



## Memorandum

*To: SCDNR*

*From: CDM Smith*

*Date: June 21, 2021*

*Subject: 2021 Broad SWAM Model Updates*

### 1.0 Introduction and Overview

The Broad Basin baseline water allocation model was updated to incorporate newly available water use and return data and to extend the baseline hydrologic period of the model. Model updates included recalculating baseline 10-year average water demands (2010 – 2019) for all water users, adding new water users, removing water users with inactive permits and extending the baseline simulation period from January 2014 through December 2019. Extending the baseline simulation period required using recent USGS streamflow gage data, combined with water use and return data and area transposition methods, to “un-impair” flow records and generate un-impaired model headwater boundary condition flows. Updated downstream flow records were then used to validate model hydrologic parameterization.

The result of this work is an updated model with more recent representation of water demands in the basin and a larger range of hydrologic variability captured by the simulation period. Previously calibrated hydrologic parameters throughout the basin were validated with comparisons of modeled and gaged flows for the simulation extension period.

The Broad Basin baseline water allocation model was also updated to incorporate recent enhancements to SWAM, the most significant being the addition of a scenario planning module.

### 2.0 Model Object Changes

**Table 1** (all tables and figures are included in **Attachment A**) lists the explicit tributaries and the gages and reference gages used for computing headwater flows. **Table 2** lists the implicit tributaries and their reference gages used for confluence flows. No new explicit or implicit tributaries were added as part of this update. **Table 3** lists all tributary objects, their confluence location, drainage area, headwater area, drainage area ratio and subbasin flow factors. **Table 4** lists the reservoir inputs. The evaporation time series was updated for each reservoir through 2019. One new reservoir was added, Lake Lanier, on Vaughn Creek (North Pacolet River). Since no information characterizing this reservoir’s volume or area-capacity relationship was available, a simple area-capacity relationship was developed based on estimates of reservoir surface area and

depth. **Table 5** lists the reservoir area-capacity relationship for all reservoirs. **Table 6** lists the advanced reservoir operating rules, as they apply to select reservoirs.

New water users represent those that are newly registered or have just recently surpassed the minimum water use threshold for inclusion in the model of 3 million gallons per month (MGM). Water demands associated with the new users were quantified based on the South Carolina Department of Health and Environmental Control (DHEC) reported water use and discharge databases. **Table 7** lists the surface water user objects included in the model and their sources of supply. Water demands are specified in the baseline model as monthly mean values for all water user objects.

To facilitate DNR model review, responses to SCDNR inquiries and suggested model updates from correspondence dated February 22, 2021, are included in **Attachment B**.

### 3.0 Baseline Period Extension

The baseline simulation period was extended by six years, from 1929 – 2013 to 1929 – 2019. For the extension, model boundary condition (headwater) flows were developed for the additional six years, on both a monthly and daily timestep. As done for the original model development, un-impaired gaged flow data were used to estimate flows at ungaged model input locations. The un-impairment process exactly followed the process detailed elsewhere (CDM Smith, 2016) whereby un-impaired flows were calculated by adding in all known upstream consumptive water withdrawals and subtracting out upstream discharges from a downstream USGS gaged flow record. The statistical methods employed, and the assignment of reference gages, are described elsewhere (CDM Smith, 2016).

The USGS gages serve as key reference points for ungaged flow estimates at model input points. Area transposition methods, based on ratios of drainage areas, were used to estimate monthly and daily flows for the period extension, for key model headwater input locations. Again, the assignment of reference gages for this exercise matched that employed during the original model development. Flows prior to 2014 were unchanged in the model.

In addition to extending model flow inputs, water demand estimates were updated to more accurately reflect current conditions. New baseline water demand, discharge and consumptive use estimates for the 10-year period 2010 through 2019 were developed using the DHEC reported water use and discharge data. These calculations were consistent with methodologies employed for the original baseline model development (CDM Smith, 2017). Updated mean monthly water demands and discharge parameters were entered into the model for all water user objects. The updated baseline water demands are provided in **Table 8** for industrial (IN), mining (MI), power/hydro (PH), power/nuclear (PN) and water supply (WS) users and in **Table 9** for agriculture (IR) and golf course (GC) users. Model return (discharge) locations are listed in **Table 10**. Updated consumptive use percentages are provided in **Table 11** and updated return flows for discharge objects are provided in **Table 12**.

## 4.0 Model Validation

Existing model hydrologic parameters throughout the basin were validated using data associated with the extended simulation period. Comparison of modeled and gaged flow for the extension period (2014 – 2019) returned satisfactory results for a subset of basin gages selected for analysis, thereby validating previous calibration work. Model validation results for the extension period that were generated using the updated baseline model are provided in **Attachment C**. Only graphs for a select subset of gages with available daily flow data for the 2014 – 2019 extension period are provided. Graphs depict the comparison of mean monthly and daily model simulated flows versus reported gage flows in cubic feet per second.

## 5.0 References

CDM Smith, 2016. Technical Memorandum – Methodology for Unimpaired Flow Development Broad River Basin, South Carolina

CDM Smith, 2016. Technical Memorandum - Unimpaired Flow Dataset for the Broad River Basin.

CDM Smith, 2017. South Carolina Surface Water Quantity Models – Broad River Basin Model.

2021 Broad SWAM Model Updates

Attachment A

Tables

**Table 1. Gages and Reference Gages Used for Headwater Flows on Explicit Tributaries**

Project ID	Headwater Input			USGS Reference Gage (Unimpaired)		
	Type	USGS Number	SWAM Tributary	Project Gage ID	USGS Number	Stream
Node 500	OASIS output <sup>1</sup>	-	Mainstem	-	0215100	Boiling Springs (NC)
Node 610	OASIS output <sup>1</sup>	-	Buffalo Creek	-	02143500	Indian Creek (NC)
BRD201	Ungaged	-	Cherokee Creek	BRD07	02153700	Thicketty Creek
BRD209	Ungaged	-	Bullock Creek	BRD08	02153780	Clarks Fork
BRD210	Ungaged	-	North Pacolet River	BRD10	02154500	North Pacolet
BRD211	Ungaged	-	Pacolet River	BRD11	02154790	Pacolet River
BRD216	Ungaged	-	Lawsons Fork Creek	BRD16	02156050	Lawsons Fork
BRD220	Ungaged	-	Turkey Creek	BRD20	021563931	Turkey Creek
BRD225	Ungaged	-	Jordan Creek	BRD25	02156999	Tyger River
BRD227	Ungaged	-	Middle Tyger River	BRD27	02157470	Middle Tyger River
BRD233	Ungaged	-	South Tyger River	BRD34	02158410	South Tyger River
BRD239	Ungaged	-	Fairforest Creek	BRD42	02160105	Tyger River
BRD226	Ungaged	-	Tyger River			
BRD243	Ungaged	-	Mountain Creek	BRD44	02160325	Brushy Creek
BRD248	Ungaged	-	Enoree River	BRD48	02160390	Enoree River
BRD246	Ungaged	-	Gilder Creek	BRD47	02160381	Durbin Creek
BRD247	Ungaged	-	Durbin Creek			
BRD250	Ungaged	-	Duncan Creek			
BRD254	Ungaged	-	Cannons Creek	BRD53	02160775	Hellers Creek
BRD255	Ungaged	-	Crims Creek			
BRD224	Ungaged	-	Sandy River			
BRD263	Ungaged	-	Little River			
BRD401	Ungaged	-	Monticello Local Inflow	BRD56	02161700	West Fork Little River
BRD257	Ungaged	-	Big Cedar Creek	BRD57	02162010	Cedar Creek
BRD260	Ungaged	-	Sand Creek			
BRD261	Ungaged	-	Jackson Creek			
BRD262	Ungaged	-	Mill Creek			
BRD04	Gaged	02153590	Kings Creek	-	-	-
BRD05	Gaged	021536097	Gilkey Creek	-	-	-
BRD07	Gaged	02153700	Thicketty Creek	-	-	-
BRD08	Gaged	02153780	Clarks Fork	-	-	-
BRD23	Gaged	02156450	Neals Creek	-	-	-
BRD28	Gaged	02157490	Beaverdam Creek	-	-	-
BRD44	Gaged	02160325	Brushy Creek	-	-	-
BRD53	Gaged	02160775	Hellers Creek	-	-	-
BRD56	Gaged	02161700	West Fork Little River	-	-	-
BRD59	Gaged	02162080	Crane Creek	-	-	-
BRD60	Gaged	02162093	Smith Branch	-	-	-

<sup>1</sup> OASIS Model output was available up to Oct 2009. The listed reference gage was used to compute flows from Oct 2009 through Dec 2019.

**Table 2. Reference Gages Used for Confluence Flows on Implicit Tributaries**

	Ungaged Basin	USGS Reference Gage (Unimpaired)		
Project ID	SWAM Tributary	Project Gage ID	USGS Number	Stream
BRD301	Ross Creek	BRD04	02153590	Kings Creek
BRD305	Guyonmoore Creek	BRD08	02153780	Clarks Fork
BRD307	Abingdon Creek			
BRD309	Beaverdam Creek			
BRD311	Browns Creek	BRD23	02156450	Neals Creek
BRD313	Beaver Creek	BRD53	02160775	Hellers Creek
BRD315	Rocky Creek			
BRD317	Terrible Creek			
BRD319	Wateree Creek	BRD57	02162010	Cedar Creek
BRD321	Hollinshead Creek			

**Table 3. Model Tributary Inputs**

SWAM Tributary Object	Tributary Type	Confluence Stream	Confluence Location (mile)	Area (ac)	Head-water ID	End Mile	Original Drainage Ratio	Subbasin Flow Factor (unitless)
Broad River (Mainstem)	Explicit	None	None	3,412,000	None	8	-	0.02*
						47.9	-	-0.001*
						53.3	-	0.001*
						80.4	-	0*
						500	-	0*
Beaverdam Creek	Explicit	Middle Tyger River	15.2	10,350	BRD28	0.3	1.0	1.0
Big Cedar Creek	Explicit	Mainstem	94.5	61,529	BRD257	20	23.6	23.6
Brushy Creek	Explicit	Enoree River	8.8	9,622	BRD44	5.5	1.6	2.0
Buffalo Creek	Explicit	Mainstem	6.3	113,347	Node 610	6.5	1.5	1.8
Bullock Creek	Explicit	Mainstem	29.1	72,085	BRD209	11.1	1.9	1.9
Cannons Creek	Explicit	Mainstem	77.4	43,023	BRD254	7.8	1.6	1.6
Cherokee Creek	Explicit	Mainstem	8.6	14,876	BRD201	1.9	1.5	6
						7.2	2.1	2.1
Clarks Fork	Explicit	Bullock Creek	0.1	27,248	BRD08	10	1.8	1.8
Crane Creek	Explicit	Mainstem	102.4	41,602	BRD59	1.1	1.0	1.0
Crims Creek	Explicit	Mainstem	80.4	21,949	BRD255	11	11.7	11.7
Duncan Creek	Explicit	Enoree River	75	76,647	BRD250	25.2	7.1	7.1
Durbin Creek	Explicit	Enoree River	32.3	33,279	BRD247	2.6	3.4	3.4
						11.5	13.7	13.7
Enoree River	Explicit	Mainstem	65.5	468,153	BRD248	0.8	1.0	1.55
						9.2	1.5	2
						33	3.7	3
						73.1	8.9	5
						92.7	13.4	7.4
Fairforest Creek	Explicit	Tyger River	50.7	139,857	BRD239	11.4	11.3	10.2
						22.2	27.2	24.5
						35.3	55.2	49.6
						46.5	69.5	55
Gilder Creek	Explicit	Enoree River	18.1	20,378	BRD246	8.3	2.8	2.8
Gilkey Creek	Explicit	Thicketty Creek	23.7	17,177	BRD05	4.8	1.3	1.3
Hellers Creek	Explicit	Mainstem	74	26,160	BRD53	10.8	4.9	4.9
Indian Creek	Explicit	Enoree River	82.5	62,182	BRD51	6.5	1.5	1.5
Jackson Creek	Explicit	Little River	5.9	22,437	BRD261	8.1	12.6	12.6
Jordan Creek	Explicit	Tyger River	0.1	8,084	BRD225	4.7	4.2	4.2
Kings Creek	Explicit	Mainstem	15.4	43,792	BRD04	10.8	2.5	2.5
Lawsons Fork Creek	Explicit	Pacolet River	40.1	54,463	BRD216	20.5	17.5	18
						27.1	20.0	18
Little River	Explicit	Mainstem	90.7	150,558	BRD263	24.6	2.2	2.2
Middle Tyger River	Explicit	Tyger River	10.6	54,673	BRD227	9.7	7.0	7
						14.4	9.7	8.5
						21.8	11.3	10.6
						34.5	14.8	14.8

**Table 3. Model Tributary Inputs (continued)**

SWAM Tributary Object	Tributary Type	Confluence Stream	Confluence Location (mile)	Area (ac)	Head-water ID	End Mile	Original Drainage Ratio	Subbasin Flow Factor (unitless)
Mill Creek	Explicit	Little River	10	11,599	BRD262	8	3.3	3.3
Monticello Local Inflow	Explicit	Mainstem	78	11,243	BRD400	8	1.0	0.9
Mountain Creek	Explicit	Enoree River	10.2	7,554	BRD243	5.1	3.1	7
Neals Creek	Explicit	Mainstem	48.1	8,036	BRD23	0.9	1.0	1.0
North Pacolet River	Explicit	Pacolet River	18.5	74,997	BRD210	25.2	44.0	44
						27	45.2	45.2
Pacolet River	Explicit	Mainstem	30.5	329,990	BRD211	6.3	4.0	4.1
						18.7	6.7	6.4
						28.1	11.2	9.5
						40	15.5	13
						68	22.8	16
Sand Creek	Explicit	Jackson Creek	2.9	4,200	BRD260	3.9	5.0	5.0
Sandy River	Explicit	Mainstem	55.1	100,753	BRD224	16.1	4.4	4.4
Smith Branch	Explicit	Mainstem	103	4,759	BRD60	2.1	1.3	1.3
South Tyger River	Explicit	Tyger River	22.3	107,411	BRD233	7.3	3.9	3.9
						14.7	5.7	5.7
						21.7	7.8	7.7
						46.3	13.7	10.7
Thicketty Creek	Explicit	Mainstem	25.6	100,885	BRD07	26.2	5.4	5.4
Turkey Creek	Explicit	Mainstem	38.3	91,831	BRD220	1.3	1.2	2
						12.3	13.1	14.0
						17.9	17.3	18.0
						24.8	30.3	30.3
Tyger River	Explicit	Mainstem	60.7	515,006	BRD226	2.2	1.1	1.4
						10.5	2.6	2.6
						22.2	3.9	3.9
						50.6	10.7	7
						68.7	16.7	10
West Fork Little River	Explicit	Little River	0.1	21,394	BRD56	3.4	1.3	1.3
Abingdon Creek	Implicit	Mainstem	20.8	8,738	none	0	1.0	1.0
Beaver Creek	Implicit	Mainstem	65.8	27,946	none	0	1.0	1.0
Beaverdam Creek	Implicit	Mainstem	26.3	4,115	none	0	1.0	1.0
Browns Creek	Implicit	Mainstem	42.1	33,975	none	0	1.0	1.0
Guyonmoore Creek	Implicit	Mainstem	19.5	6,644	none	0	1.0	1.0
Hollinshead Creek	Implicit	Mainstem	94.4	10,963	none	0	1.0	1.0
Rocky Creek	Implicit	Mainstem	67.1	7,186	none	0	1.0	1.0
Ross Creek	Implicit	Mainstem	2.2	11,212	none	0	1.0	1.0
Terrible Creek	Implicit	Mainstem	70.5	7,290	none	0	1.0	1.0
Wateree Creek	Implicit	Mainstem	85.8	16,623	none	0	1.0	1.0

*\*On the Mainstem, these are referred to as "gain/loss factors", not "subbasin flow factors".*

**Table 4. Reservoir Inputs**

Reservoir	Purpose	Receiving Stream	Temperature Station for Evaporation	Evaporation Station	Precipitation Station	Release Location (mi)	Storage Capacity (MG)	Dead Pool (MG)	Operating Rules
Gaston Shoals Lake	Power, recreation, and water supply	Mainstem (Broad)	Santuck USC00387722	Clemson USC00381770	Gaston Shoals USC00383433	4	815	270	Advanced
Lake Whelchel	Water supply	Cherokee Creek	Santuck USC00387722	Clemson USC00381770	Gaston Shoals USC00383433	1.9	815	10	Simple
Ninety-Nine Islands Lake	Power and recreation	Mainstem (Broad)	Santuck USC00387722	Clemson USC00381770	99 Islands USC00386293/ Gaffney USC00383356	14.9	750	560	Advanced
Neal Shoals Reservoir	Power	Mainstem (Broad)	Santuck USC00387722	Clemson USC00381770	Santuck USC00387722/ Lockhart USC00385232	47.7	515	363	Advanced
Parr Shoals Reservoir	Power and recreation	Mainstem (Broad)	Little Mountain USC00385200	Blackville USC00380764	Blair USC00380772/ Parr USC00386688	79	10,427	970	Advanced
Lake Monticello	Power and recreation	Monticello Local Inflow	Little Mountain USC00385200	Blackville USC00380764	Blair USC00380772/ Parr USC00386688	7	130,000	119,408	Advanced
Lake William C. Bowen	Recreation and water supply	Pacolet River (S. Pacolet River)	Clemson USC00381770	Clemson USC00381770	Rainbow Lake USC00387113/ Simms USC00387885/ Clemson USC00381625	14.4	7,780	2,800	Advanced
Spartanburg Municipal Reservoir #1	Recreation and water supply	Pacolet River (S. Pacolet River)	Clemson USC00381770	Clemson USC00381770	Rainbow Lake USC00387113/ Simms USC00387885/ Clemson USC00381625	18	816	455	Simple
Lake H. Taylor Blalock	Recreation and water supply	Pacolet River	Clemson USC00381770	Clemson USC00381770	Rainbow Lake USC00387113/ Simms USC00387885/ Clemson USC00381625	27.6	8,066	219	Advanced
Lake Lyman	Recreation and water supply	Middle Tyger River	Clemson USC00381770	Clemson USC00381770	Cleveland USC00381804	14.4	1,367	0	Simple
Lake Cooley	Recreation and flood control	Jordan Creek	Clemson USC00381770	Clemson USC00381770	Greer USW00003870	2.1	1,727	40	Simple
Lake John A. Robinson	Recreation and water supply	South Tyger River	Clemson USC00381770	Clemson USC00381770	Cleveland USC00381804	7.2	4,495	0	Simple
Lake Cunningham	Recreation and water supply	South Tyger River	Clemson USC00381770	Clemson USC00381770	Cleveland USC00381804	10.9	248	0	Simple
Lake Lanier	Recreation and water supply	N. Pacolet River (Vaughn Creek)	Clemson USC00381770	Clemson USC00381770	Rainbow Lake USC00387113/ Simms USC00387885/ Clemson USC00381625	2.5	553	200	Simple

Note: For all reservoirs, the "Simple" area-capacity relationship table was used.

**Table 5. Reservoir Area-Capacity Relationship**

Reservoir	Volume (MG)	Area (Acres)	Reservoir	Volume (MG)	Area (Acres)	
Gaston Shoals Lake <sup>1</sup>	0	0	Lake William C. Bowen <sup>3</sup>	2,925	698	
	378	45		2,947	768	
	815	300		3,508	897	
Lake Whelchel <sup>1</sup>	0	0		4,122	979	
	3	1		4,810	1,100	
	16	4		5,551	1,180	
	41	9		6,373	1,300	
	81	18		7,256	1,400	
	130	28		7,780	1,440	
	228	50		Spartanburg Municipal Reservoir #1 <sup>3</sup>	161	62
	358	78	205		72	
	554	120	256		86	
	815	177	319		104	
Ninety-Nine Islands Lake <sup>2</sup>	0	0	397		131	
	9	4	503		180	
	18	7	640		228	
	42	20	808		271	
	64	34	816		276	
	97	56	Lake H. Taylor Blalock <sup>1</sup>		0	0
	152	97		8,066	1,105	
	237	157	Lake Lyman <sup>1</sup>	0	0	
	401	231		1	5	
	652	325		16	24	
750	433	41		44		
Neal Shoals Reservoir <sup>2</sup>	0	0		104	87	
	20	21		167	120	
	72	82		301	160	
	332	391		616	227	
	515	613		1,051	314	
Parr Shoals Reservoir <sup>2</sup>	0	0		1,367	357	
	261	800	Lake Cooley <sup>1</sup>	0	0	
	1,151	1,850		57.5	35.8	
	3,314	2,727		164	72	
	8,903	4,116		311	110	
	16,656	5,402		719	190	
Lake Monticello <sup>2</sup>	0	37		1,062	249	
	283	137		1,509	309	
	961	279		1,727	335	
	6,553	943		Lake John A. Robinson <sup>1</sup>	0	0
	14,875	1,682			4,495	810
	38,939	3,320	Lake Cunningham <sup>1</sup>	0	0	
	50,735	3,920		248	132	
	64,486	4,520	Caldwell Lake	0	0	
	80,257	5,160		200	42	
	98,244	5,880	Lake Lanier <sup>4</sup>	0	0	
	118,300	6,430		275	51	
	140,458	7,170		553	85	

Sources

1 - User correspondence  
2 - HDR, 2007

3 - FERC Application  
4 - Estimated (no data available)

**Table 6. Advanced Reservoir Rules**

Reservoir	Priority	Type	Target <sup>1</sup>	Months	Conditioned On <sup>2</sup> :
Gaston Shoals	1	Minimum Release (cfs)	868	Jan - Feb	Storage > 668 MG (98')
			868	Mar - Apr	Storage > 741 MG (99')
			651	May	Storage > 741 MG (99')
			651	Jun, Dec	Storage > 668 MG (98')
			434	Jul - Nov	Storage > 668 MG (98')
	2	Minimum Release (cfs)	150	Jan - Feb	Storage < 668 MG (98')
			350	Mar - May	Storage < 741 MG (99')
			150	Jun - Dec	Storage < 668 MG (98')
	3	Storage Curve (MG)	741 (99')	Jan - Feb	
778 (99.5')			Mar - May		
741 (99')			Jun - Dec		
Ninety-Nine Islands Lake	1	Minimum Release (cfs)	1	Jan - Dec	BRD02 flow < 483 CFS
	2	Minimum Release (cfs)	483	Jan - Dec	BRD02 flow > 482 CFS
	3	Minimum Release (cfs)	966	Jan - Feb	Storage > 561.4 MG (98')
			966	Mar -Apr	Storage > 660.6 MG (99')
			725	May	Storage > 660.6 MG (99')
			725	Jun, Dec	Storage > 561.4 MG (98')
			483	Jul - Nov	Storage > 561.4 MG (98')
Neal Shoals Reservoir	1	Minimum Release (cfs)	1	Jan - Dec	BRD21 flow < 730 CFS
	2	Minimum Release (cfs)	730	Jan - Dec	BRD21 flow > 729 CFS
	3	Storage Curve (MG)	484.4 (334')	Jan - Dec	
Parr Shoals Reservoir	1	Minimum Release (cfs)	1	Jan - Feb	BRD52 flow < 800 CFS & > 150 CFS
			1	Mar - May	BRD52 flow < 1000 CFS
			1	Jun - Dec	BRD52 flow < 800 CFS & > 150 CFS
	2	Minimum Release (cfs)	800	Jan - Feb	BRD52 flow > 799 CFS
			1,000	Mar - May	BRD52 flow > 999 CFS
			800	Jun - Dec	BRD52 flow > 799 CFS
			150	Jan - Feb	BRD52 flow < 150 CFS
			150	Jun - Dec	BRD52 flow < 150 CFS
	3	Storage Curve (MG)	4,432 (261')	Jan - Dec	
Lake Monticello	1	Minimum Release (cfs)	1	Jan - Feb	BRD52 flow < 800 CFS & > 150 CFS
			1	Mar - May	BRD52 flow < 1000 CFS
			1	Jun - Dec	BRD52 flow < 800 CFS & > 150 CFS
	2	Minimum Release (cfs)	150	Jan - Dec	Parr Shoals storage < 3000 MG & BRD52 < 150
	3	Storage Curve (MG)	124,394 (423.0')	Jan - Dec	

<sup>1</sup> Target of 1 or 0.9 refers to a moving target ratio, where minimum release is set to ratio of inflow.

<sup>2</sup> Volumes pertaining to specific rules, not determined through calibration, have corresponding elevations listed.

**Table 6. Advanced Reservoir Rules (continued)**

Reservoir	Priority	Type	Target <sup>1</sup>	Months	Conditioned On <sup>2</sup> :
Lake William C. Bowen	1	Minimum Release (cfs)	5	Jan - Dec	Reservoir #1 Storage between 816 & 810.1 MG
			15	Jan - Dec	Reservoir #1 Storage between 810 & 805.1 MG
			20	Jan - Dec	Reservoir #1 Storage between 805 & 800.1 MG
			25	Jan - Dec	Reservoir #1 Storage between 800 & 795.1 MG
			30	Jan - Dec	Reservoir #1 Storage between 795 & 790.1 MG
			45	Jan - Dec	Reservoir #1 Storage < 790 MG
Lake H. Taylor Blalock	1	Minimum Release (cfs)	122	Jan - Apr	Storage > 6,246 MG (705')
			81	May - Jun	Storage > 6,246 MG (705')
			61	Jul - Nov	Storage > 6,246 MG (705')
			81	Dec	Storage > 6,246 MG (705')
			162	Jan - Apr	Storage > 7,534 MG (709')
			122	May - Jun	Storage > 7,534 MG (709')
			81	Jul - Nov	Storage > 7,534 MG (709')
			122	Dec	Storage > 7,534 MG (709')
	2	Minimum Release (cfs)	81	Jan - Apr	Storage > 3459 MG (694') & BRD12 > 162 CFS
			61	Jan - Apr	Storage > 3459 MG (694') & BRD12 < 162 CFS
			61	May - Dec	Storage > 3459 MG (694') & BRD12 > 61 CFS
	3	Minimum Release (cfs)	0.9	Jan - Dec	Storage < 3459 MG (694') & BRD12 < 61 CFS
			1	Jan - Dec	Storage > 3459 MG (694') & BRD12 < 61 CFS
	4	Minimum Release (cfs)	61	Jan - Dec	Storage < 3459 MG (694') & BRD12 > 61 CFS

<sup>1</sup> Target of 1 or 0.9 refers to a moving target ratio, where minimum release is set to ratio of inflow.

<sup>2</sup> Volumes pertaining to specific rules, not determined through calibration, have corresponding elevations listed.

**Table 7. Water User Objects and Sources of Supply Included in the Broad River Basin Model**

Model Object ID	Facility Name	Source of Supply	Intake ID	Diversion Location (mi)	Permit Limit (MGD)	Note
GC: Carolina CC	CAROLINA COUNTRY CLUB	Fairforest Creek	42GC010S01	11.5	49.1	1
GC: CC of Spartanburg	THE COUNTRY CLUB OF SPARTANBURG	Lawsons Fork Creek	42GC005S01	20.7	71.4	1
GC: Fox Run CC	FOX RUN COUNTRY CLUB	Durbin Creek	23GC003S01	0.1	19	1
GC: Holly Tree	HOLLY TREE COUNTY CLUB	Gilder Creek	23GC009S01	0.1	6.25	1
GC: Links O'Tryon	LINKS O'TRYON	Pacolet River (South Pacolet River)	42GC015S01	5.8	11.83	1
GC: Mid Carolina	MID CAROLINA GOLF CLUB	Crims Creek	36GC050S01	0.1	32.364	1
GC: Musgrove Mill	MUSGROVE MILL GOLF CLUB	Enoree River	30GC003S02	52.1	24.55	1
GC: Pebble Creek	PEBBLE CREEK GOLF CLUB	Mountain Creek	23GC011S01	1.2	53.57	1
			23GC011S02		35.7	1
			23GC011S03		35.7	1
GC: Willow Creek	WILLOW CREEK GOLF CLUB	Enoree River	42GC013S01	15.2	33.48	1
IN: Carlisle Finishing	CARLISLE FINISHING LLC	Broad River	44IN003S01	52.3	178.56	1
IN: Chemtrade	CHEMTRADE	Broad River	12IN002S01	51.5	6.696	1
			12IN002S02		15.624	1
IN: JPS Automotive	JPS AUTOMOTIVE TAYLORS PLANT 2	Enoree River	23IN032S01	2.1	NA	2
IN: Milliken	MILLIKEN - MAGNOLIA PLANT	Broad River	11IN002S01	6.1	232	1
IN: Reflective Recycling	REFLECTIVE RECYCLING LLC	Pacolet River	42IN075S01	41.9	4.46	2
IR: Fisher Bros	FISHER BROTHERS FARMS	Middle Tyger River	23IR002S01	11	220	2
IR: Gilberts	GILBERTS NURSERY INC	North Pacolet River	42IR026S01	19.3	30	2
			42IR026S02		19	2
			42IR026S03		5	2
			42IR026S04		4	2
			42IR026S05		1.8	2
IR: Hyder Austin	HYDER AUSTIN FARMS INC	Pacolet River (South Pacolet River)	23IR007S01	0.6	4	1,4
			23IR007S03		7.49	1,4
		Middle Tyger River	23IR007S02	0.7	4.64	1,4
			23IR007S04		3.8	1,4
IR: Lewis Nursery	LEWIS NURSERY & FARM	Tyger River	36IR010S01	58.3	3	2
IR: Walden Farm	SC DEPT OF CORRECTIONS - WALDEN FARM	Broad River	40IR059S01	100.7	27	1
MI: Vulcan	VULCAN CONSTRUCTION MATERIALS	Pacolet River	42MI001S01	41.6	59.4	1
			42MI001S02		59.5	1
PN: V.C. Summer	SCE&G - V.C. SUMMER NUCLEAR STATION	Monticello Reservoir (Monticello Local Inflow)	20PN001S01	7.0	26194.76	1
			20PN001S02		49.1	1
WS: Clinton	CITY OF CLINTON WTP	Enoree River	30WS001S01	47	310	1
		Duncan Creek	30WS001S02	0.1	105	1
WS: Columbia	City of Columbia - Lake Murray Water Plant	Out of basin (Saluda)	40WS002S02	NA	3875	3
	CITY OF COLUMBIA - CANAL WATER PLANT	Broad River	40WS054S01	104.9	3875	1

Note 1 indicates the withdrawal is currently active, and was included in both the baseline and calibration model.

Note 2 indicates the withdrawal was previously active, and was included in the calibration model.

Note 3 indicates the withdrawal occurs outside the Broad Basin.

Note 4 indicates registered limit for irrigation.

Note 5 indicates permit is in the process of being issued.

**Table 7. Water User Objects and Sources of Supply Included in the Broad River Basin Model (continued)**

Model Object ID	Facility Name	Source of Supply	Intake ID	Diversion Location (mi)	Permit Limit (MGM)	Note
WS: Gaffney	GAFFNEY WTP	Gaston Shoals Lake (Broad River)	11WS001S01	4.0	620	1
		Lake Whelchel (Cherokee Creek)	11WS001S02	1.9	651	1
WS: Greer	GREER CPW - WATER TREATMENT PLANT	Lake Cunningham (S. Tyger River)	23WS004S01	10.9	1682.86	1
WS: ICWD	INMAN CAMPOBELLO N SPARTANBURG PROJECT #1	North Pacolet River	42WS001S01	22.2	248	1
WS: Landrum	CITY OF LANDRUM (SPARTANBURG CPW)	North Pacolet River (Vaughn Creek)	42WS008S01	1	34.41	1
		North Pacolet River (Vaughn Creek)	42WS008S02	1	4.65	1
WS: Tryon	CITY OF TRYON	Lake Lanier (North Pacolet River)	23WS009S01	2.5	NA	5
WS: SJWD	SJWD MIDDLE TYGER WTP	Middle Tyger River	42WS012S01	21.7	713	1
		Tyger River (North Tyger River)	42WS012S02	2.2	620	1
		Lake Cooley (Jordan Creek)	42WS012S03	2.1	434	1
WS: Spartanburg	SPARTANBURG CPW	Lake Blalock (Pacolet River)	42WS004S01	27.6	2790	1
		Lake Bowen/Reservoir #1 (Pacolet River)	42WS014S01	18	5673	1
WS: Spring Industries	SPRING TREATMENT PLANT	Middle Tyger River	42IN005S02	21.7	NA	2
WS: Union	CITY OF UNION WTP	Broad River	44WS001S01	41.3	446	1
WS: Whitmire	TOWN OF WHITMIRE WTP	Enoree River	36WS003S01	72.5	68.2	1
		Duncan Creek	36WS003S02	21.9	31	1
WS: Winnsboro	TOWN OF WINNSBORO WTP	Sand Creek	20WS001S01	0.1	62	1
		Mill Creek	20WS001S03	1.2	124	1
		Broad River	20WS001S05	81.6	310	1
WS: Woodruff-Roebuck	WOODRUFF-ROEBUCK WTP	Tyger River (North Tyger River)	42WS005S01	21	279	1
		South Tyger River	42WS005S02	44.6	279	1
WS: York	CITY OF YORK WTP	Turkey Creek	46WS002S01	1.4	93	1

Note 1 indicates the withdrawal is currently active, and was included in both the baseline and calibration model.

Note 2 indicates the withdrawal was previously active, and was included in the calibration model.

Note 3 indicates the withdrawal occurs outside the Broad Basin.

Note 4 indicates registered limit for irrigation.

Note 5 indicates permit is in the process of being issued.

**Table 8. Baseline Model Average Monthly Demand for IN, MI, PH, PN, and WS Water Users**

Baseline Model Average Monthly Demand (MGD)											
Month	IN: Carlisle Finishing	IN: Chemtrade	IN: Milliken	MI: Vulcan	PH: Fairfield Pumped Storage	PN: V.C. Summer	WS: Clinton	WS: Columbia	WS: Gaffney	WS: Greer	WS: ICWD
<b>Permit Limit (MGD)</b>	<b>5.9</b>	<b>0.7</b>	<b>7.6</b>	<b>3.9</b>	<b>-</b>	<b>863.3</b>	<b>13.7</b>	<b>254.9</b>	<b>41.8</b>	<b>55.4</b>	<b>8.2</b>
Jan	0.7	0.1	2.0	0.0	1401.3	764.1	2.4	26.3	6.3	7.4	-
Feb	0.7	0.1	2.3	0.0	1265.8	776.4	2.3	25.4	6.2	7.3	-
Mar	0.7	0.1	2.3	0.0	1345.1	746.5	2.2	25.3	6.7	7.4	-
Apr	0.7	0.1	2.3	0.1	1732.8	611.9	2.4	29.1	6.3	8.3	-
May	0.7	0.1	2.3	0.1	2350.3	599.0	2.5	31.8	7.3	9.7	-
Jun	0.8	0.1	2.5	0.1	2966.7	763.6	2.7	35.3	9.7	10.6	-
Jul	0.7	0.2	2.4	0.1	2920.2	770.2	2.8	36.7	10.1	10.7	-
Aug	0.8	0.2	2.4	0.1	3040.9	769.3	2.8	37.4	9.7	10.1	-
Sep	0.7	0.2	2.3	0.1	2583.1	770.9	2.8	34.7	10.1	10.2	-
Oct	0.7	0.2	2.3	0.1	1753.2	610.1	2.6	31.7	7.8	9.1	-
Nov	0.8	0.2	2.4	0.0	1257.4	607.0	2.5	28.4	8.1	8.1	-
Dec	0.6	0.1	2.0	0.0	1334.2	746.6	2.3	25.9	5.9	7.5	-

Baseline Model Average Monthly Demand (MGD)										
Month	WS: Landrum	WS: SJWD	WS: Spartanburg	WS: Tryon	WS: Union	WS: Whitmire	WS: Winnsboro	WS: Woodruff-Roebuck	WS: York	IN: GE/Gas
<b>Permit Limit (MGD)</b>	<b>1.3</b>	<b>58.1</b>	<b>278.4</b>	<b>NA</b>	<b>14.7</b>	<b>3.3</b>	<b>16.3</b>	<b>18.4</b>	<b>3.1</b>	<b>NA</b>
Jan	0.4	5.7	23.9	0.5	2.8	0.3	1.6	2.6	0.8	0.2
Feb	0.4	5.6	23.6	0.5	2.6	0.3	1.5	2.6	0.8	0.2
Mar	0.4	5.8	23.8	0.5	2.6	0.3	1.5	2.5	0.8	0.2
Apr	0.4	6.4	24.2	0.5	2.7	0.3	1.6	2.7	0.7	0.2
May	0.4	8.1	26.8	0.5	2.9	0.3	1.7	3.1	0.8	0.2
Jun	0.5	8.5	28.9	0.5	3.3	0.3	1.8	3.3	0.9	0.2
Jul	0.5	8.7	30.3	0.5	3.6	0.3	1.9	3.3	0.8	0.2
Aug	0.4	8.5	29.3	0.5	3.6	0.3	1.8	3.3	0.8	0.2
Sep	0.4	8.7	29.1	0.5	3.5	0.3	1.8	3.2	0.8	0.2
Oct	0.4	7.7	26.8	0.4	3.2	0.3	1.7	3.0	0.6	0.2
Nov	0.4	6.8	24.6	0.5	2.9	0.3	1.6	2.7	0.4	0.2
Dec	0.4	6.0	23.4	0.5	2.7	0.3	1.5	2.6	0.4	0.2

Permit limits shown in MGD rather than MGM for comparative purposes. Actual permit limits are in MGM. GE/Gas sourced exclusively from groundwater.

Source: BroadCUandDemand.xlsx Summary tab

**Table 9. Baseline Model Average Monthly Demand for GC and IR Water Users**

Baseline Model Average Monthly Demand (MGD)												
Month	IR: Fisher Bros	IR: Hyder Austin	IR: Walden	GC: Fox Run CC	GC: Holly Tree	GC: Pebble Creek	GC: Musgrove Mill	GC: Mid Carolina	GC: CC of Spartanburg	GC: Carolina CC	GC: Willow Creek	GC: Links O'Tryon
Jan	0.00	0.00	0.00	0.00	0.06	0.09	0.00	0.00	0.04	0.00	0.00	0.00
Feb	0.00	0.00	0.08	0.00	0.08	0.15	0.00	0.00	0.04	0.01	0.01	0.00
Mar	0.00	0.00	0.33	0.00	0.18	0.28	0.00	0.01	0.11	0.05	0.05	0.03
Apr	0.00	0.00	0.34	0.02	0.29	0.53	0.01	0.01	0.17	0.13	0.08	0.06
May	0.03	0.00	0.35	0.03	0.34	0.57	0.05	0.04	0.26	0.12	0.11	0.07
Jun	0.11	0.01	0.38	0.06	0.46	0.78	0.09	0.05	0.27	0.20	0.15	0.07
Jul	0.17	0.01	0.36	0.07	0.50	0.87	0.09	0.11	0.27	0.16	0.23	0.08
Aug	0.06	0.00	0.36	0.05	0.46	0.79	0.09	0.11	0.34	0.16	0.19	0.07
Sep	0.00	0.00	0.37	0.05	0.39	0.58	0.07	0.09	0.30	0.11	0.21	0.07
Oct	0.00	0.00	0.35	0.02	0.28	0.44	0.01	0.02	0.27	0.11	0.16	0.05
Nov	0.00	0.00	0.15	0.00	0.11	0.22	0.00	0.00	0.24	0.06	0.05	0.03
Dec	0.00	0.00	0.00	0.00	0.06	0.14	0.00	0.00	0.12	0.01	0.01	0.00

**Table 10. Returns and Associated Model Objects**

Model Object ID	Facility Name	NPDES Pipe ID	Associated Water Permit	Discharge Tributary	Model River Mile	% of Return Flow
<b>Returns Represented Within Water User Objects</b>						
IN: Milliken	MILLIKEN/MAGNOLIA FINISHING PLANT	SC0003182-T1M	11IN002	Broad River	6.4	100
WS: Tryon	CITY OF TRYON	NC0021601	23WS009S01	Vaughn Creek	2.5	100
WS: Gaffney	BLACKSBURG/CANOE CREEK (NEW)	SC0047457-001	11WS001	Broad River	7.2	5.5
	GAFFNEY/CLARY WWTF	SC0031551-001		Thicketty Creek	1.3	52.4
	GAFFNEY/PEOPLES CRK-BROAD RVR	SC0047091-001		Broad River	10.2	42.1
IN: Chemtrade	CHEMTRADE PERF CHEMICALS/LEEDS	SC0022756-001	12IN002	Broad River	51.9	100
PN: V.C. Summer	SCE&G/V C SUMMER NUCLEAR STAT	SC0030856	20PN001	Monticello Local Inflow	6.0	100
WS: Winnsboro	WINNSBORO/JACKSON CREEK PLANT	SC0020125-001	20WS001	Jackson Creek	0.1	92.1
	RIDGEWAY, TOWN OF	SC0022900-001		Big Cedar Creek	0.2	7.9
WS: Greer/WS: SJWD	GREER/MAPLE CREEK PLANT	SC0046345-001	23WS004/ 42WS012	South Tyger River	19.6	75/10
WS: Greer/Greenville Import	ReWa/PELHAM WWTF	SC0033804-001	23WS004	Enoree River	8.9	22.0
WS: Greer	UNITED UTILS/N GREENVILLE COLL	SC0026565-001		South Tyger River	1	3.0
WS: Clinton	LAURENS CO W&S/CLINTON-JOANNA	SC0037974-001	30WS001	<b>Out of basin (Saluda)</b>	<b>999</b>	100
WS: Whitmire	WHITMIRE, TOWN OF	SC0022390-001	36WS003	Duncan Creek	22.5	100
WS: Columbia	COLUMBIA/METRO PLANT	SC0020940-001	40WS054	<b>Out of basin (Saluda)</b>	<b>1000</b>	100
	EAST RICH CO PSD/GILLS CREEK	SC0038865-001				
MI: Vulcan	VULCAN MATERIALS - PACOLET Quarry	SCG730293	42MI001	Pacolet River	41.7	100
WS: ICWD	INMAN, CITY OF	SC0021601-001	42WS001	Lawsons Fork Creek	2.0	100
	MILLIKEN/DEWEY PLANT	SC0003581-001				
WS: Spartanburg	SSSD/FAIRFOREST PLANT**	SC0020435-002	42WS014/ 42WS004	Pacolet River	41.5	67.0
	SSSD/PACOLET MILLS WWTP	SC0044717-001		Pacolet River	18.6	18.0
	SIMMS WTP	SCG646049		Pacolet River	33.7	7.0
	AURIGA POLYMERS INC./SPARTANBURG	SC0002798-002				
	CHESNEE WWTF	SC0025763-001				
	SSSD/CLIFTON WWTP	SCG570017-001				
SSSD/COWPENS-PACOLET RIVER	SC0045624-001					
WS: Spartanburg/ WS: SJWD	SSSD/LOWER N TYGER RIVER WWTP	SC0048143-001	42WS014/ 42WS012	Tyger River (North Tyger River)	14.0	8.0/10.0
WS: SJWD	LYMAN, CITY OF	SC0021300-001	42WS012	Middle Tyger River	22.5	67.0
	SJWD WTP	SCG646023				
	SSSD/S. TYGER RV REGIONAL WWTP	SC0047732-001				
WS: Woodruff-Roebuck	WOODRUFF/ENOREE RIVER	SC0045802-001	42WS005	Enoree River	29.0	100
WS: Landrum	SSSD/PAGE CREEK WWTP	SC0026875-001	42WS008	North Pacolet River	11.3	88.9
	SWS LANDRUM WTP	SCG64500		North Pacolet River	3.1	11.1
IN: Carlisle Finishing	CONE MILLS CORP/CARLISLE PLANT	SC0001368-TM1	44IN003	Broad River	52.8	100.0
WS: Union	UNION/TOSCH'S CREEK WWTP	SC0047244-001	44WS001	Fairforest Creek	39.8	74.3
	CITY OF UNION WTP	SCG646042		Broad River	7.1	15.6
	JONESVILLE, TOWN OF	SC0024988-001		Pacolet River	28.3	4.2
	LOCKHART TREATMENT FACILITY	SCG5700019		Broad River	36.7	5.9
IN: GE/Gas	GE/GAS TURBINE MFG OPERATION	SC0003484-001	23IN058G	Enoree River	11.1	100
WS: York	YORK/FISHING CREEK WWTF	SC0038156-001	46WS002	<b>Out of basin (Catawba)</b>	<b>1001</b>	100

Note: Returns outside of the Broad River Basin are indicated in **bold**.

\* Only represented in the calibration model

\*\* Represented by a Discharge object in the calibration model and a return in a Water User object in the baseline model.

**Table 10. Returns and Associated Model Objects (continued)**

Model Object ID	Facility Name	NPDES Pipe ID	Associated Water Permit	Discharge Tributary	Model River Mile	% of Return Flow
<b>Transbasin Imports Represented by Discharge Objects</b>						
Chester Import	CHESTER/SANDY RIVER WWTF	SC0036081-001	12WS002	Sandy River	0.1	-
Greenville Import (Durbin)	ReWa/DURBIN CREEK	SC0040002-001	23WS007	Durbin Creek	3.5	-
Greenville Import (Gilder)	ReWa/GILDER CREEK	SC0040525-001	23WS007	Enoree River	17.2	-
Greenville Import (Pelham)	ReWa/PELHAM WWTF	SC0033804-001	23WS007	Enoree River	8.9	-
Greenville Import (Taylors)*	ReWa/TAYLORS AREA PLANT	SC0024309-001	23WS007	Enoree River	2.6	-
NCWSA Import	NCW&SA/CANNONS CREEK WWTP	SC0048313-001	36WS002	Cannons Creek	0.2	-
Columbia Import	RICHLAND CO/BROAD RIVER WWTF	SC0046621-001	40WS002	Broad River	94.8	-
Columbia Import	CHAPIN, TOWN OF	SC0040631-001	40WS002	Broad River	85.6	-
<b>In-basin Returns Represented by Individual or Aggregated Discharge Objects</b>						
SSSD/Lawson Fork*	SSSD/LAWSON FORK PLANT	SC0020427-001	42WS014	Lawsons Fork Creek	21	-
Old Fairforest Creek (001)*	SSSD/FAIRFOREST PLANT	SC0020435-001	42WS014	Fairforest Creek	10	-
Midland	MIDLAND CAPITAL LLC/MOORE PLANT	SC0036145-001	none	South Tyger River	37	-
SC Dept Corr	SC DEPT CORR/TYGER RIVER CORRE	SC0036773-001	none	Tyger River	31	-

Note: Returns outside of the Broad River Basin are indicated in **bold**.

\* Only represented in the calibration model

\*\* Represented by a Discharge object in the calibration model and a return in a Water User object in the baseline model.

**Table 11. Baseline Model Monthly Consumptive Use Percentage**

Monthly Consumptive Use (%)											
Month	IN: Carlisle Finishing	IN: Chemtrade	IN: Milliken	MI: Vulcan	PH: Fairfield Pumped Storage	PN: V.C. Summer	WS: Clinton	WS: Columbia	WS: Gaffney	WS: Greer	WS: ICWD
Jan	69.9	92.9	4.2	90.0	0.0	20.0	38.7	46.1	34.4	63.2	-
Feb	66.8	93.3	2.2	90.0	0.0	21.2	39.2	47.2	33.5	62.8	-
Mar	63.6	95.9	2.4	90.0	0.0	21.6	35.3	45.5	34.4	65.2	-
Apr	62.7	97.6	3.3	90.0	0.0	18.9	43.8	65.6	33.1	68.6	-
May	69.8	97.3	2.7	90.0	0.0	13.2	54.0	90.5	45.7	74.9	-
Jun	73.2	95.8	2.5	90.0	0.0	12.6	60.1	93.9	59.0	77.8	-
Jul	71.2	95.6	6.8	90.0	0.0	11.8	61.5	90.2	61.9	77.0	-
Aug	64.5	95.8	4.3	90.0	0.0	12.6	60.8	91.8	59.1	75.7	-
Sep	69.4	96.5	4.1	90.0	0.0	10.2	62.6	94.4	61.8	77.4	-
Oct	69.1	96.1	5.4	90.0	0.0	10.4	58.5	83.2	49.8	74.3	-
Nov	67.7	98.2	10.8	90.0	0.0	19.2	51.9	65.5	48.1	69.4	-
Dec	67.3	94.2	6.5	90.0	0.0	16.9	40.4	57.3	35.6	63.5	-

Monthly Consumptive Use (%)										
Month	WS: Landrum	WS: SJWD	WS: Spartanburg	WS: Tryon	WS: Union	WS: Whitmire	WS: Winnsboro	WS: Woodruff-Roebuck	WS: York	IN: GE/Gas
Jan	8.5	47.9	72.2	34.8	75.2	73.8	46.4	84.9	24.1	69.2
Feb	11.9	45.5	71.7	7.4	75.1	71.6	44.2	85.3	24.1	74.0
Mar	11.2	51.2	70.7	16.4	76.3	70.2	51.8	86.9	24.1	75.1
Apr	17.3	54.4	74.0	15.6	78.6	73.5	51.1	87.9	24.1	73.8
May	24.0	59.3	76.5	21.9	78.9	73.1	54.0	90.8	24.1	74.2
Jun	27.0	64.3	79.0	26.3	81.9	74.9	59.2	91.0	24.1	75.9
Jul	34.9	67.8	79.8	32.2	83.2	76.4	61.0	92.7	24.1	73.1
Aug	29.1	67.2	80.0	41.0	83.9	73.7	58.8	91.5	24.1	76.2
Sep	29.8	67.8	81.3	43.7	84.6	77.2	54.6	91.8	24.1	79.0
Oct	23.6	63.6	78.3	26.5	82.8	78.8	54.0	88.4	24.1	79.6
Nov	17.9	58.2	76.9	41.2	80.4	77.4	49.8	87.1	24.1	79.0
Dec	10.4	50.1	72.3	16.4	76.1	73.9	43.7	82.9	24.1	79.6

Source: BroadCUandDemand.xlsx Summary tab

**Table 12. Baseline Model Monthly Return Flows for Discharge Objects**

Monthly Return Flow (MGD)									
Month	Greenville Import: ReWa Pelham	Greenville Import: ReWa Gilder	Greenville Import: ReWa Durbin	Midland	SC Dept Corr	Chester Import	NCW&SA Import	Columbia Import: Chapin	Columbia Import: Richland
Jan	10.7	4.7	1.8	0.0	0.2	1.5	0.3	0.7	2.2
Feb	10.8	4.6	1.9	0.0	0.2	1.5	0.3	0.7	2.1
Mar	10.4	4.5	1.8	0.0	0.2	1.4	0.3	0.6	2.1
Apr	10.4	4.3	1.8	0.0	0.2	1.3	0.3	0.6	2.1
May	10.1	4.1	1.8	0.0	0.2	1.2	0.3	0.6	1.9
Jun	9.7	3.9	1.6	0.0	0.2	1.1	0.3	0.6	1.8
Jul	9.6	3.9	1.6	0.0	0.2	1.1	0.3	0.6	1.7
Aug	10.0	4.1	1.7	0.0	0.2	1.1	0.3	0.6	1.8
Sep	9.2	3.9	1.6	0.0	0.2	1.0	0.2	0.6	1.7
Oct	9.3	4.0	1.7	0.0	0.2	1.1	0.3	0.6	1.8
Nov	9.7	4.3	1.8	0.0	0.2	1.2	0.3	0.7	1.9
Dec	10.5	4.6	2.0	0.0	0.2	1.4	0.3	0.7	2.1

2021 Broad SWAM Model Updates

Attachment B

Responses to SCDNR Comments

# Broad SWAM Model Updates

SCDNR, February 22, 2021

The red text below each comment indicates how the model was adjusted by CDM Smith as part of the 2021 Broad SWAM updates.

Please find below a list of updates to the Broad SWAM baseline model. The updates are grouped together by the type of update required.

## A. General Updates

1. Replace all water demand and discharge data with data from new baseline period: 2010-2019. **This was completed.**
2. Extend headwater flows through 2019. **This was completed.**

## B. To be verified with DHEC

1. **WS: Gaffney (11WS001-S01/S02):** In the current model, the user has a permit of 620 MGM for intake S01 from Lake Whelchel and a permit of 651 MGM for intake S02 from Gaston Shoals Lake (according to the identifying notes). However, according to a recent DHEC shapefile, intake on Lake Whelchel (S02) has a permit of 651 MGM and the intake on Broad river (S01) has a permit of 620 MGM.

Verify with DHEC if the current set up in the model is correct or if it needs to be changed.

**DHEC confirmed that the Lake Whelchel intake (S02) should be 651 MGM and the Gaston Shoals/Broad River intake (S01) should be 620. The model setup was revised to reflect this.**

2. **WS: Winnsboro (20WS001-S01/S02/S03/S05):** In the current model, the user has a permit of 0 MGM for intake S01 from Sand Creek. According to the model's identifying note, the intake S01 went offline in 2008. Intake S03 is on Mill Creek (Winnsboro lake) and has a permit of 124 MGM, and intake S05 is on mainstem with permit limit of 310 MGM.

According to a recent DHEC shapefile and the water use database, intake S01 on Mill Creek (1.2 mi div loc) has 0 MGM withdrawals since 2009 (non-zero withdrawals from 1983-2008) but has an active permit of 124 MGM. Intake S02 is on Sand Creek (0.1 mi div loc) and has a permit of 62 MGM. Intake S03 is on mainstem (81.6 mi div loc) with permit limit of 310 MGM. Recent DHEC water use database also has intake S05 active from 2015 and has reported non-zero water withdrawals only in 2019.

Verify with DHEC if the current set up in the model is correct or if it needs to be changed.

**DHEC confirmed that the intakes are in the correct spot (in the Water Atlas) but were labeled incorrectly. The intake on Sand Creek was labeled S02 but should be S01; the intake on Mill Creek was labeled S01, but should be labeled S03; and**

the intake S05 on the Broad River should be S05 not S03. DHEC has made the corrections on the GIS layer and Watershed Atlas. Permitted amounts listed in the Watershed Atlas were correct. DHEC confirmed that only S01, S03, and S05 are active for the permit. The updated SWAM model represents these intakes correctly.

3. **WS: SJWD (42WS012S01, S02, S03):** The current model has included permit for intake S01 (713 MGM) from Middle Tyger river and for intake S03 (434 MGM) from Lake Cooley. Withdrawals from Lake Cooley is still 0. Note in the model mentions, "Intake S03 is on Lake Cooley, but withdrawals are reported from S02 downstream". The permit limit of 620 MGM for intake S02 (on North Tyger river) is not shown in the model. Needs review and clarification from DHEC.  
DHEC confirmed that the S03 intake should be added as a source in the model, even though there have been no reported withdrawals. Object updates were made to reflect all sources, and the preference for use.
- C. Inactive Users (Can be removed from the model after verifying with DHEC)
1. **IN: Reflective Recycling (42IN075S01)**
  2. **IR: Fishers Orchard (23IR008S01)**
  3. **IR: Lewis Nursery (36IR01S01)**
  4. **IR: Gilberts (42IR026S01-S05)**  
These four objects were removed after confirming with DHEC.
- D. Non-zero withdrawals
1. **GC: Links O'Tryon (42GC015S01):** The model has 0 MGD monthly usage. DHEC's recent water use database shows small non-zero water withdrawals from 2012 onwards. The withdrawals were updated accordingly
  2. **WS: ICWD (42WS001S01):** No monthly usage in the model. DHEC's water withdrawal database has small non-zero water withdrawals for 2019. (Had higher withdrawals from 1986-2000, followed by a reporting gap until 2013, then 0 withdrawals reported from 2013-2018.) Consumptive use and withdraw information has not been updated since a full year of withdrawal data has not been recorded. CDM Smith recommends updating the baseline withdrawals with 2020 and/or 2021 data, once available.
- E. New registration
1. **40IR059S01: SC Dept of Corrections - Walden Farm**, on mainstem (near 100.7 RM, registration limit: 27 MGM) A new water user object was added, IR: Walden Farm.

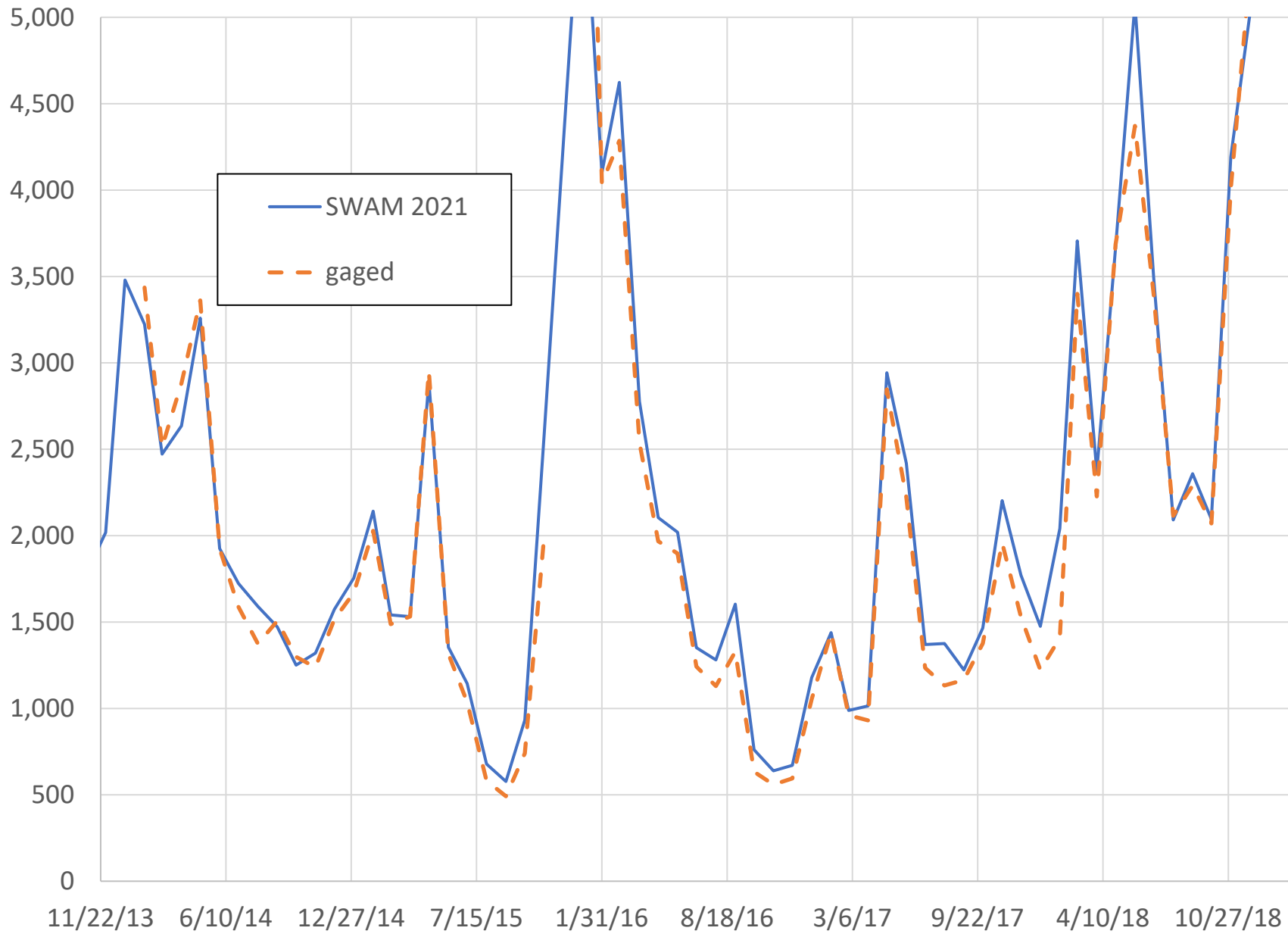
2021 Broad SWAM Model Updates

Attachment C

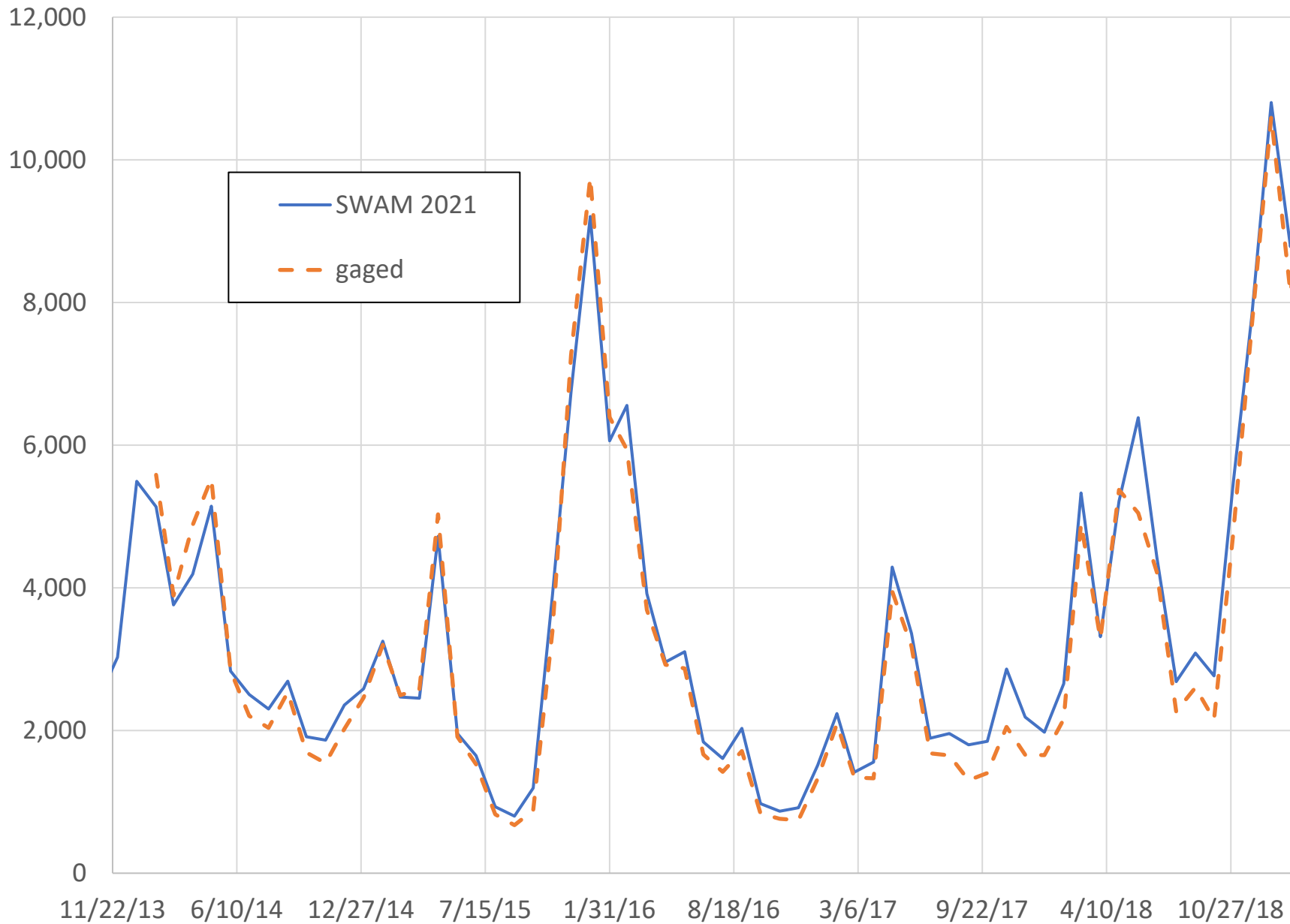
Validation Results

Attachment C  
Monthly Validation Results

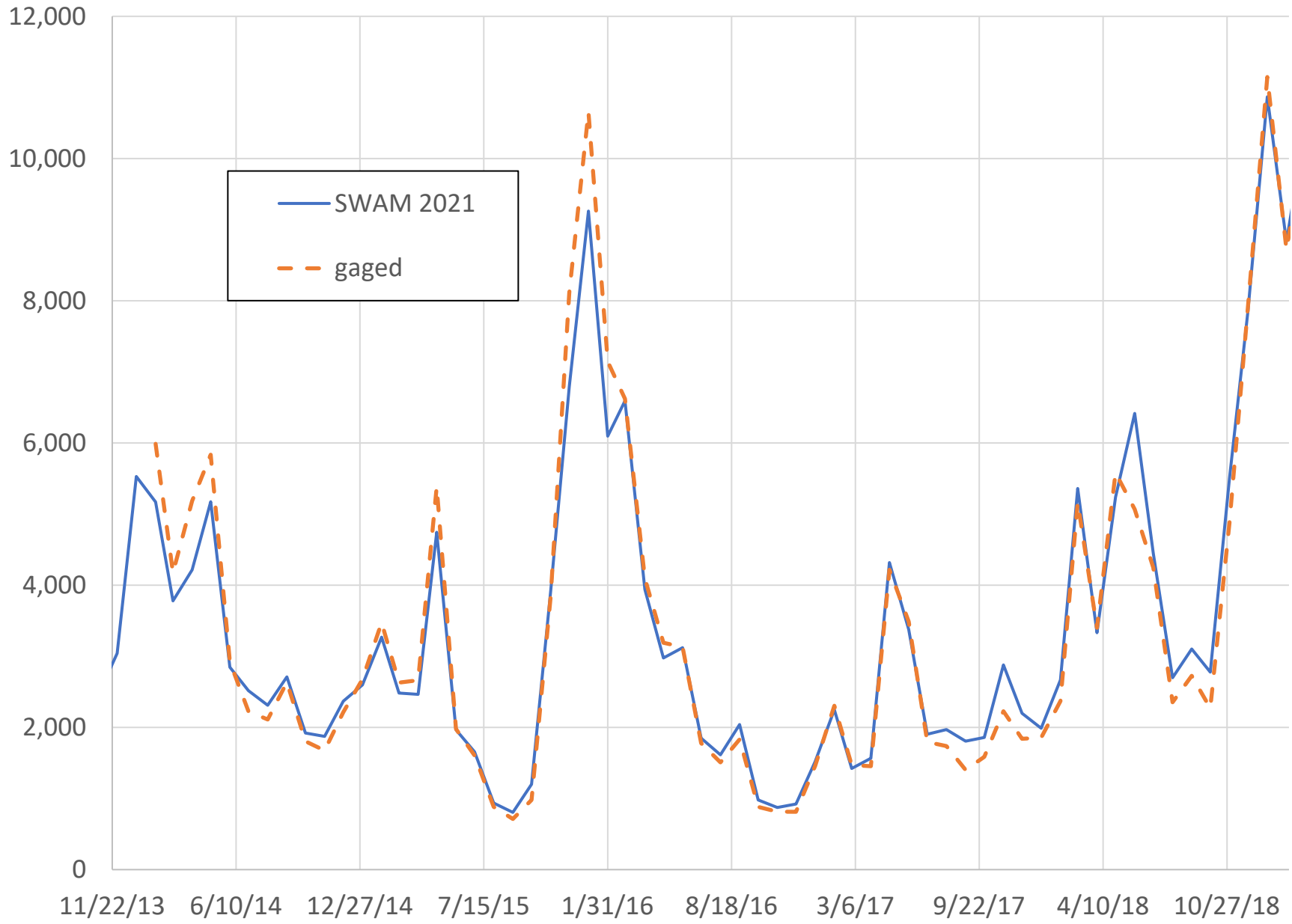
BRD03: Broad River below NinetyNine Island Reservoir (cfs)



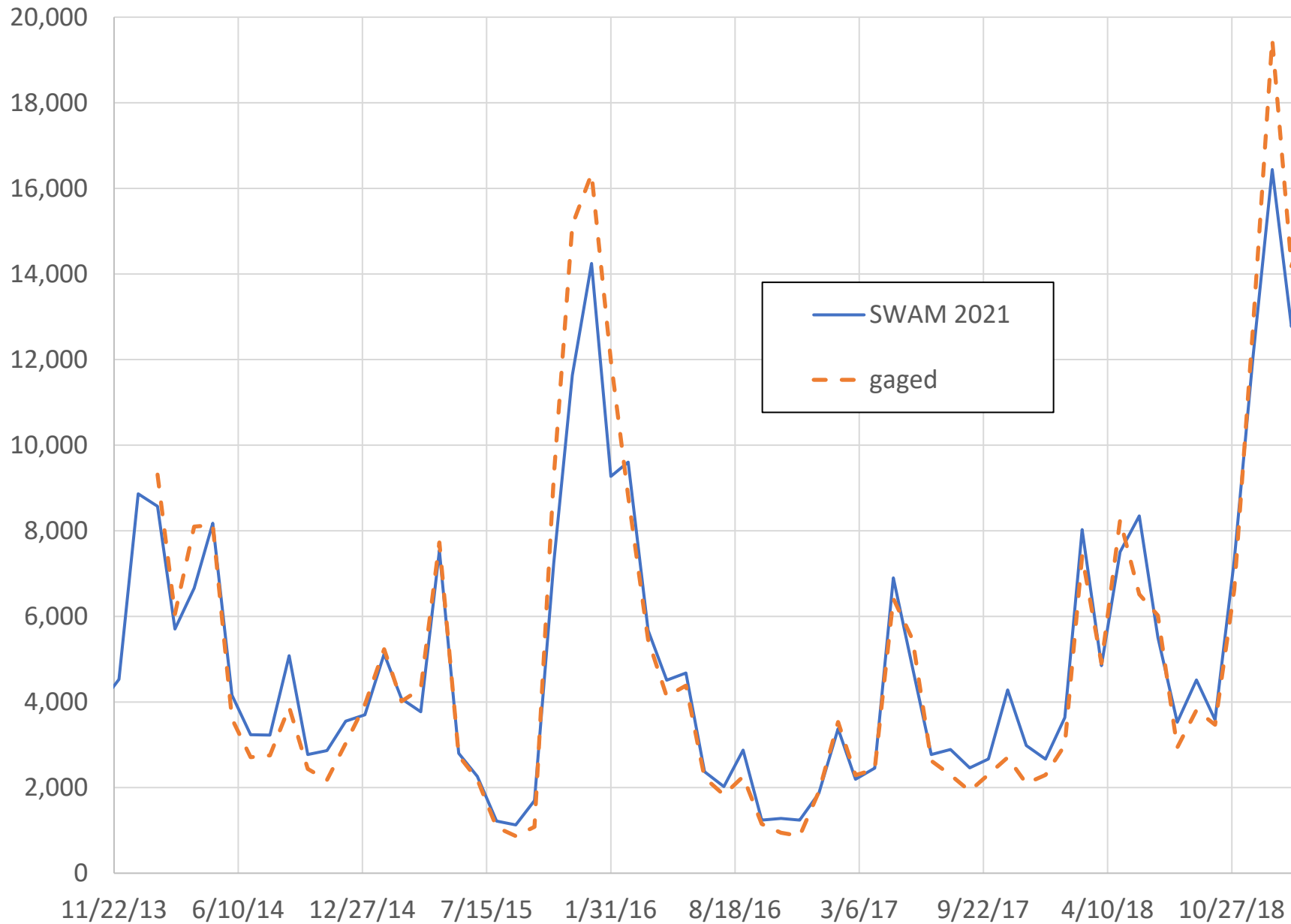
BRD22: Broad River below Neal Shoals (cfs)



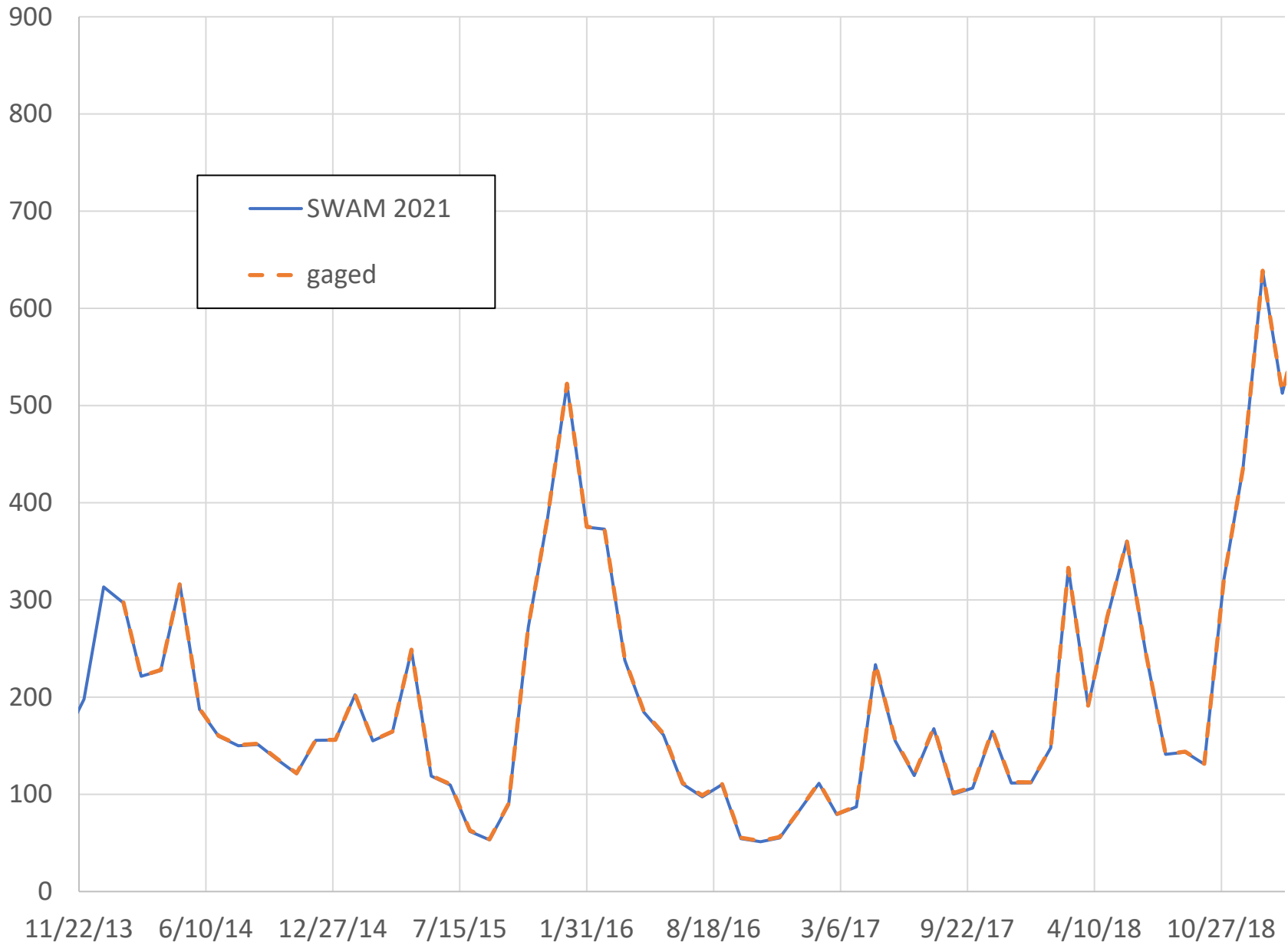
BRD24: Broad River near Carlisle (cfs)



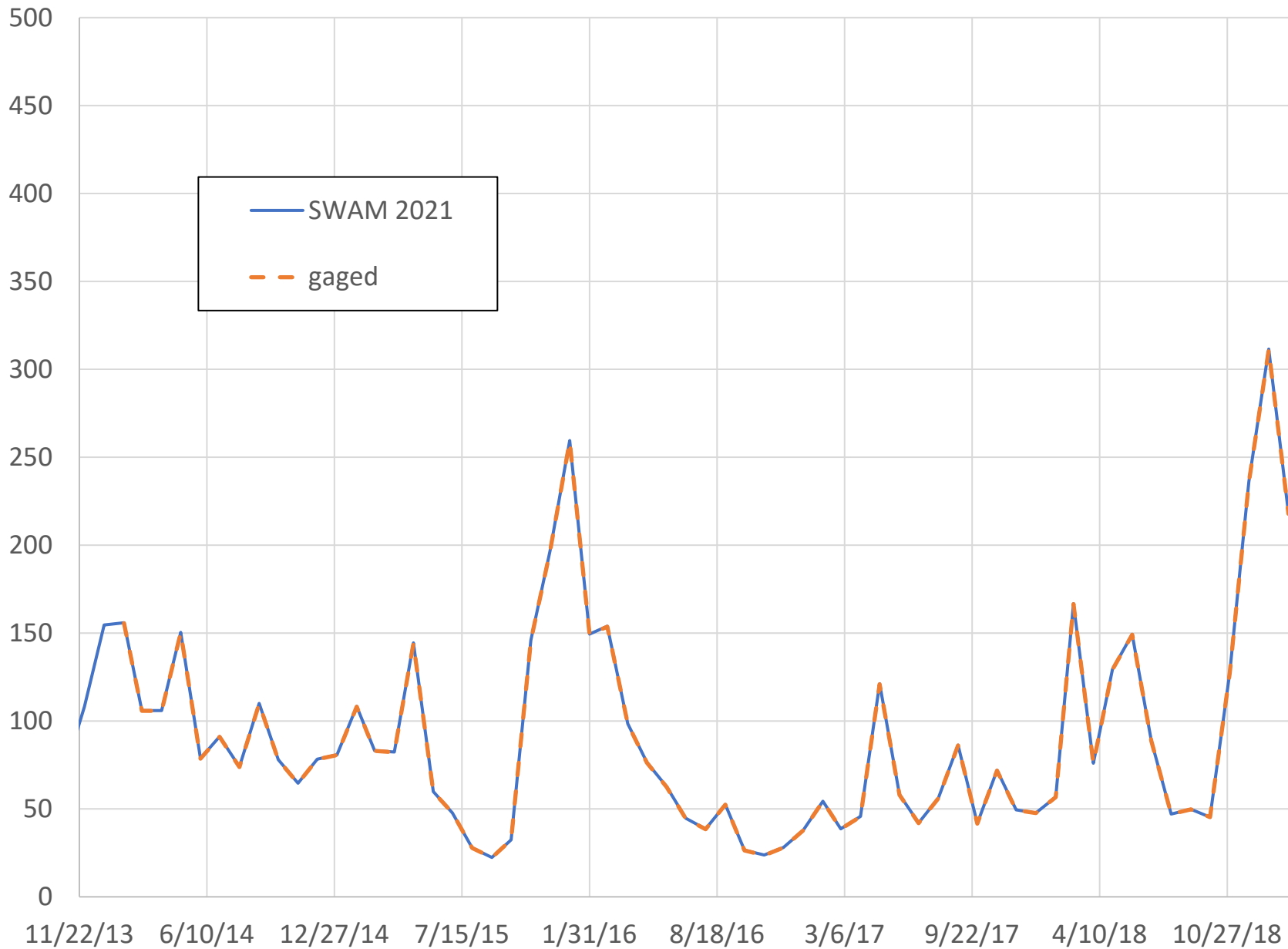
BRD54: Broad River at Alston (cfs)



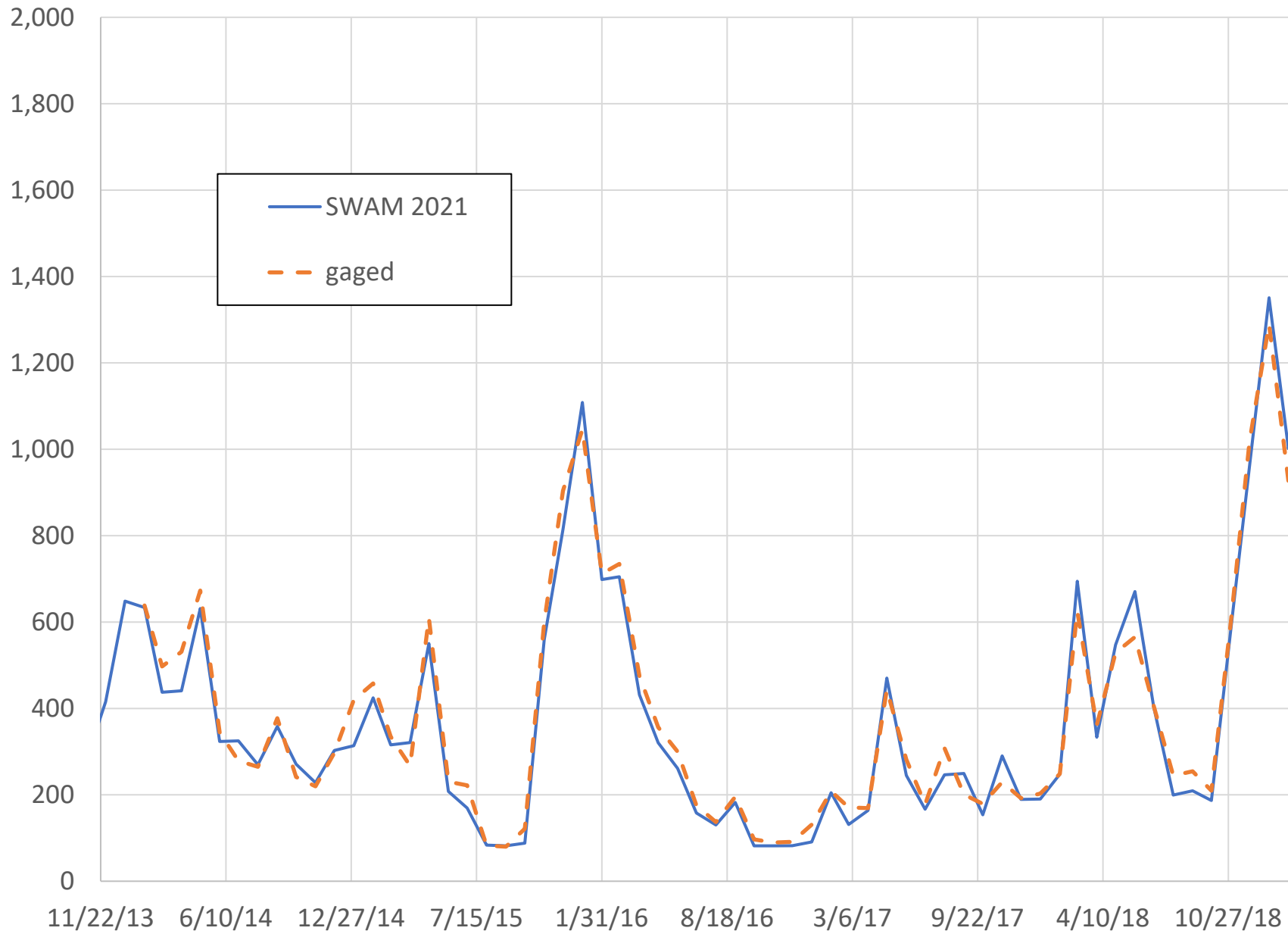
BRD10: N. Pacolet River at Fingerville (cfs)



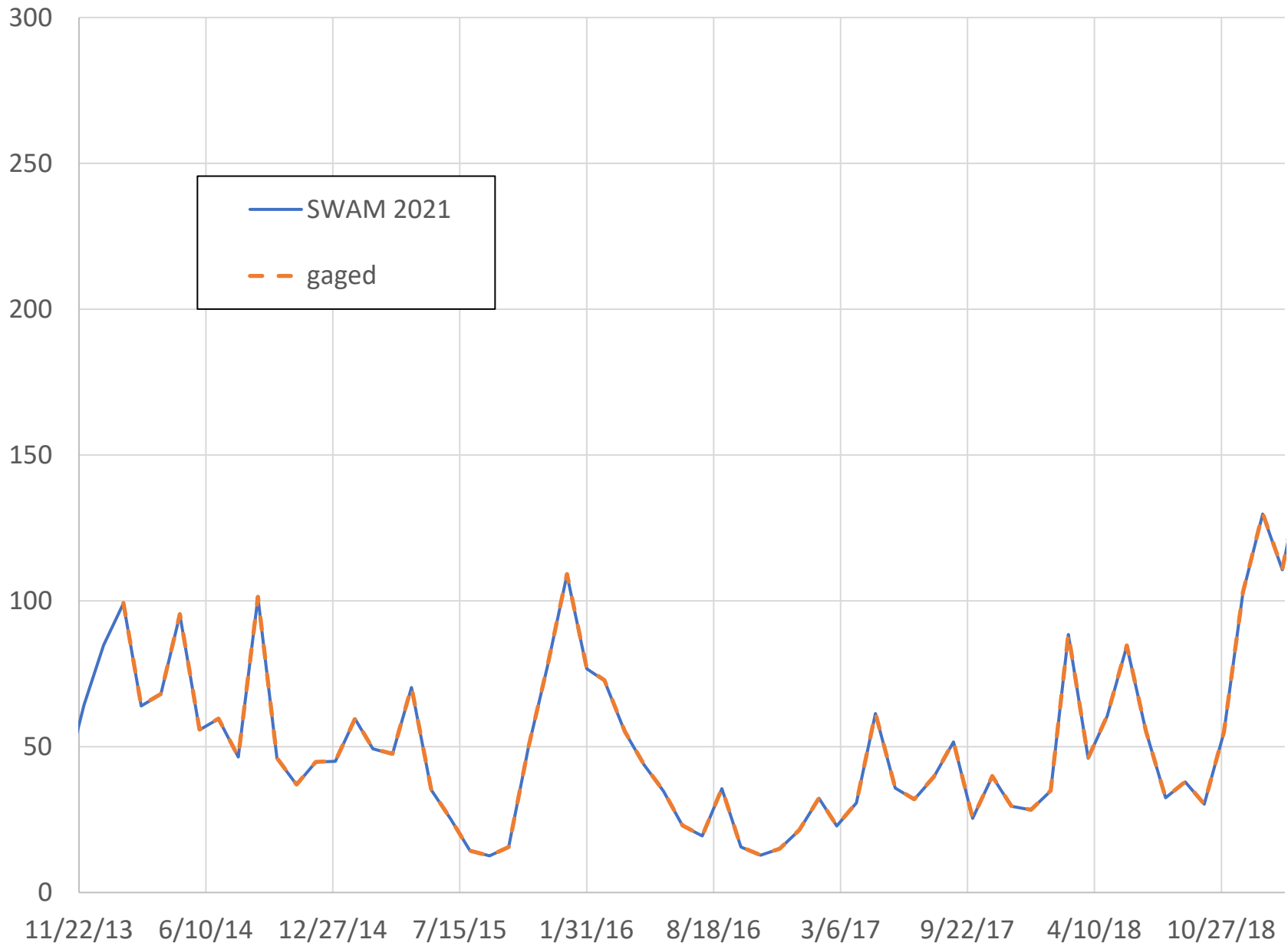
BRD11: S. Pacolet River near Campobello (cfs)



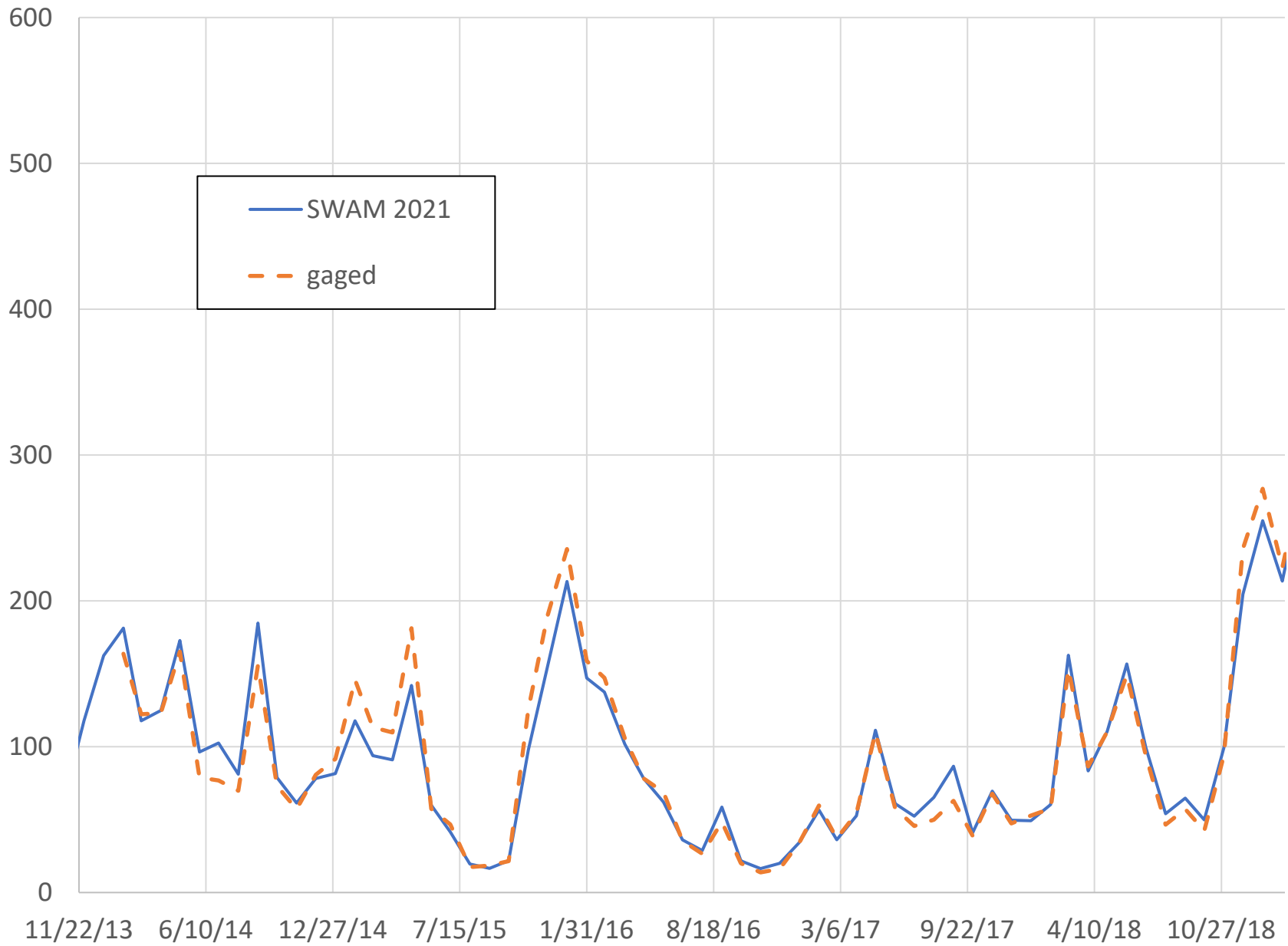
BRD14: Pacolet River below Lake Blalock (cfs)



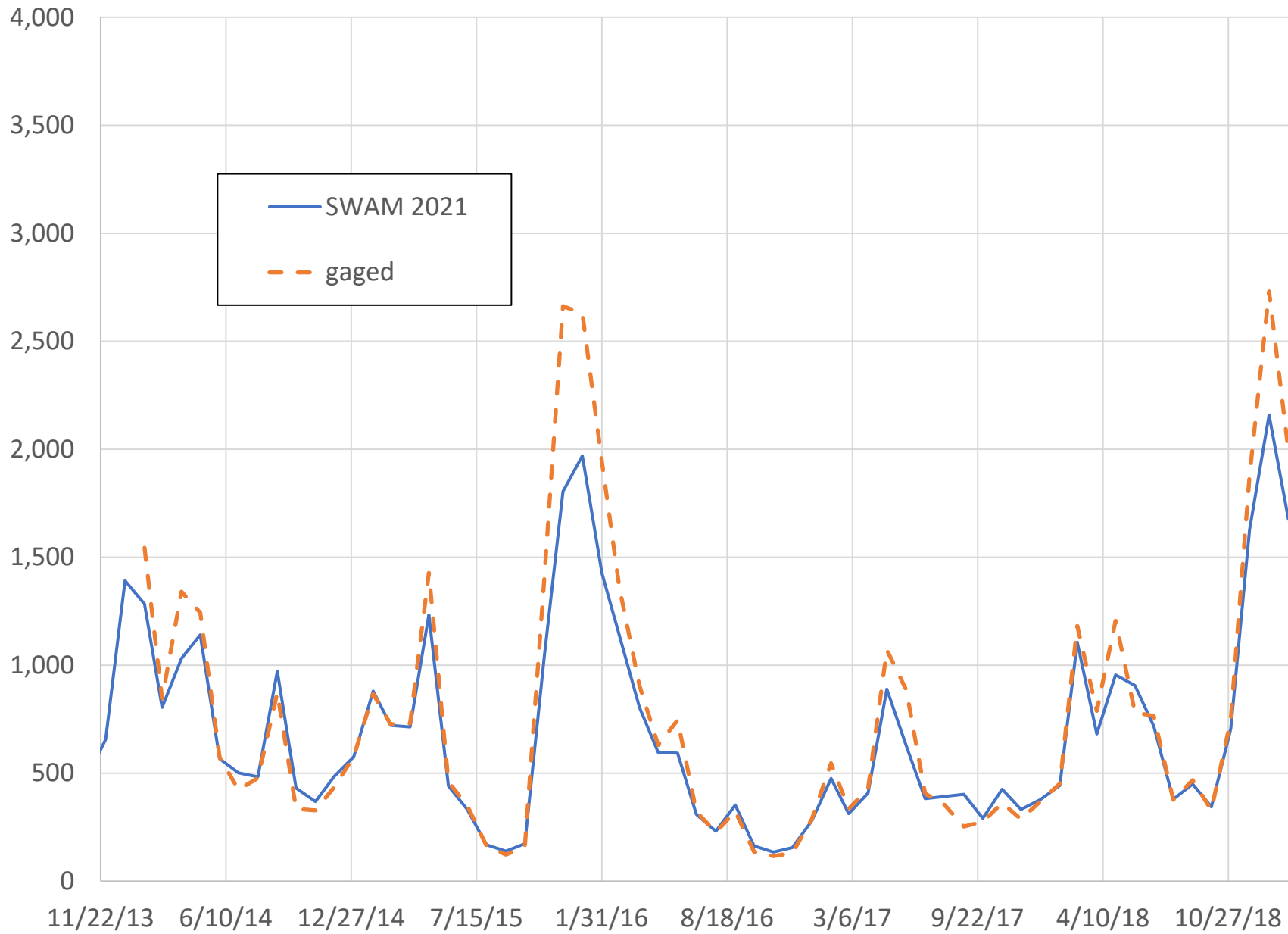
BRD27: Middle Tyger River near Gramling (cfs)



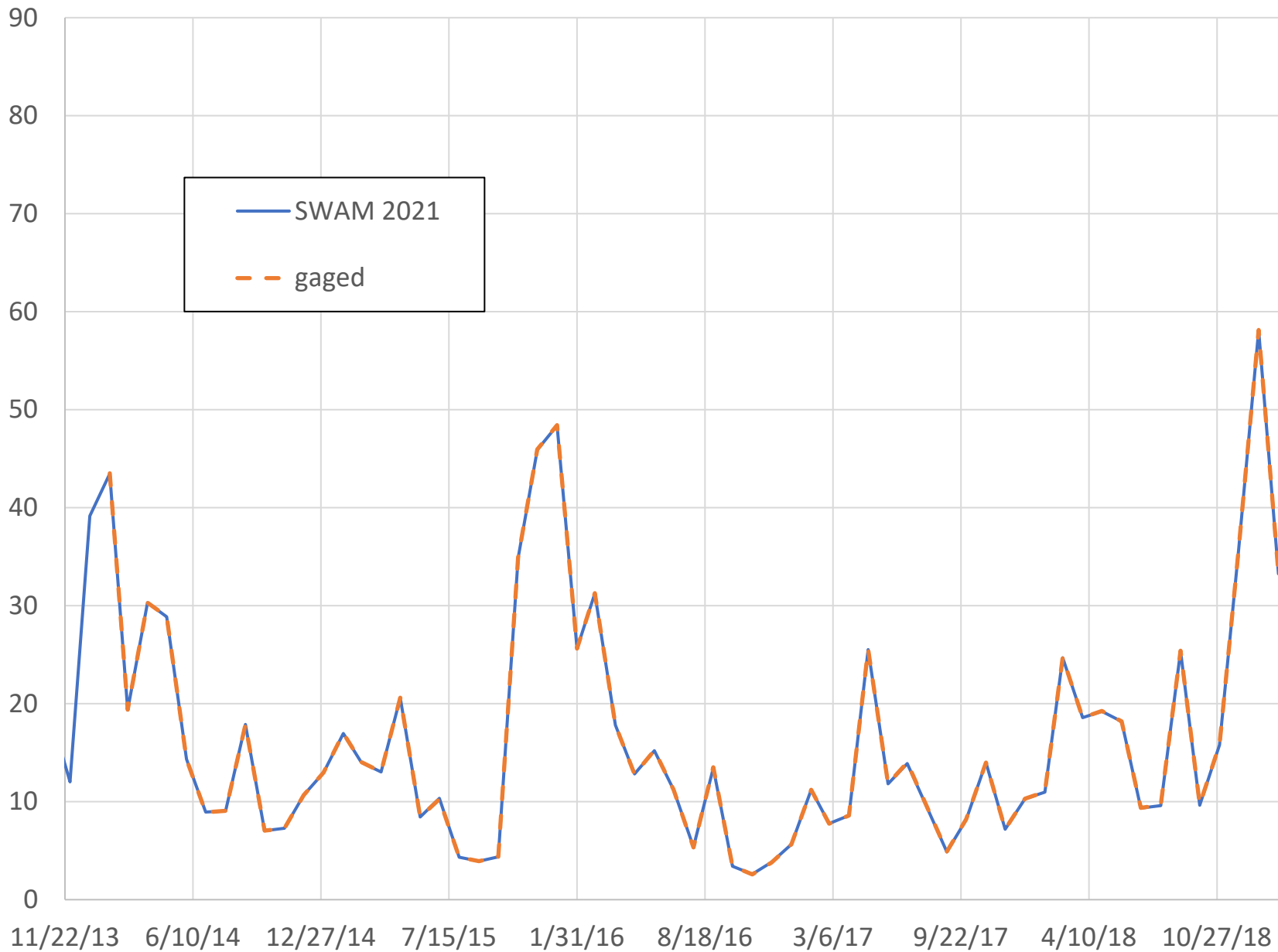
BRD30: Middle Tyger River near Lyman (cfs)



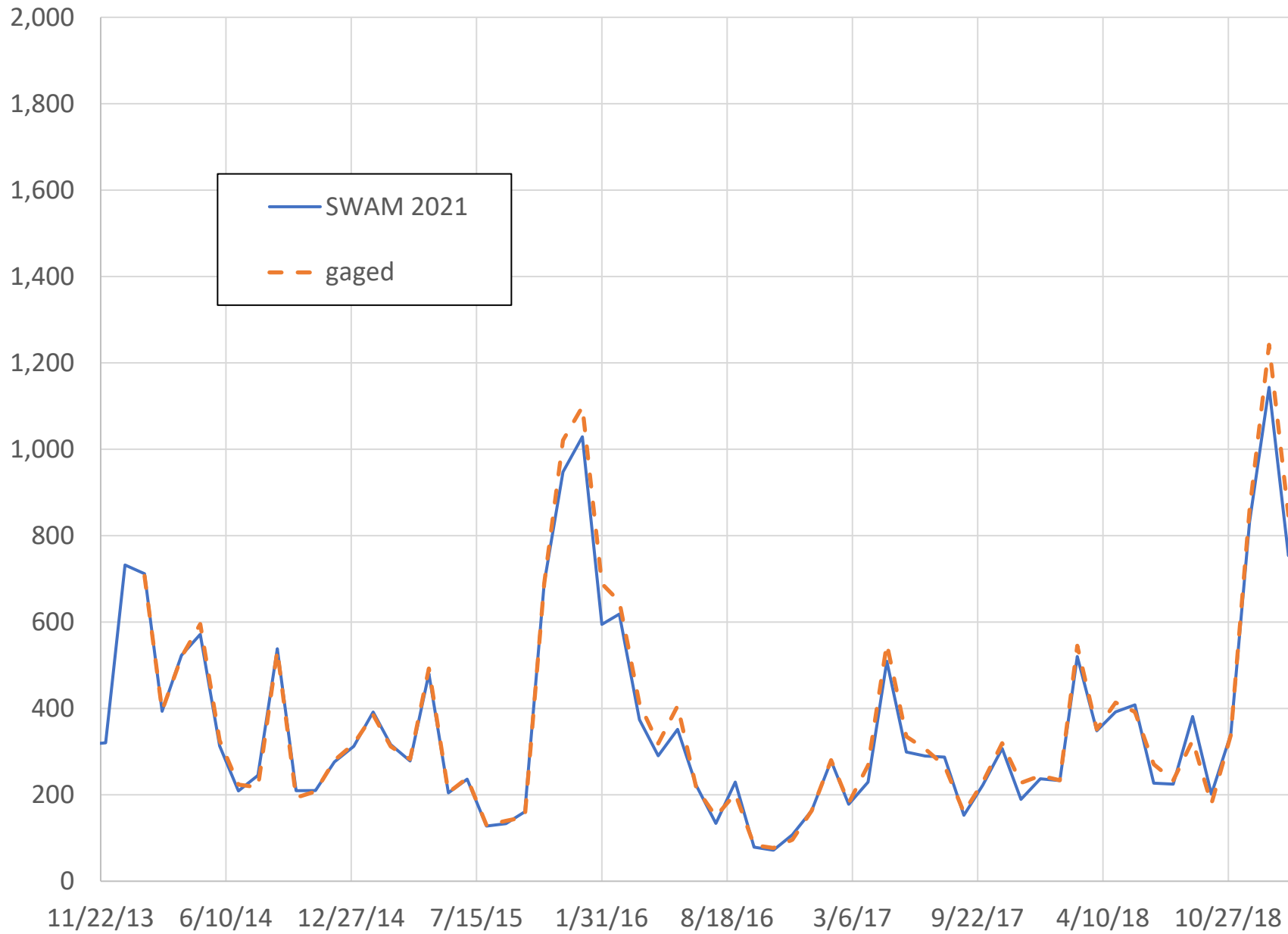
BRD42: Tyger River near Delta (cfs)



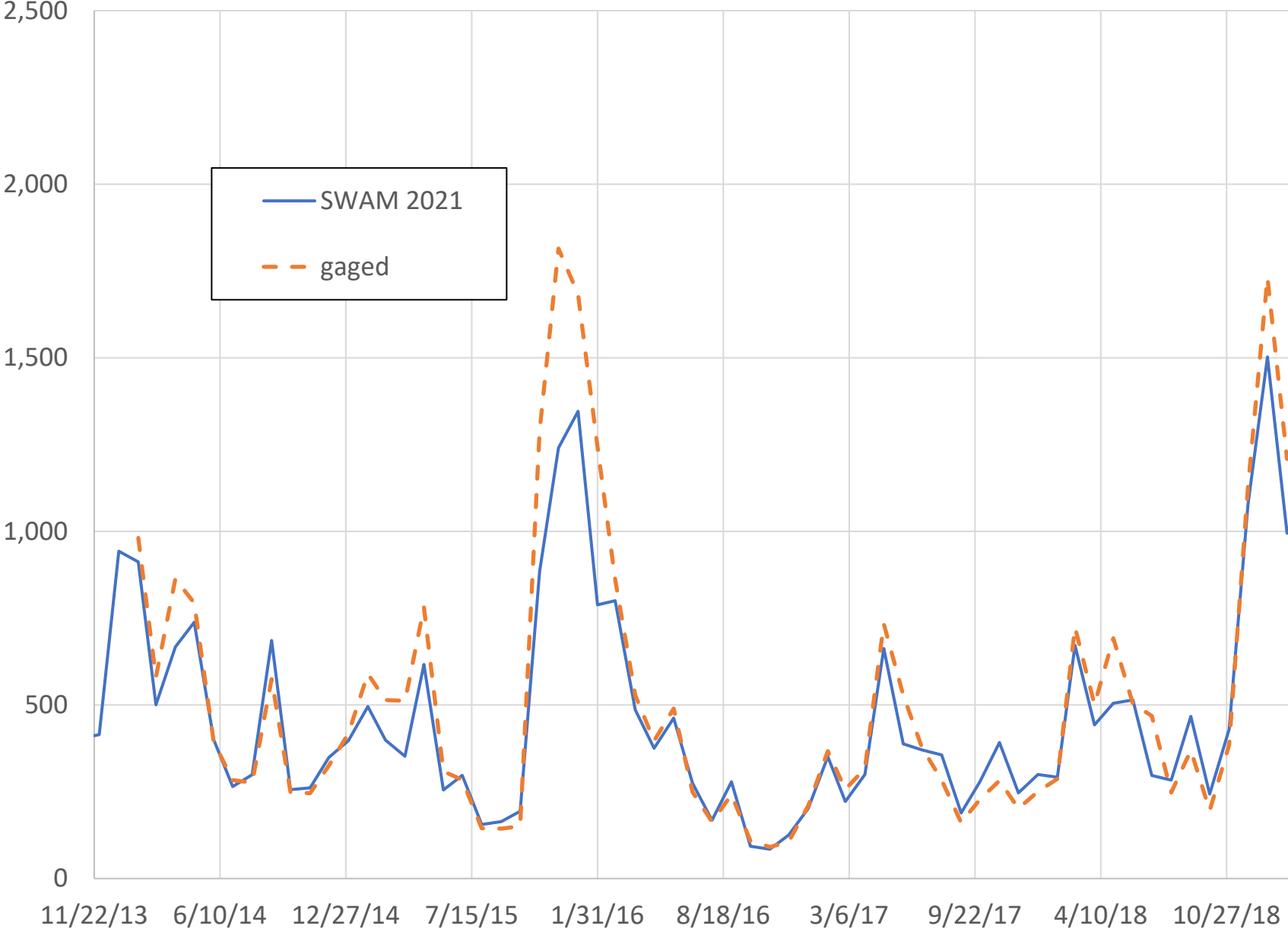
BRD47: Durbin Creek above Fountain Inn (cfs)



BRD48: Enoree River near Woodruff (cfs)

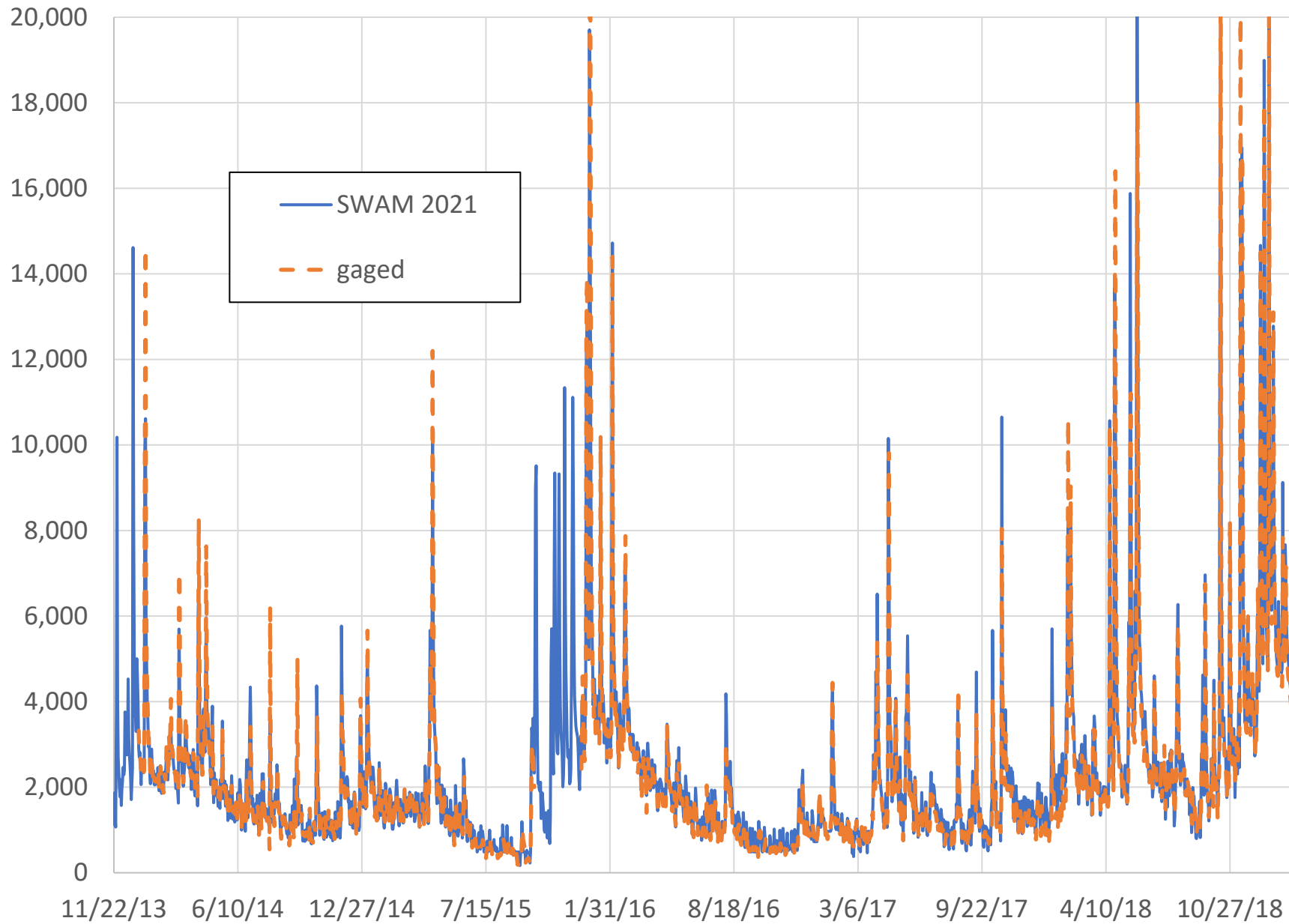


BRD50: Enoree River at Whitmire (cfs)

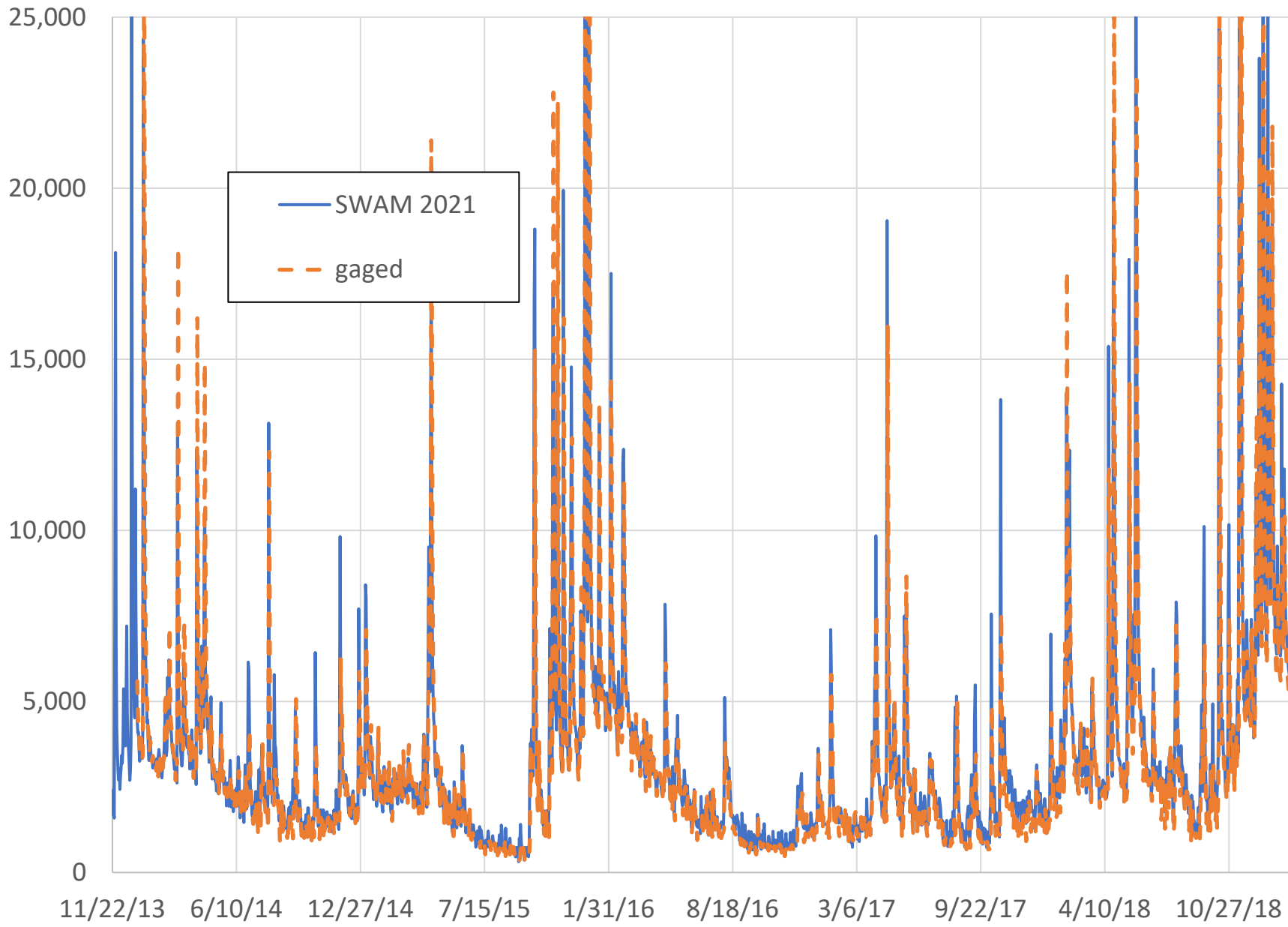


Attachment C  
Daily Validation Results

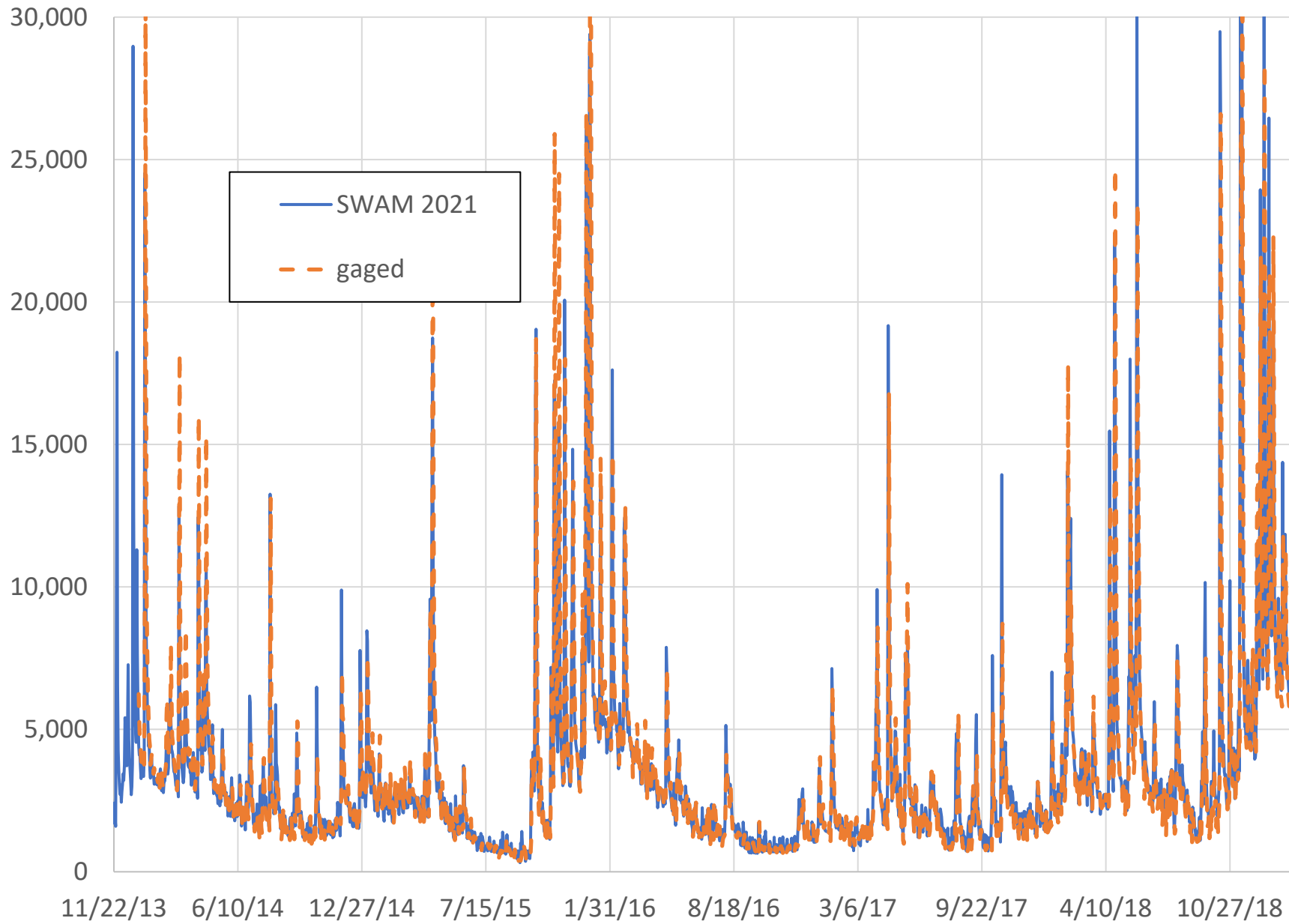
BRD03: Broad River below NinetyNine Island Reservoir (cfs)



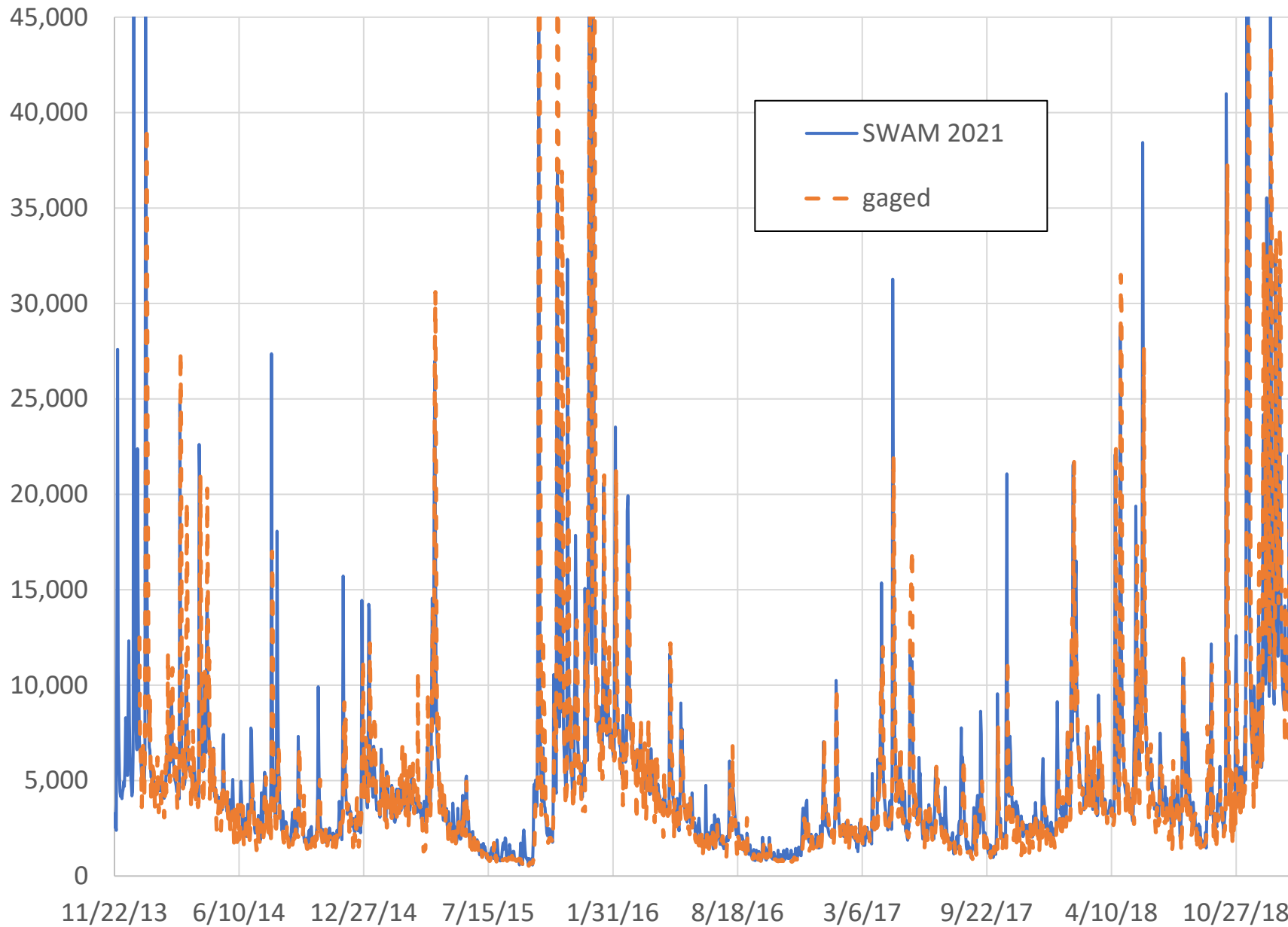
BRD22: Broad River below Neal Shoals (cfs)



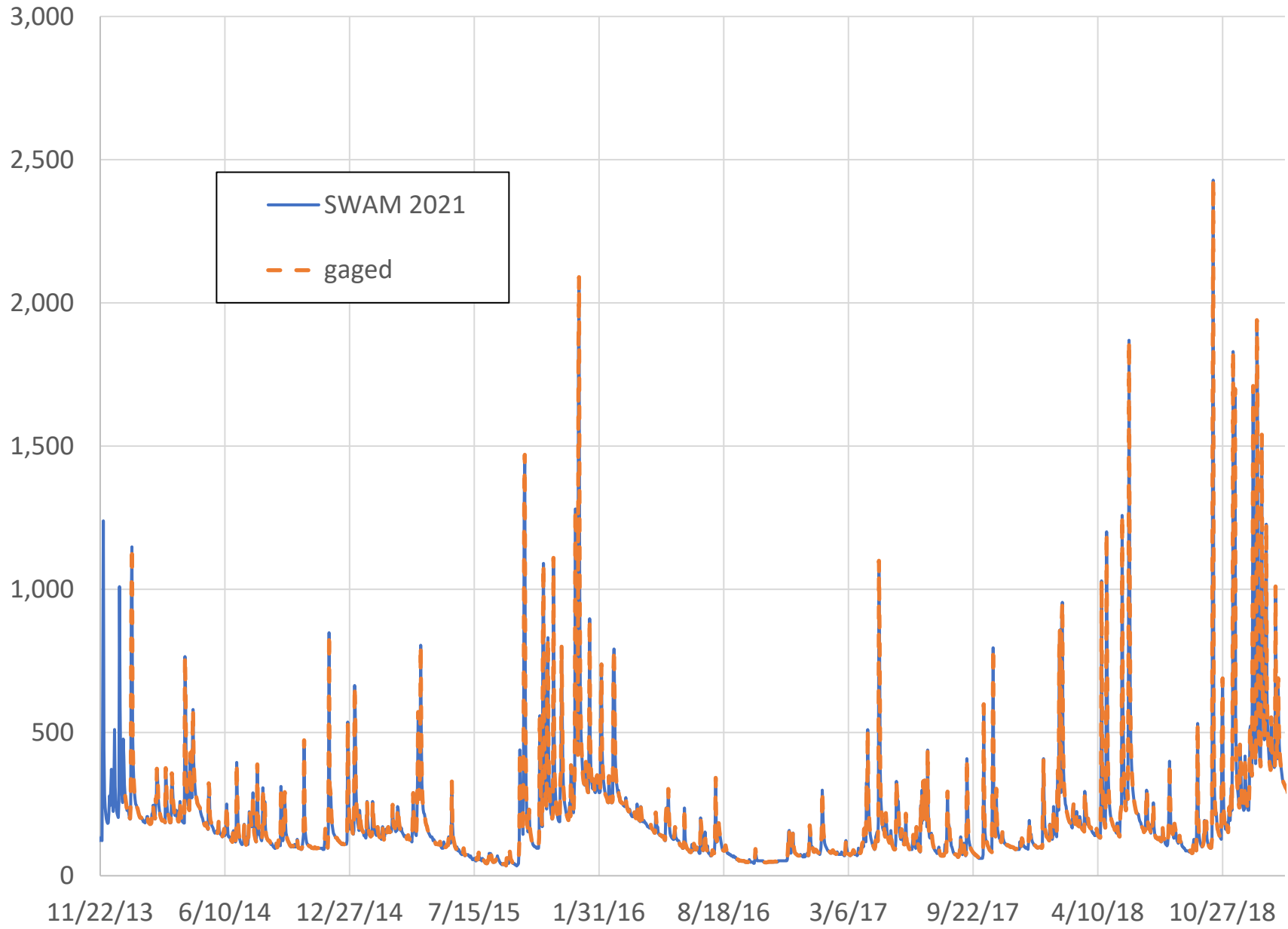
BRD24: Broad River near Carlisle (cfs)



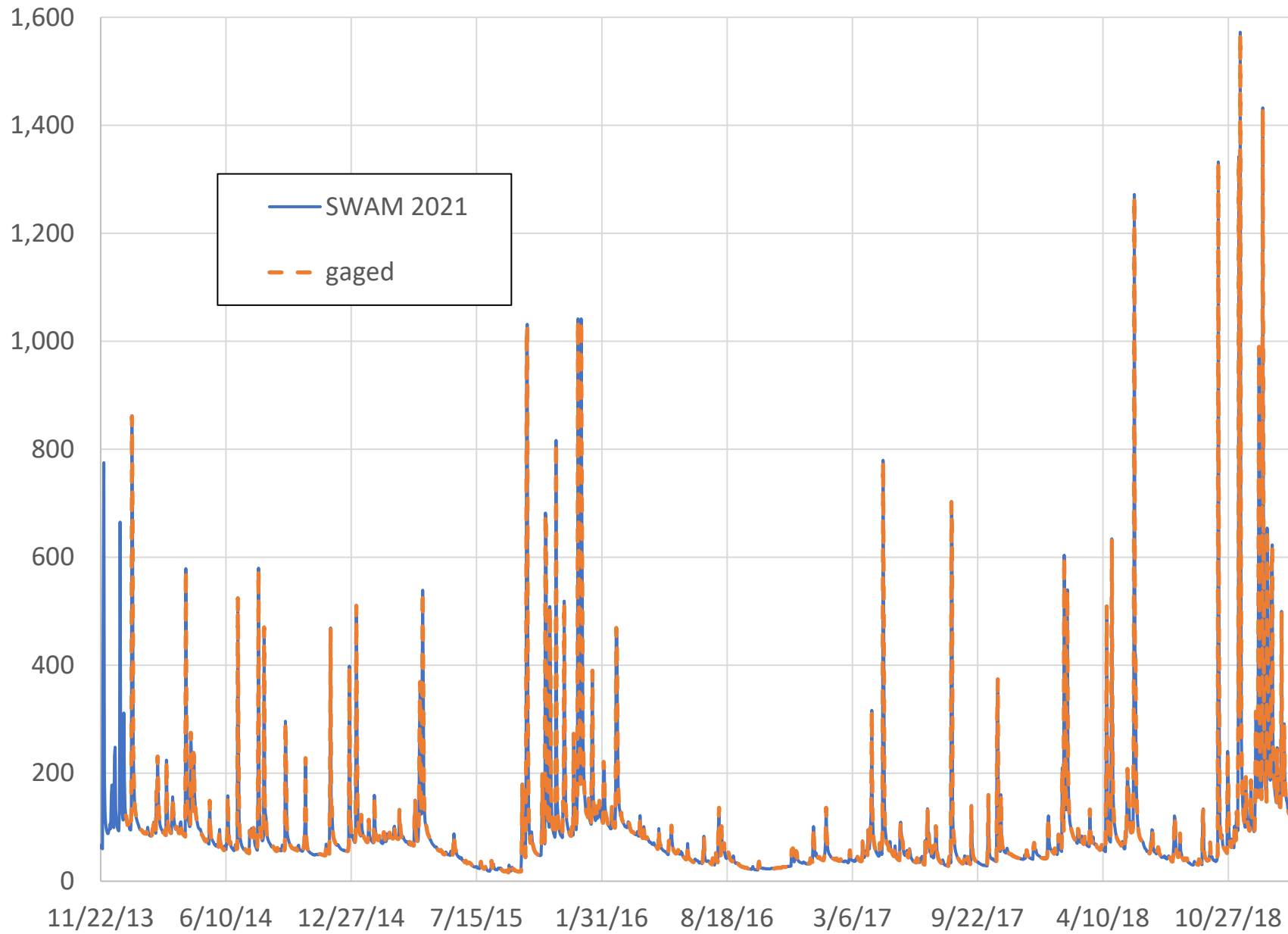
BRD54: Broad River at Alston (cfs)



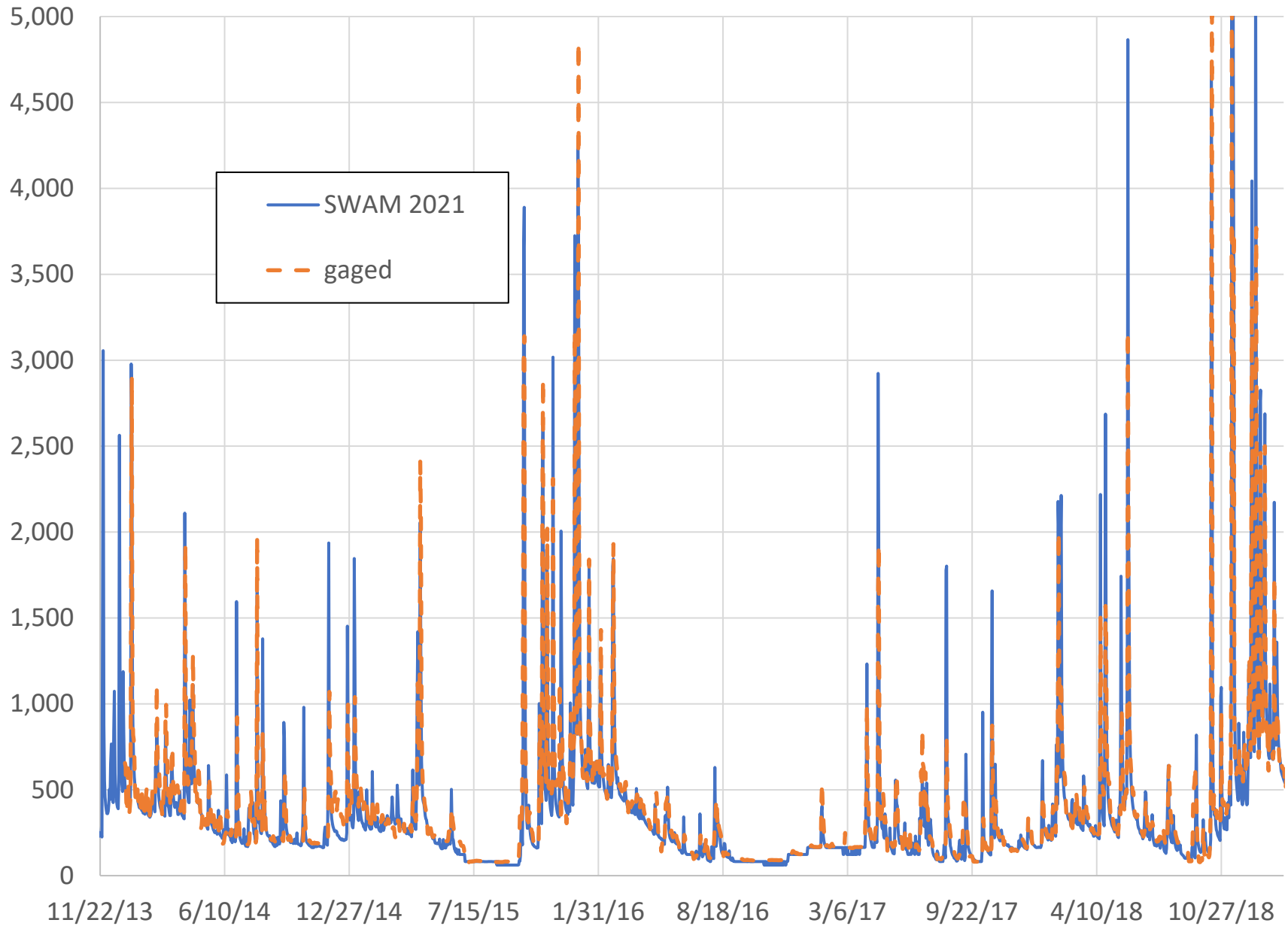
BRD10: N. Pacolet River at Fingerville (cfs)



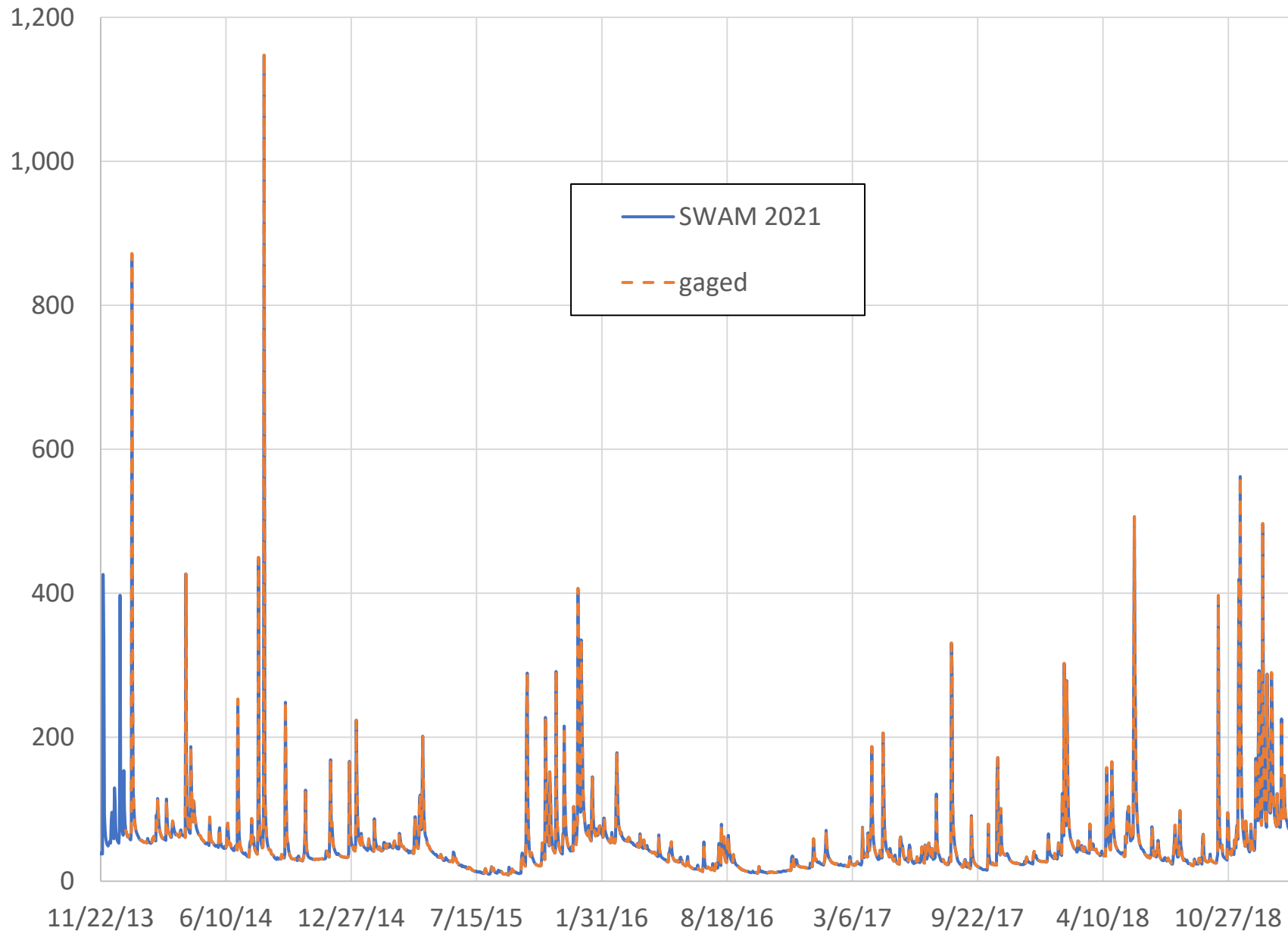
BRD11: S. Pacolet River near Campobello (cfs)



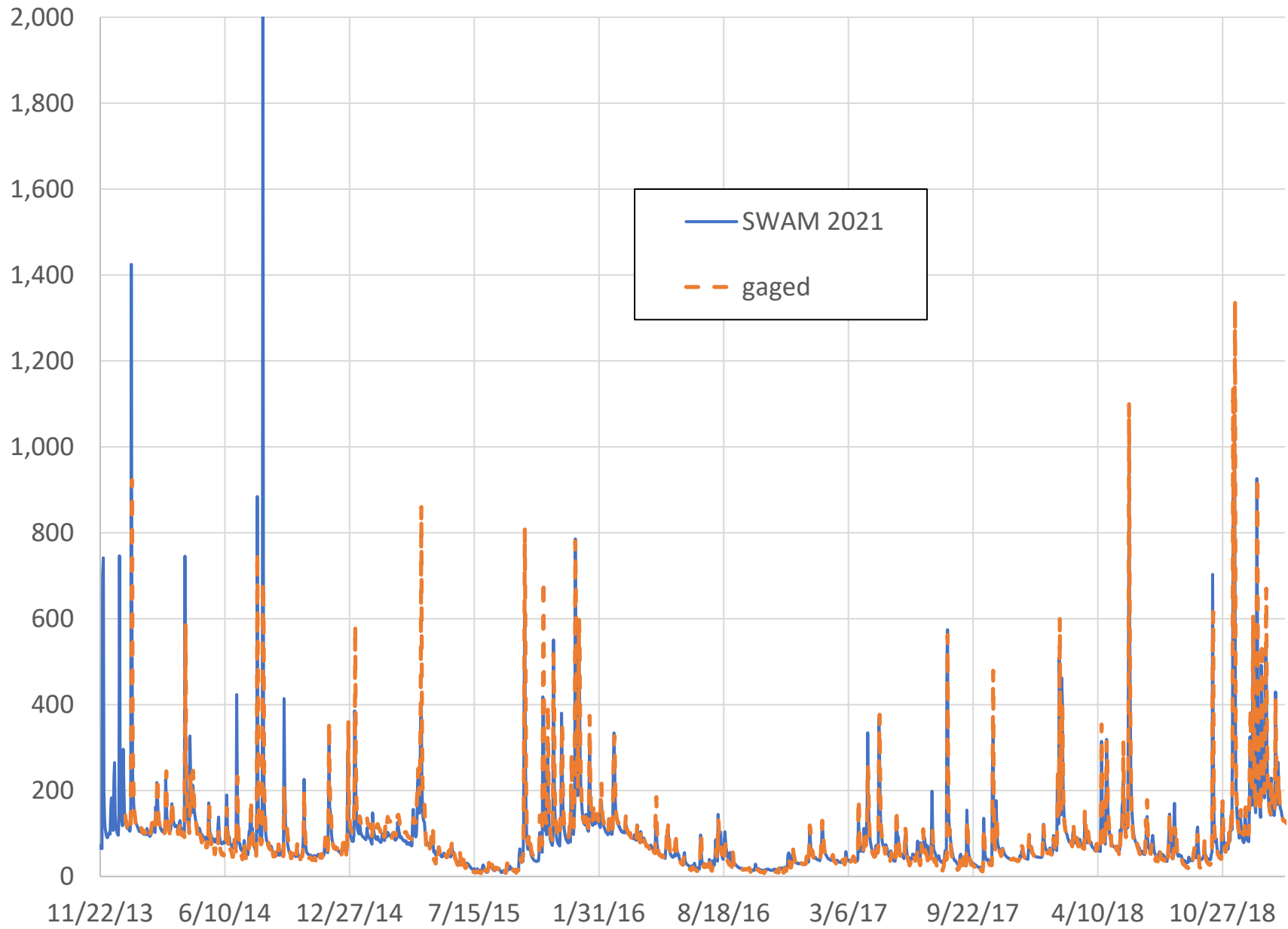
BRD14: Pacolet River below Lake Blalock (cfs)



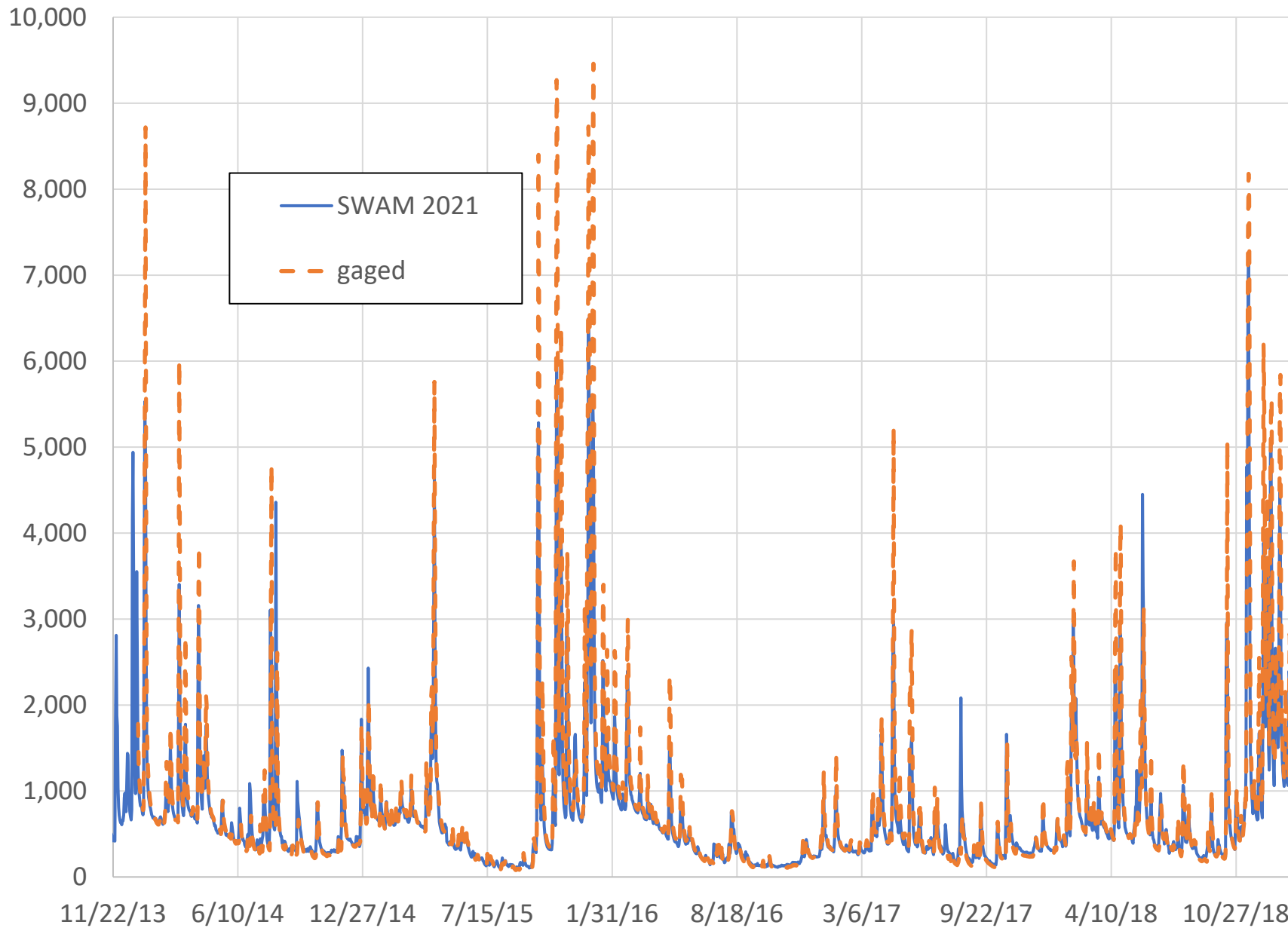
BRD27: Middle Tyger River near Gramling (cfs)



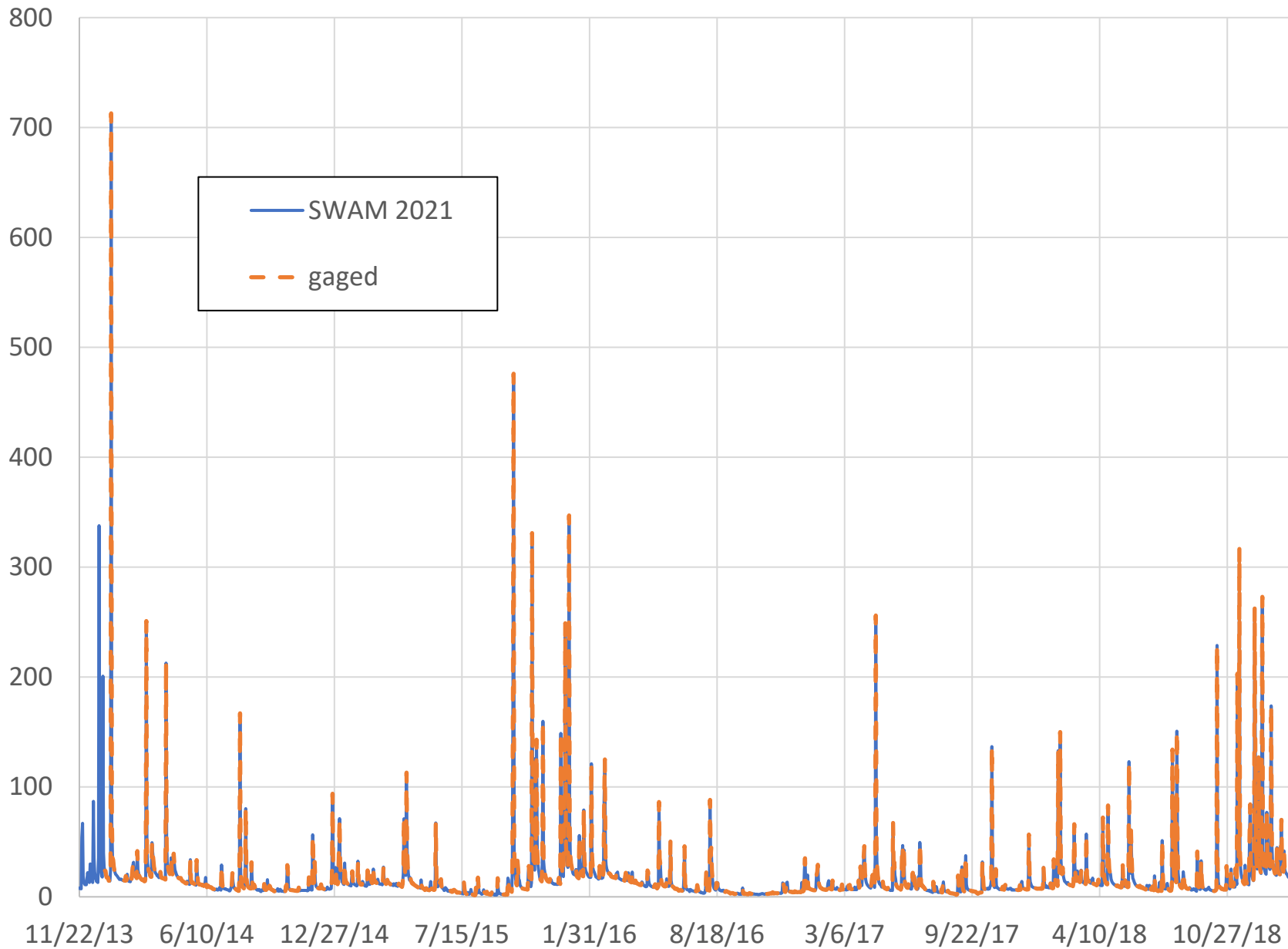
BRD30: Middle Tyger River near Lyman (cfs)



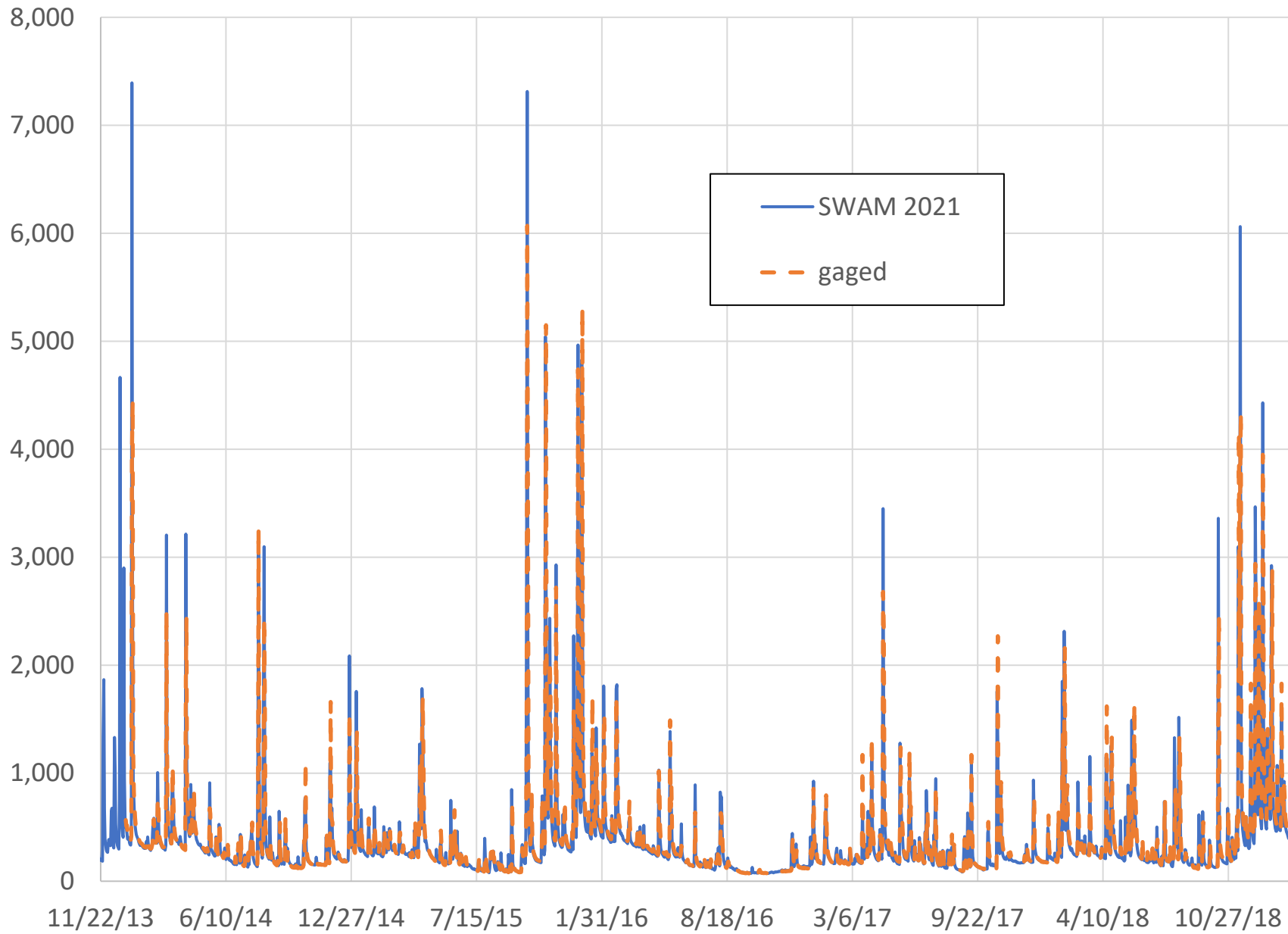
BRD42: Tyger River near Delta (cfs)



BRD47: Durbin Creek above Fountain Inn (cfs)



BRD48: Enoree River near Woodruff (cfs)



BRD50: Enoree River at Whitmire (cfs)

