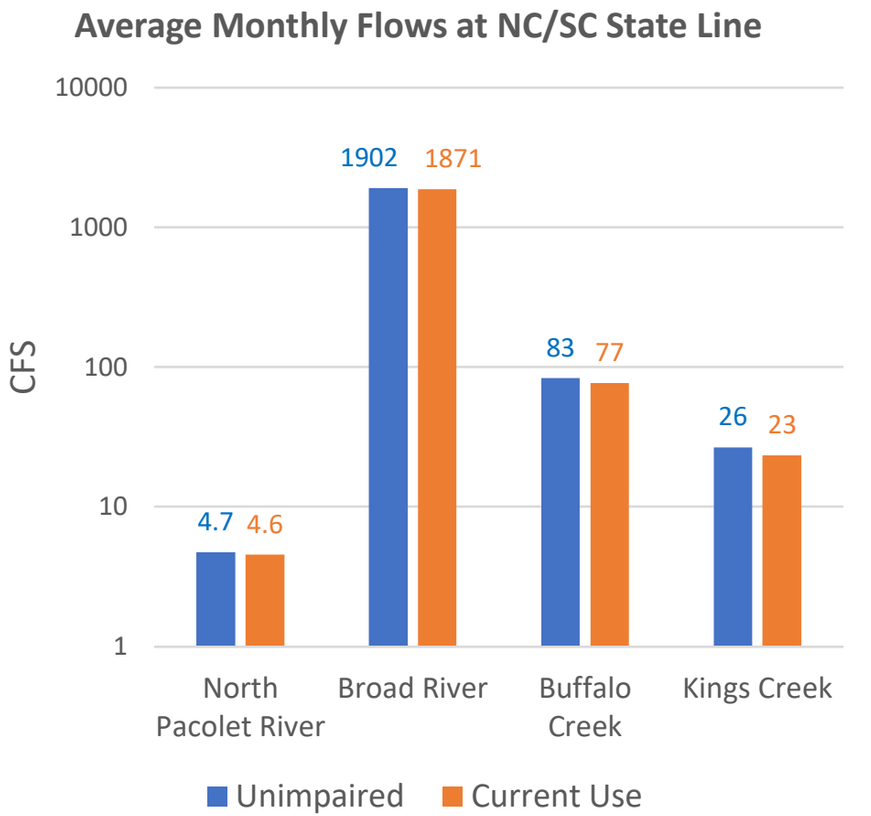
This slide was from Scott Harder's May 2022 presentation to the Broad RBC (Agenda Item 5).

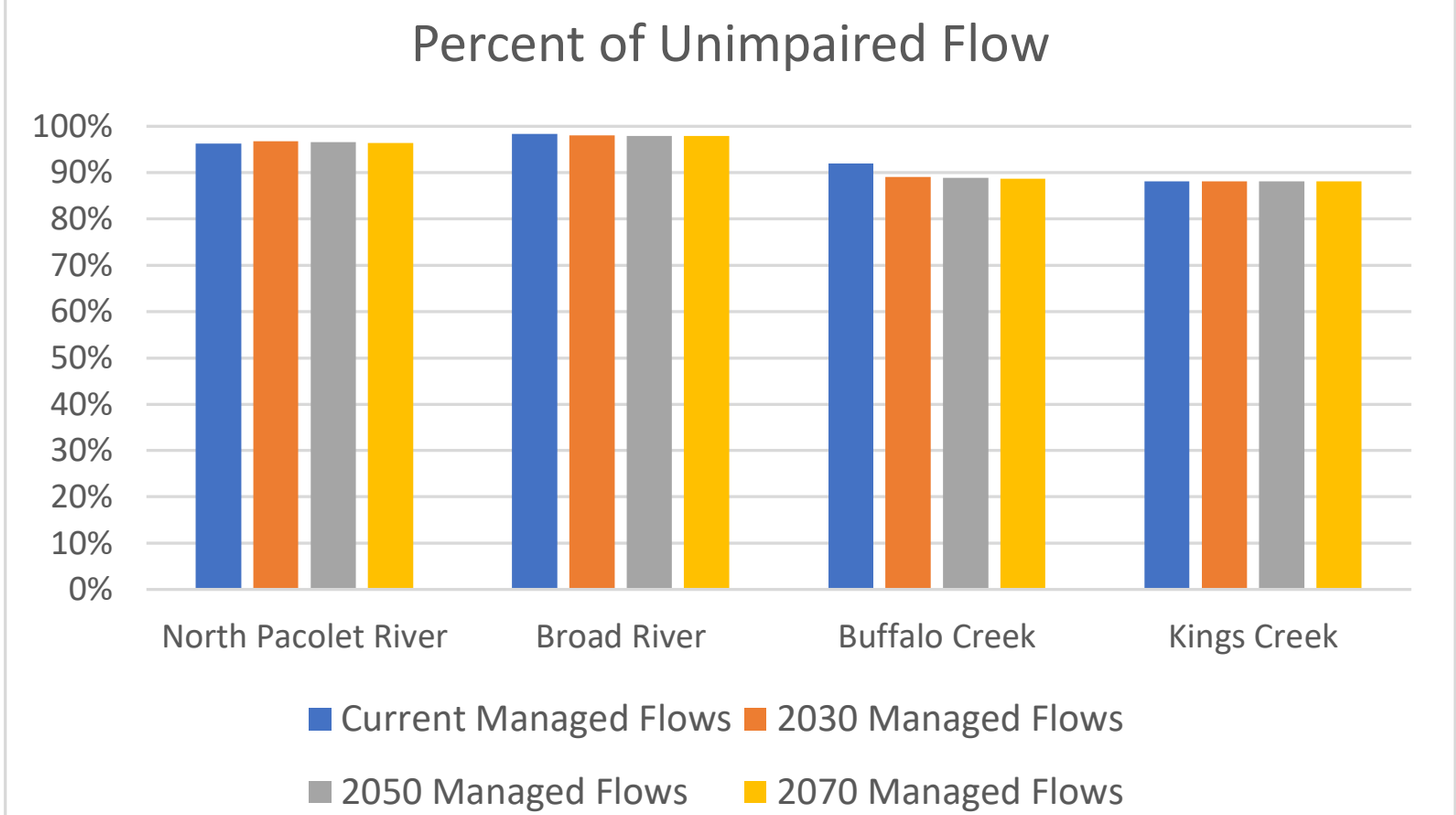
North Carolina Demands - Method and Assumptions



User Type	2020 Demand (Annual Avg mgd)	Information Source	Notes and Assumptions
Public Water Suppliers	16.64	North Carolina Local Water Supply Plans (LWSPs)	• Includes return flow • Projections through 2070
Thermoelectric Energy	6.00	Cliffside: Note from Duke Energy to SCDNR	• Projections constant through 2070
Hydroelectric Energy	13.93	OASIS model documentation (2012)	• No consumption other than reservoir evap • Assumed constant through 2070
Golf Courses	0.52	NCDEQ	• Assumed constant through 2070
Other Recreation	0.11	NCDEQ	• Assumed constant through 2070
Agriculture	1.57	OASIS Model Run (Hazen and Sawyer)	• Assumed constant through 2070
Mining	3.14	NCDEQ	• Assumed constant through 2070

Impacts of North Carolina Demands-
Managed Flow vs. Unimpaired Flow





Summary of Average Annual Demands by Scenario (in MGD)

Water Use Sector	Current Use	Moderate Demand 2070	High Demand 2070	Permitted and Registered
Mining	0.1	0.0	0.1	3.9
Agriculture	0.3	0.3	0.3	8.8
Golf Courses	1.3	1.0	1.8	12.3
Industrial/Manufacturing	3.1	5.7	12.2	14.2
Public Water Supply	92.9	149.2	249.4	640.6
Thermonuclear	711	760	842	864
Total all Sectors*	809	916	1,106	1,543.3
Percent Increase Compared to Current Use:		13%	37%	91%
Total without Thermonuclear*	98	156	264	680
Percent Increase Compared to Current Use:		60%	170%	596%

** Rounded to nearest MGD*

Summary of Average Annual Demands by Scenario (in MGD)

Water Use Sector	Current Use	Moderate Demand 2070	High Demand 2070	Permitted and Registered
Mining	0.1	0.0	0.1	3.9
Agriculture	0.3	0.3	0.3	8.8
Golf Courses				
Industrial/Manufacturing				
Public Water Supply				
Thermonuclear	711	760	842	864
Total all Sectors*	809	916	1,106	1,543.3
Percent Increase Compared to Current Use:		13%	37%	91%
Total without Thermonuclear*	98	156	264	680
Percent Increase Compared to Current Use:		60%	170%	596%

Current total demand in the basin is 52% of the Permitted and Registered Demand

** Rounded to nearest MGD*

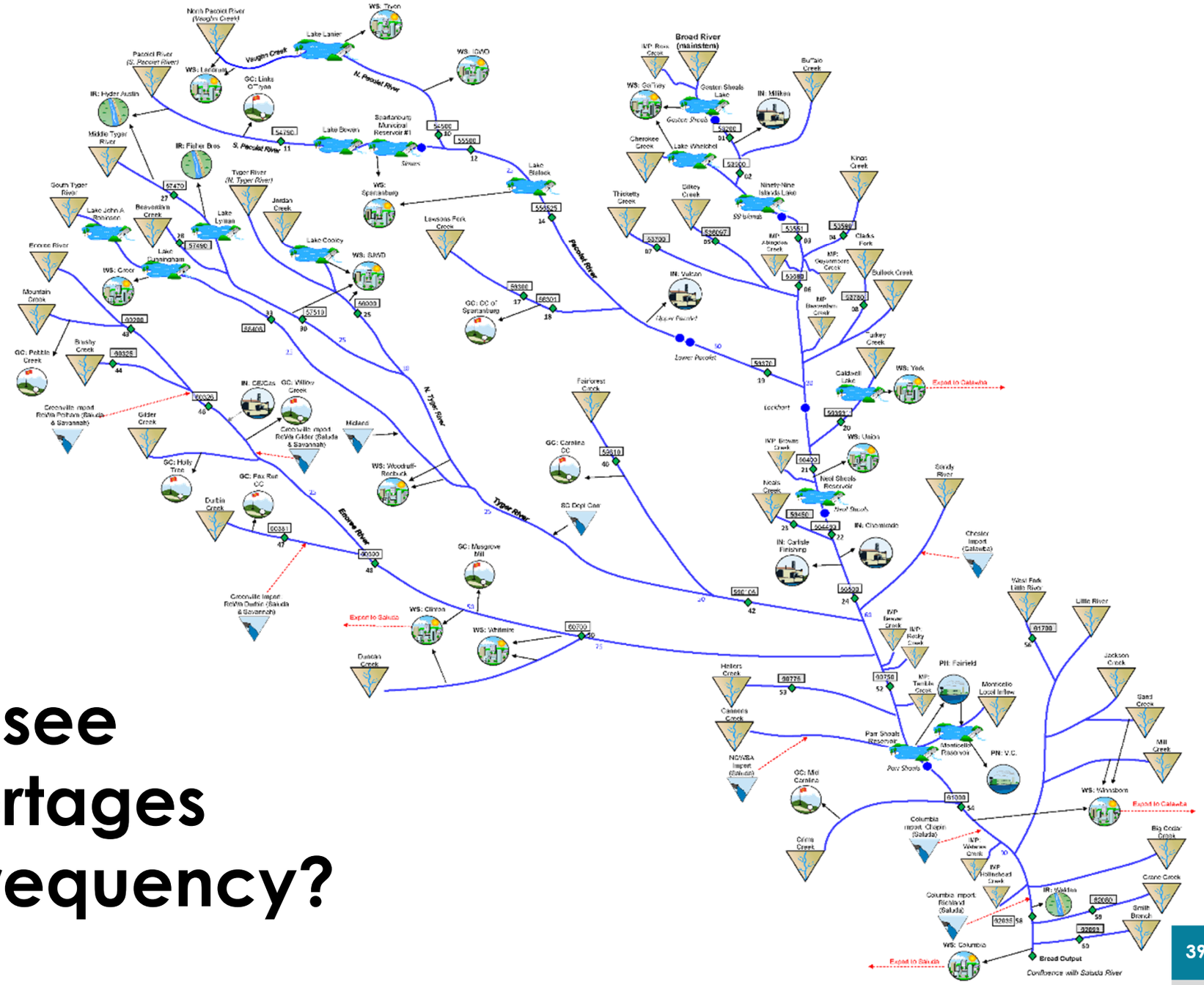
Summary of Average Annual Demands by Scenario (in MGD)

Water Use Sector	Current Use	Moderate Demand 2070	High Demand 2070	Permitted and Registered
Mining	0.1	0.0	0.1	3.9
Agriculture	0.3	0.3	0.3	8.8
Golf Courses	1.3	1.0	1.8	12.3
Industrial/Manufacturing	3.1	5.7	12.2	14.2
Public Water Supply				
Thermonuclear				
Total all Sectors*				
Percent Increase Compared to Current Use:				
Total without Thermonuclear*	98	156	264	680
Percent Increase Compared to Current Use:		60%	170%	596%

Current total demand, not including thermonuclear, is 14% of the Permitted and Registered Demand, not including thermonuclear

** Rounded to nearest MGD*

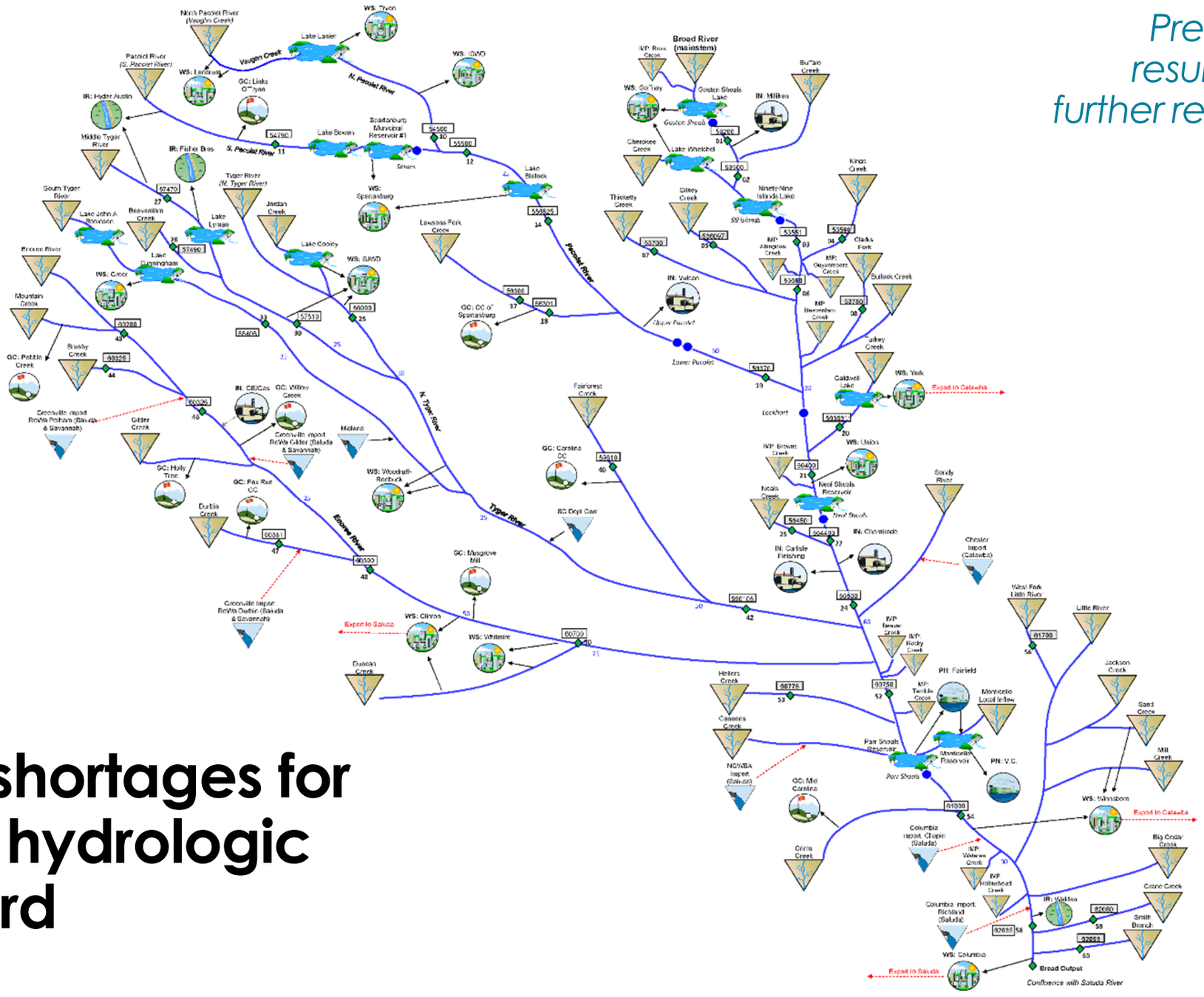
Preliminary Planning Scenario Model Results (monthly timestep)



Where do we see simulated shortages and at what frequency?

Current Use Scenario

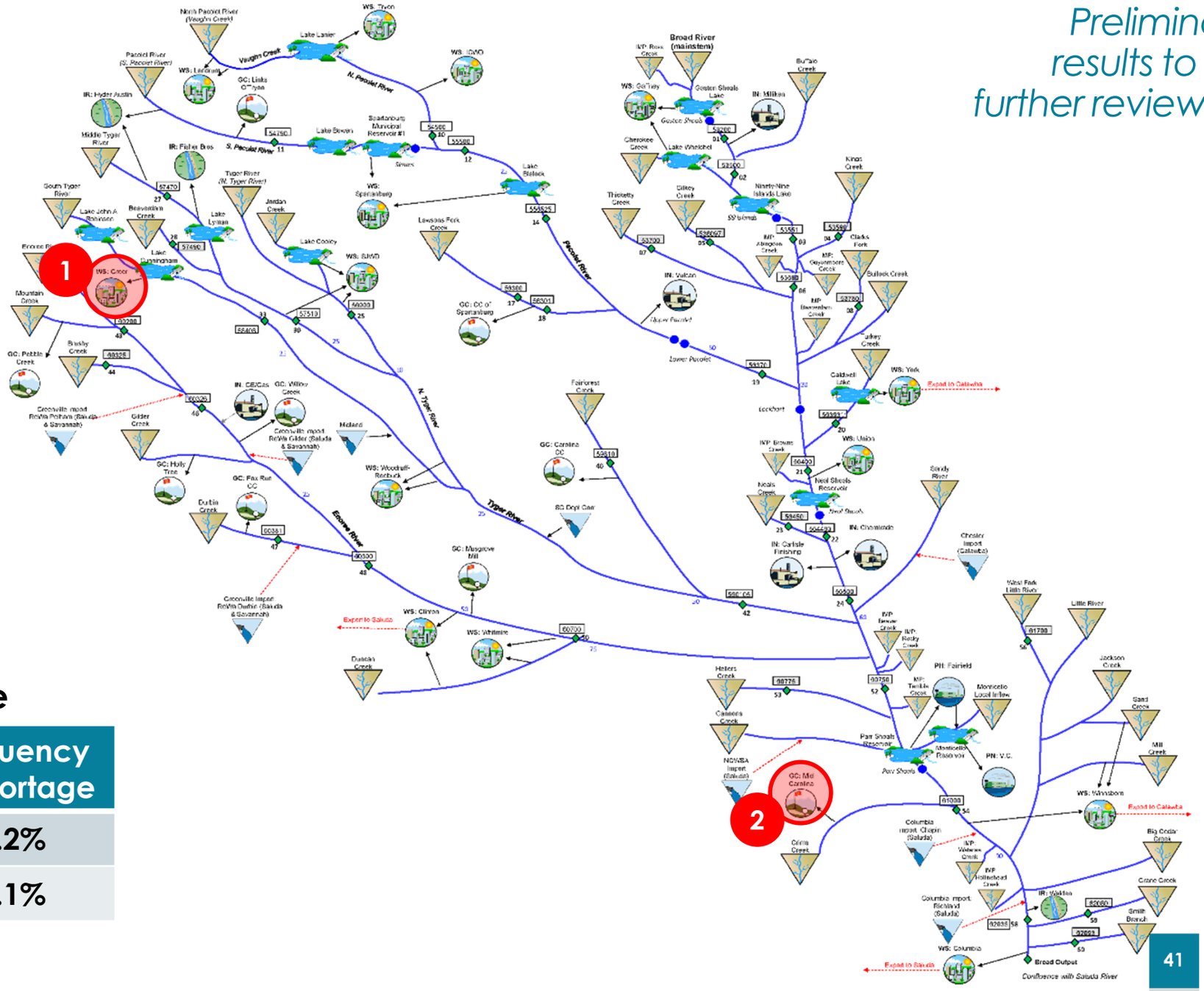
Preliminary results to be further reviewed



No simulated shortages for the 1929-2019 hydrologic period of record

Moderate Demand Scenario 2070

Preliminary results to be further reviewed

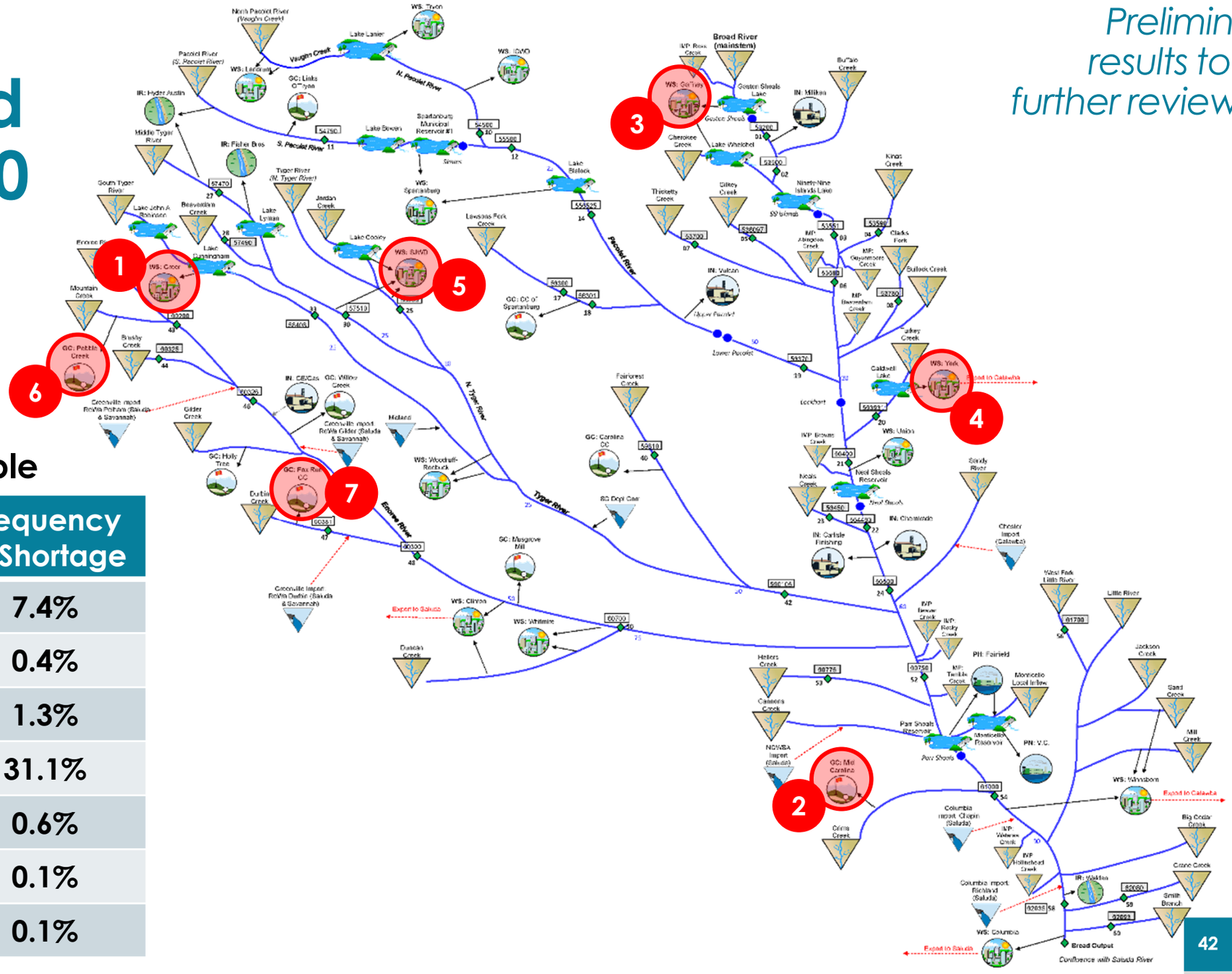


Surface Water Shortage Table

Map ID	Water User	Frequency of Shortage
1	WS: Greer	2.2%
2	GC: Mid Carolina	0.1%

High Demand Scenario 2070

Preliminary results to be further reviewed



Surface Water Shortage Table

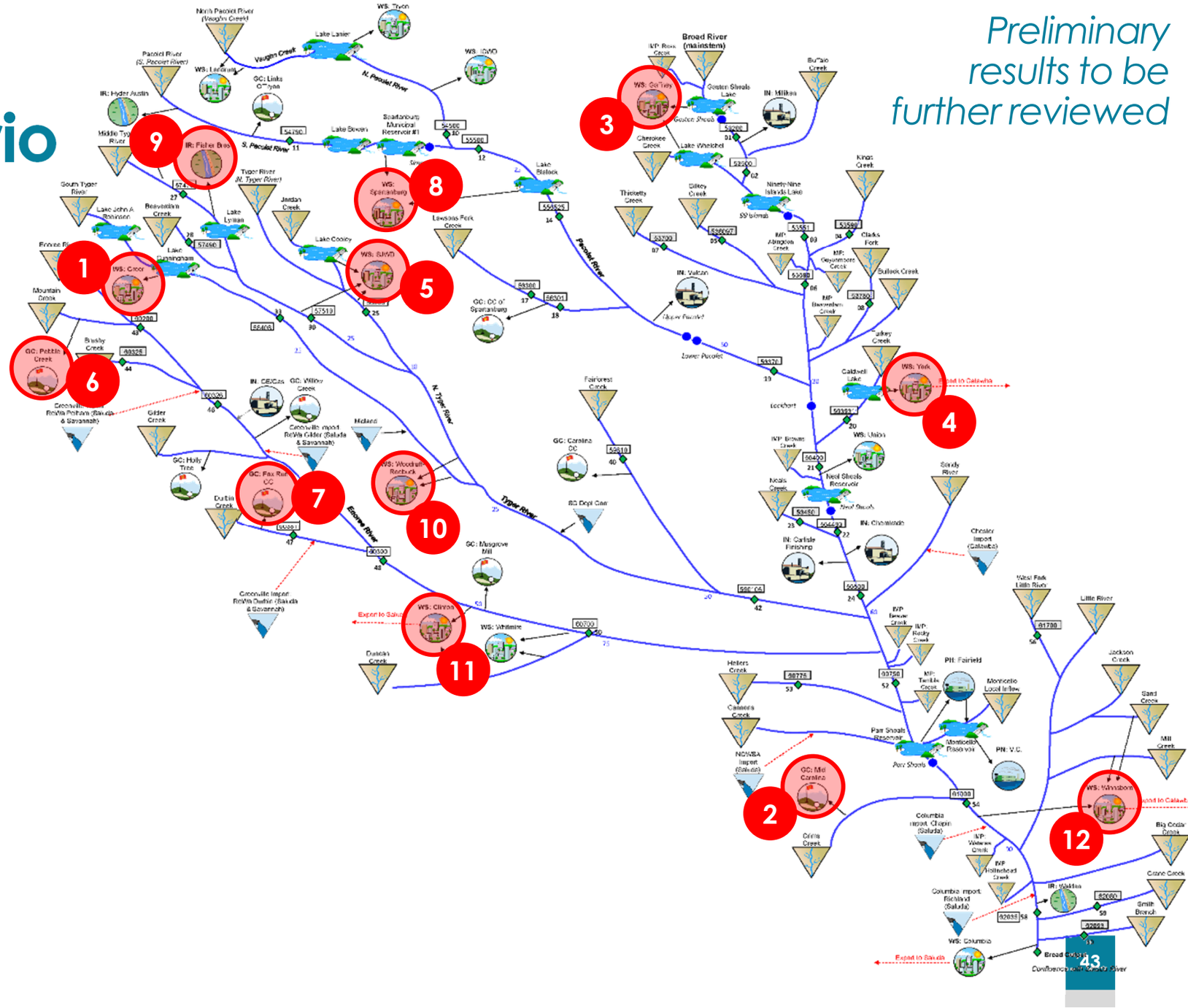
Map ID	Water User	Frequency of Shortage
1	WS: Greer	7.4%
2	GC: Mid Carolina	0.4%
3	WS: Gaffney	1.3%
4	WS: York	31.1%
5	WS: SJWD	0.6%
6	GC: Pebble Creek	0.1%
7	GC: Fox Run	0.1%

Permitted and Registered Scenario

Preliminary results to be further reviewed

Surface Water Shortage Table

Map ID	Water User	Frequency of Shortage
1	WS: Greer	47.4%
2	GC: Mid Carolina	33.5%
3	WS: Gaffney	7.0%
4	WS: York	13.3%
5	WS: SJWD	94.3%
6	GC: Pebble Crk	9.0%
7	GC: Fox Run	1.7%
8	WS: Spartanburg	91.2%
9	IR: Fisher Bros	1.8%
10	WS: Woodruff-Roebuck	0.2%
11	WS: Clinton	3.5%
12	WS: Winnsboro	89.2%

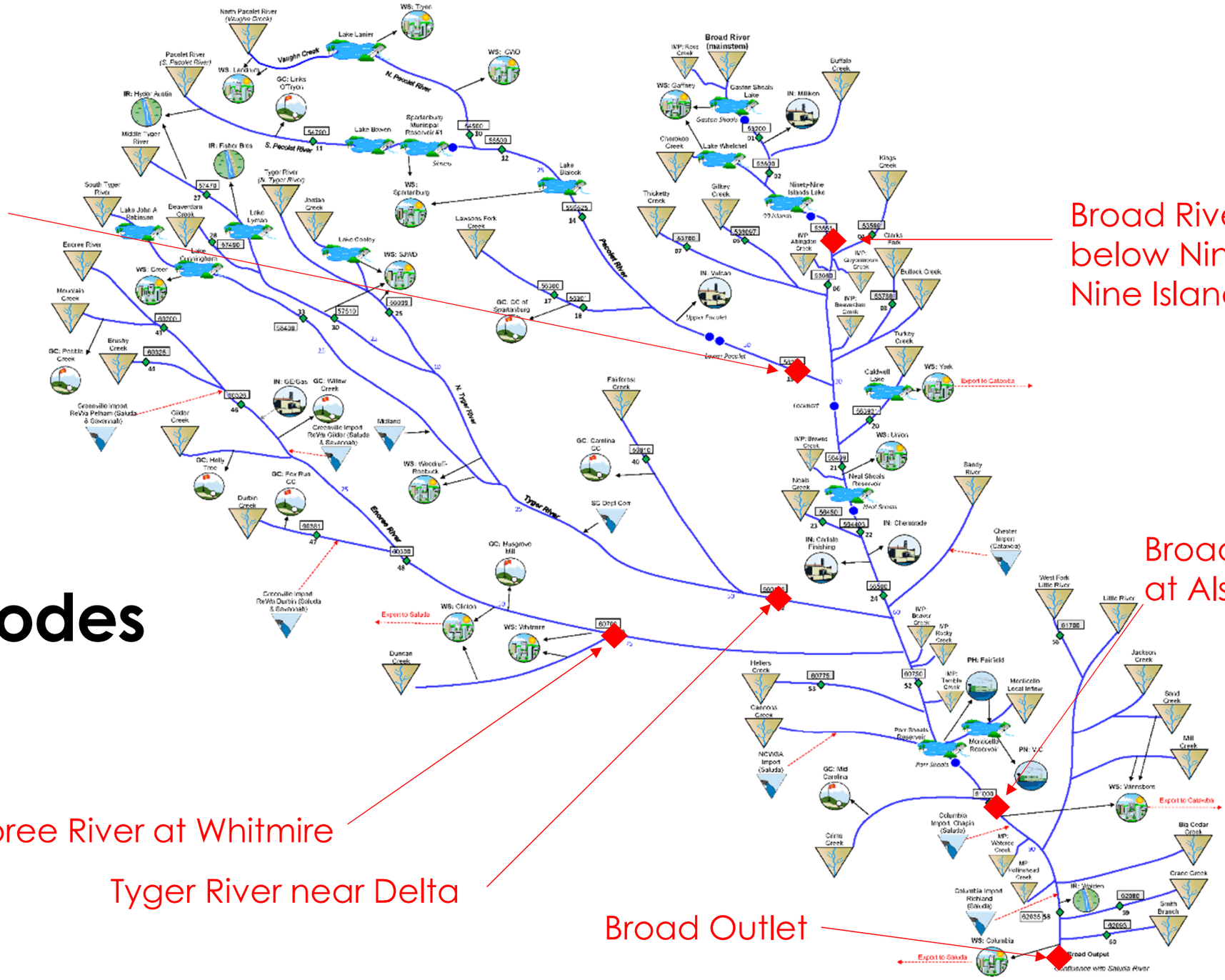


Summary of Surface Water Supply Shortages

Supply Shortage Metric	Current Use	Moderate Demand 2070	High Demand 2070	Permitted & Registered
Total basin annual mean shortage (MGD)	0.0	0.1	1.7	129.6
Maximum water user shortage (MGD)	0.0	10.4	27.8	263.9
Total basin annual mean shortage as a percentage of total water demand	0.0%	0.0%	0.2%	8.4%
Percentage of water users experiencing a shortage	0.0%	3.1%	21.9%	37.5%
Average frequency of shortage (%)	0.0%	2.2%	5.9%	32.7%

Supply shortage summary does not include Fairfield Pumped Storage Facility

Strategic Nodes



Simulated Flows at Strategic Nodes

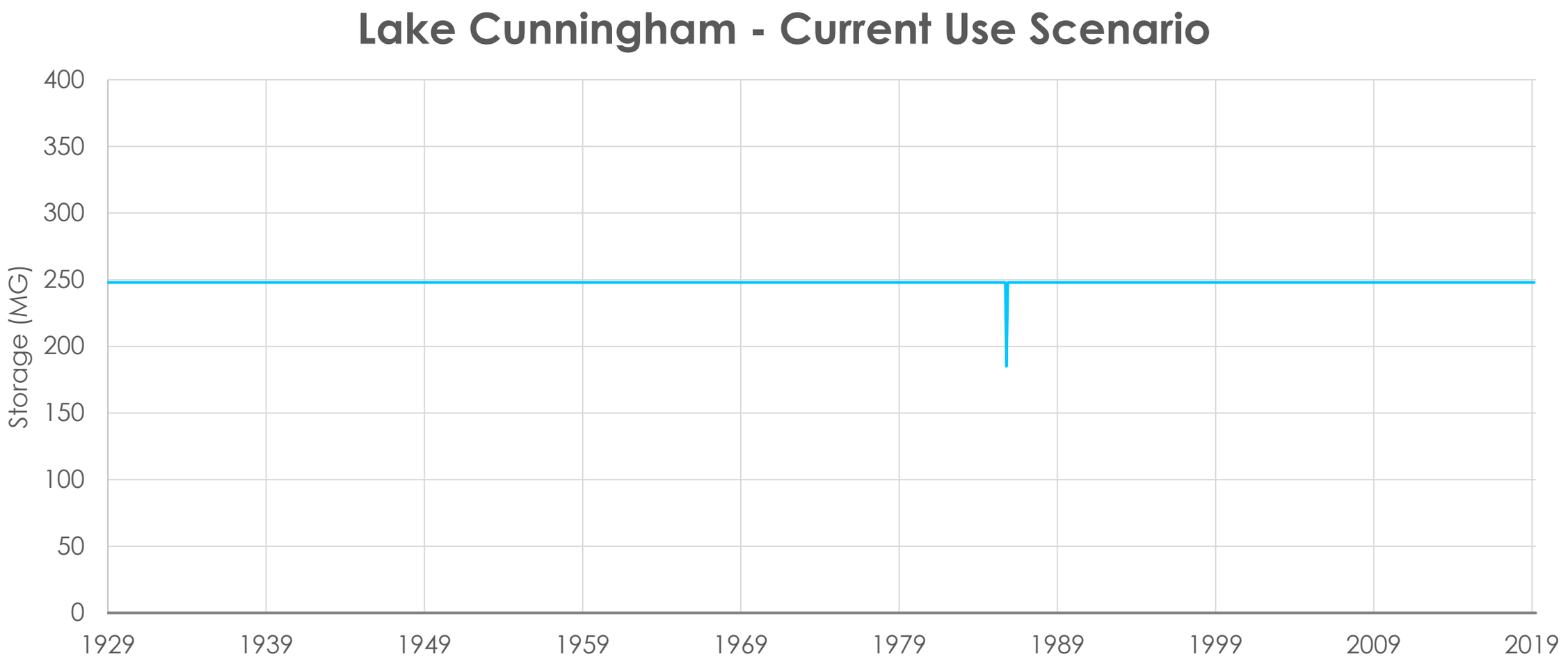
Performance Measure	BRD03 Broad River below Ninety-Nine Island Reservoir	BRD54 Broad River at Alston	Broad River Output Flow	BRD19 Pacolet River near Saratt	BRD42 Tyger River near Delta	BRD50 Enoree River at Whitmire
	All values in CFS					
Current Use Scenario						
mean flow	2,323	5,439	5,836	654	777	487
median flow	1,968	4,534	4,748	548	636	400
25th percentile flow	1,385	2,963	3,091	364	418	270
10th percentile flow	945	1,997	2,061	231	269	187
5th percentile flow	744	1,537	1,580	182	197	153
Moderate Demand Scenario						
mean flow	2,288	5,374	5,754	632	758	501
median flow	1,929	4,463	4,698	523	617	413
25th percentile flow	1,363	2,886	3,004	334	399	283
10th percentile flow	911	1,917	1,973	221	245	199
5th percentile flow	723	1,505	1,554	174	177	165
High Demand Scenario						
mean flow	2,271	5,300	5,640	610	737	502
median flow	1,905	4,375	4,550	498	595	416
25th percentile flow	1,341	2,810	2,893	313	370	284
10th percentile flow	906	1,863	1,863	213	224	201
5th percentile flow	700	1,427	1,448	163	162	165
P&R Scenario						
mean flow	2,255	5,019	5,255	471	667	470
median flow	1,892	4,073	4,157	368	522	383
25th percentile flow	1,320	2,666	2,637	244	323	252
10th percentile flow	881	1,745	1,649	175	197	169
5th percentile flow	704	1,331	1,260	133	141	132

Simulated Difference in Flows at Strategic Nodes from Current Use Scenario

Performance Measure	BRD03 Broad River below Ninety-Nine Island Reservoir	BRD54 Broad River at Alston	Broad River Output Flow	BRD19 Pacolet River near Saratt	BRD42 Tyger River near Delta	BRD50 Enoree River at Whitmire
	All values in CFS					
Current Use Scenario						
mean flow	2,323	5,439	5,836	654	777	487
median flow	1,968	4,534	4,748	548	636	400
25th percentile flow	1,385	2,963	3,091	364	418	270
10th percentile flow	945	1,997	2,061	231	269	187
5th percentile flow	744	1,537	1,580	182	197	153
Moderate Demand Scenario minus Current Use Scenario						
mean flow	-35	-65	-82	-22	-19	13
median flow	-39	-70	-50	-25	-19	13
25th percentile flow	-23	-77	-87	-30	-19	13
10th percentile flow	-34	-80	-89	-11	-24	13
5th percentile flow	-21	-32	-26	-8	-20	12
High Demand Scenario minus Current Use Scenario						
mean flow	-52	-139	-196	-44	-40	15
median flow	-63	-158	-199	-50	-41	16
25th percentile flow	-45	-153	-198	-50	-47	14
10th percentile flow	-39	-134	-198	-19	-45	14
5th percentile flow	-44	-109	-131	-19	-35	12
P&R Scenario minus Current Use Scenario						
mean flow	-69	-420	-580	-183	-110	70
median flow	-76	-461	-592	-180	-114	113
25th percentile flow	-65	-297	-454	-119	-94	65
10th percentile flow	-64	-252	-412	-57	-72	16
5th percentile flow	-41	-206	-320	-49	-56	132

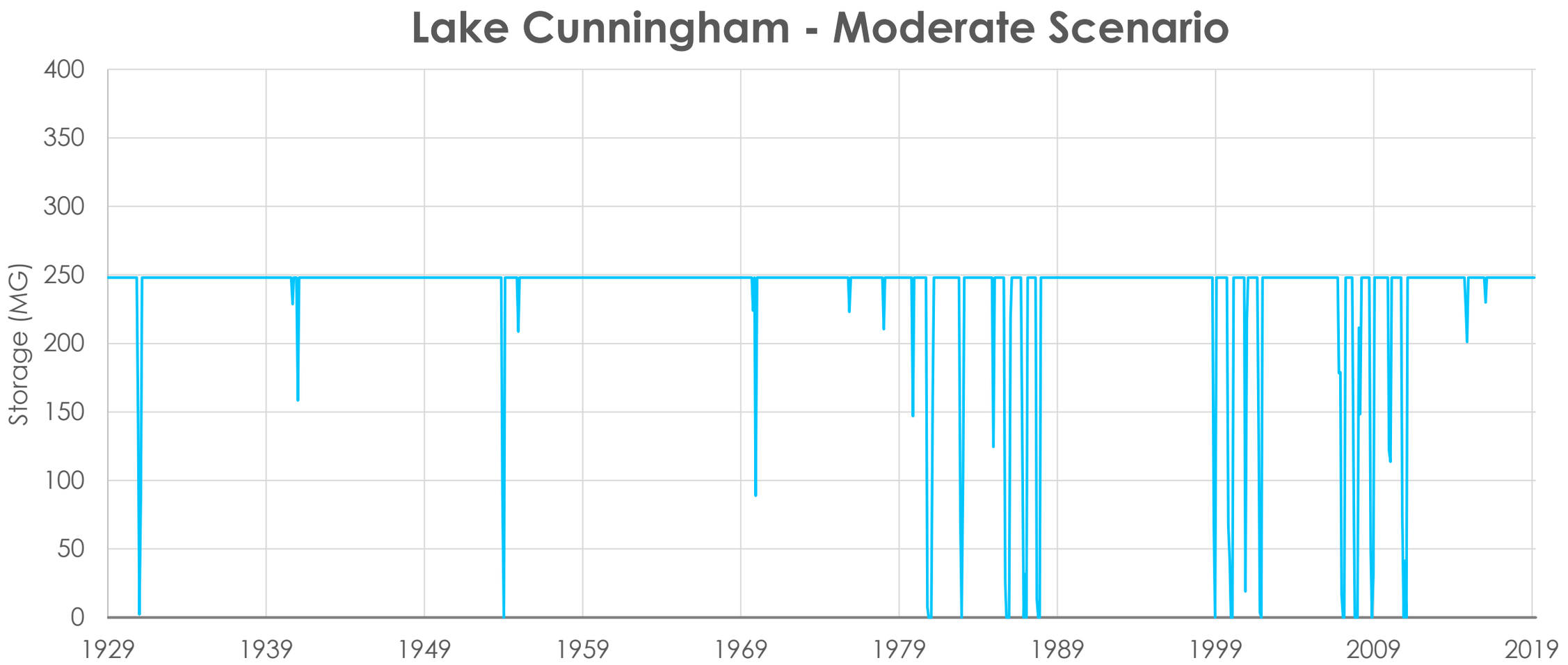
WS: Greer average annual demand is 8.9 MGD

Reservoir Storage (Example)



Reservoir Storage (Example)

WS: Greer average annual demand is 16.3 MGD
Frequency of Shortage: 2.2% (24 months)



Reservoir Storage (Example)

WS: Greer average annual demand is 23.0 MGD
Frequency of Shortage: 7.4% (80 months)