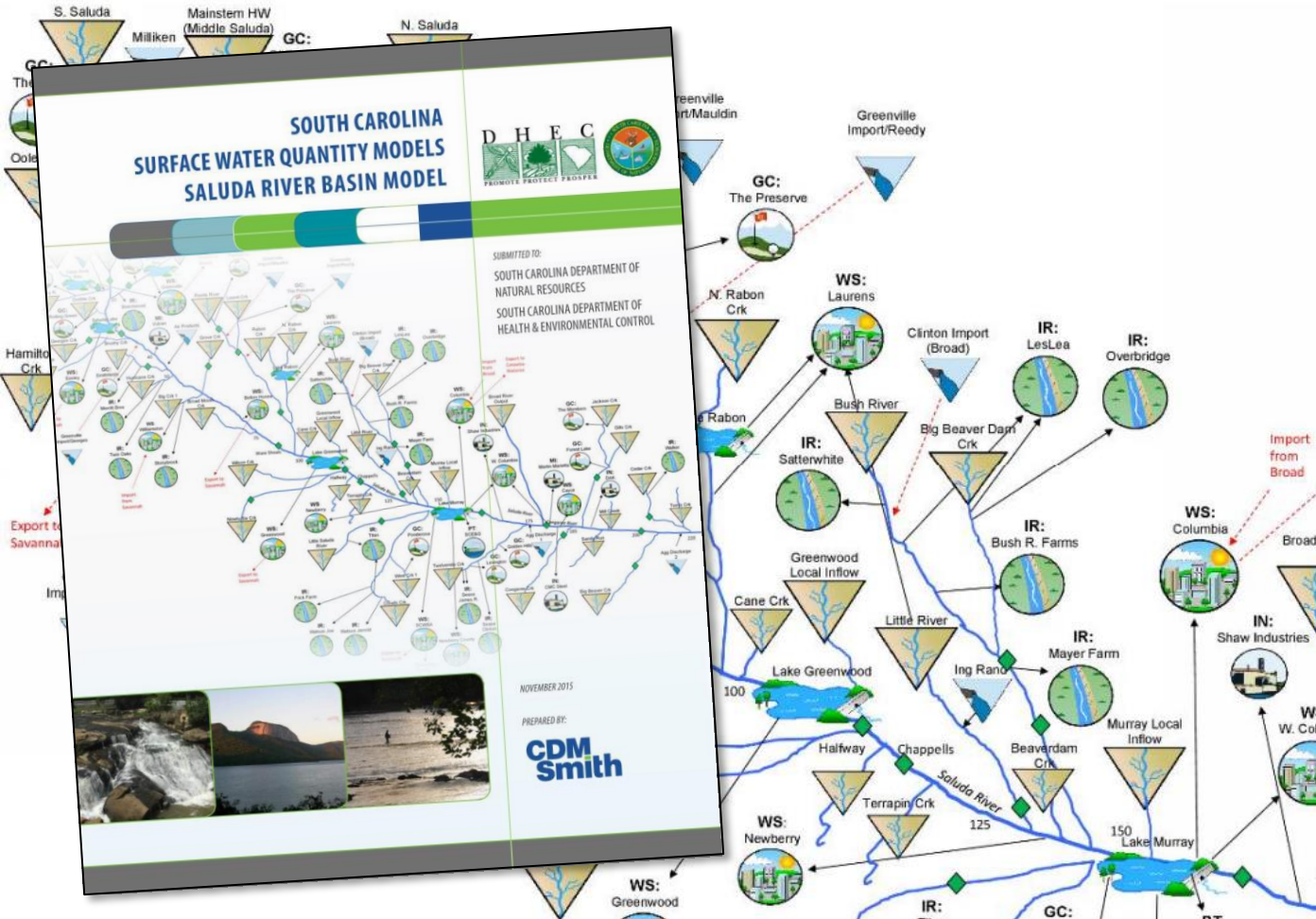


# South Carolina Surface Water Quantity Modeling Project

Saluda Basin Meeting No. 2 – Introduction to the Draft Model

Kirk Westphal, PE  
John Boyer, PE, BCEE  
Tim Cox, Ph.D., PE  
December 2, 2015



**CDM  
Smith**

# Presentation Outline

- Project Background and Status
- Model Calibration/Verification
  - Calibration/Verification Philosophy and Approach
  - Calibration Results and Discussion
- Saluda Baseline Model
  - Overview and Uses

# Project Purpose

- Build surface water quantity models capable of:
  - Accounting for inflows and outflows from a basin
  - Accurately simulating streamflows and reservoir levels over the historical inflow record
  - Conducting “What if” scenarios to evaluate future water demands, management strategies and system performance.

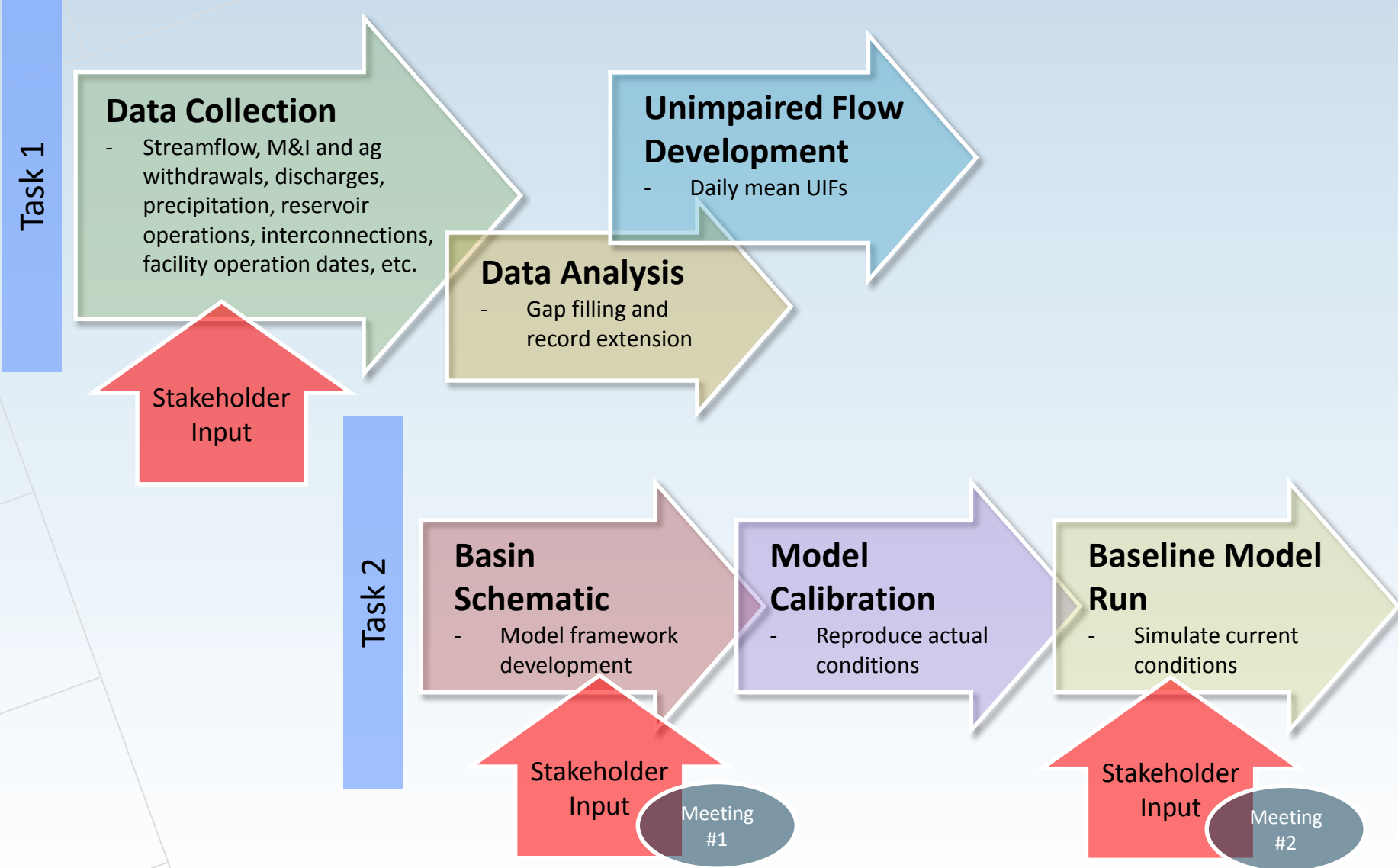


# The Simplified Water Allocation Model is...

- A water accounting tool
  - *Calculates physically and legally available water*
  - *Traces water through a natural stream network, simulating withdrawals, discharges, storage, and hydroelectric operations*
- Not precipitation-runoff model (e.g., HEC-HMS)
- Not a hydraulic model (e.g. HEC-RAS)
- Not a water quality model (e.g., QUAL2K)
- Not an optimization model
- Not a groundwater flow model (e.g., MODFLOW)



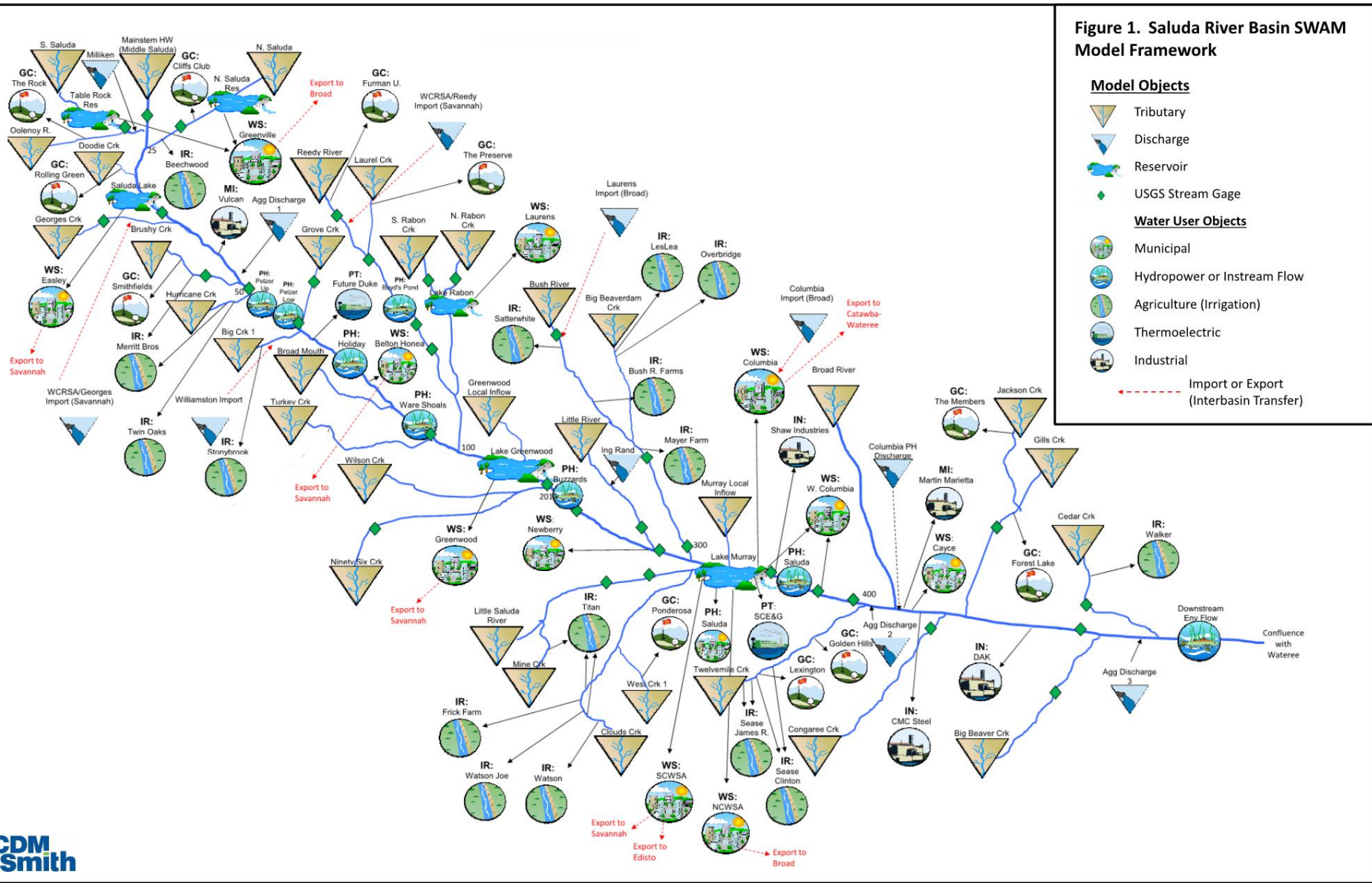
# Project Status – Saluda Basin



# Calibration vs. Baseline Model

- **Calibration Model**
  - Purpose: Confirm models ability to accurately simulate river basin flows and storage amounts
  - Uses recent withdrawal, discharge and flow records
- **Baseline Model**
  - Purpose: Evaluate water availability under future conditions
  - Uses entire record of flow and most current withdrawals and discharges

# Saluda Basin – SWAM Framework



# Modeling Report and Other Documents

- <http://www.dnr.sc.gov/water/waterplan/surfacewater.html>

The screenshot shows the website for the South Carolina Department of Natural Resources (DNR). The header includes the DNR logo and the slogan "Life's Better Outdoors". A navigation menu lists various activities: Buy, Boating, Education, Fishing, Hunting, Land, Maps, Regulations, Water, and Wildlife. The main content area is titled "Surface Water Modeling and Assessments" and contains several paragraphs of text explaining the modeling process and providing links to project documents. A sidebar on the left lists various information and contact options. At the bottom, there are social media icons for Facebook, RSS Feed, Twitter, and YouTube, along with contact information for the DNR.

Life's Better  
**Outdoors**  
South Carolina Department of Natural Resources

Buy Boating Education Fishing Hunting Land Maps Regulations Water Wildlife

Information

Contact Us  
News  
Other States  
Presentations  
Surface Water Modeling  
Water Assessment (2009 Report)  
Water Plan (2004 Report)  
White Papers  
Water Plan Home  
Hydrology Section

### Surface Water Modeling and Assessments

Effective water planning and management requires an accurate assessment of the location and quantity of the water resources of the State, and one of the most useful tools for evaluating management strategies is a computer model that simulates the surface water system throughout an entire watershed. To that end, SCDNR and SCDHEC have begun the process of developing surface-water quantity models for each of the [eight major watersheds](#), or basins, in South Carolina.

A more detailed discussion of the proposed surface water modeling can be found in the document [Basinwide Surface Water Modeling in South Carolina PDF](#), and an overview of each of the eight basins for which the models will be developed can be found in the document [Major Basins of South Carolina PDF](#).

In July 2014, CDM Smith, Inc. was awarded a contract to develop the models for the state.

#### Project Documents

For any questions regarding these reports and presentations, please contact Joe Gellici by phone (803-734-6428, [a](#)) or [email](#).

For information about stakeholder meetings, please visit [scwatermodels.com](#).

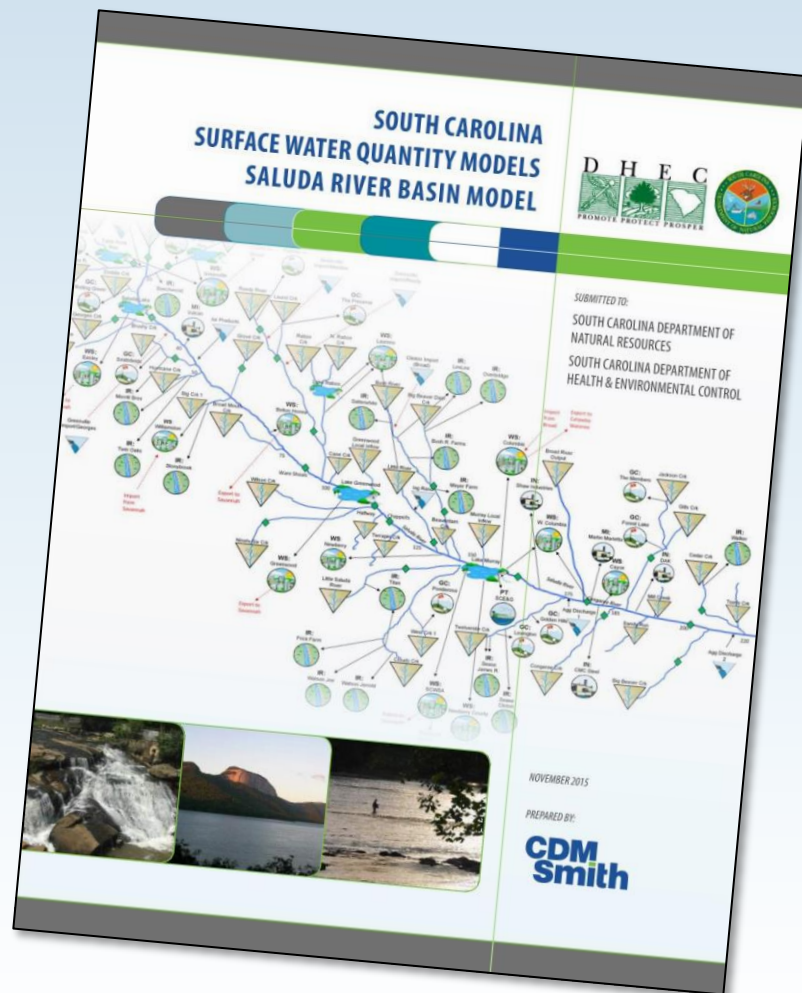
(Documents below are in PDF format.)

[Show](#) / [Hide](#) All Documents

- [Monthly Progress Reports](#)
- [Legislative Quarterly Reports](#)
- [Technical Reports](#)
- [Technical Memorandums](#)
- [Meeting Notes](#)
- [Presentations](#)
- [Videos](#)
- [River Basins](#)

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South Carolina Department of Natural Resources - [Phone Numbers](#) | [Accessibility](#) | 2014  
Rembert C. Dennis Building, 1000 Assembly Street, Columbia, SC 29201  
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Saluda River Basin

# MODEL CALIBRATION/VERIFICATION

# Calibration Objectives

1. Extend hydrologic inputs (headwater UIFs) spatially to adequately represent entire basin hydrology by parameterizing reach hydrologic inputs
2. Refine initial parameter estimates, as appropriate
  - E.g. reservoir operating rules, %Consumptive Use assumptions, return flow locations
3. Gain confidence in the model as a predictive tool by demonstrating its ability to adequately replicate past hydrologic conditions, operations, and water use
  - **without being overly prescriptive**

# Potential Sources of Model Error and Uncertainty

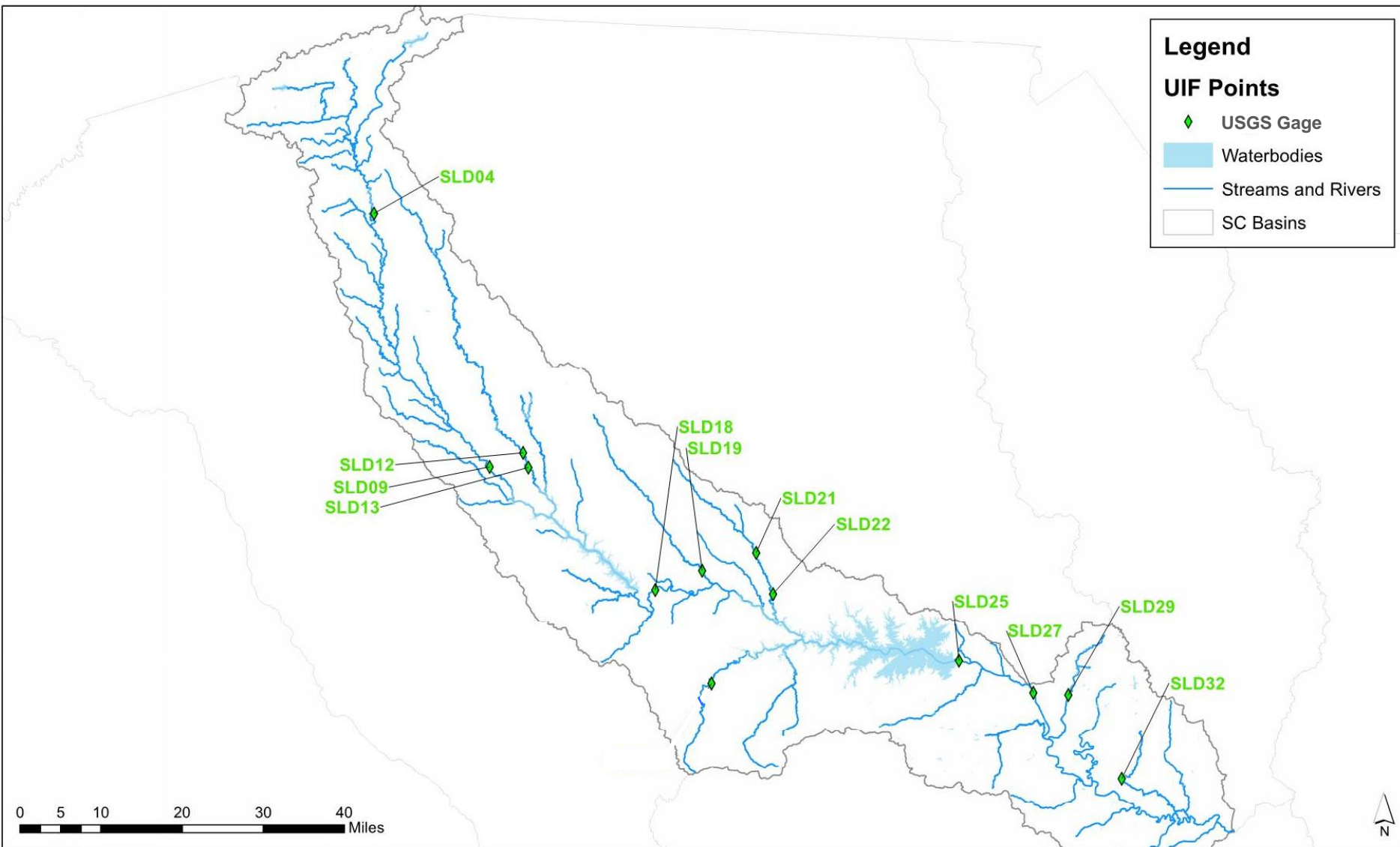
- Gaged flow data ( $\pm 20\%$ )
- Gaged reservoir levels ( $\pm ?\%$ )
- Basin climate and hydrologic variability
- Reported withdrawal data
- Consumptive use percentages
- Return flow locations (outdoor use)
- Return flow lag times (if applicable, e.g. outdoor use)
- *Reservoir operations (operator decision making)*
- *Reach hydrology: gains, losses, local runoff and inflow*

# Calibration/Validation General Approach

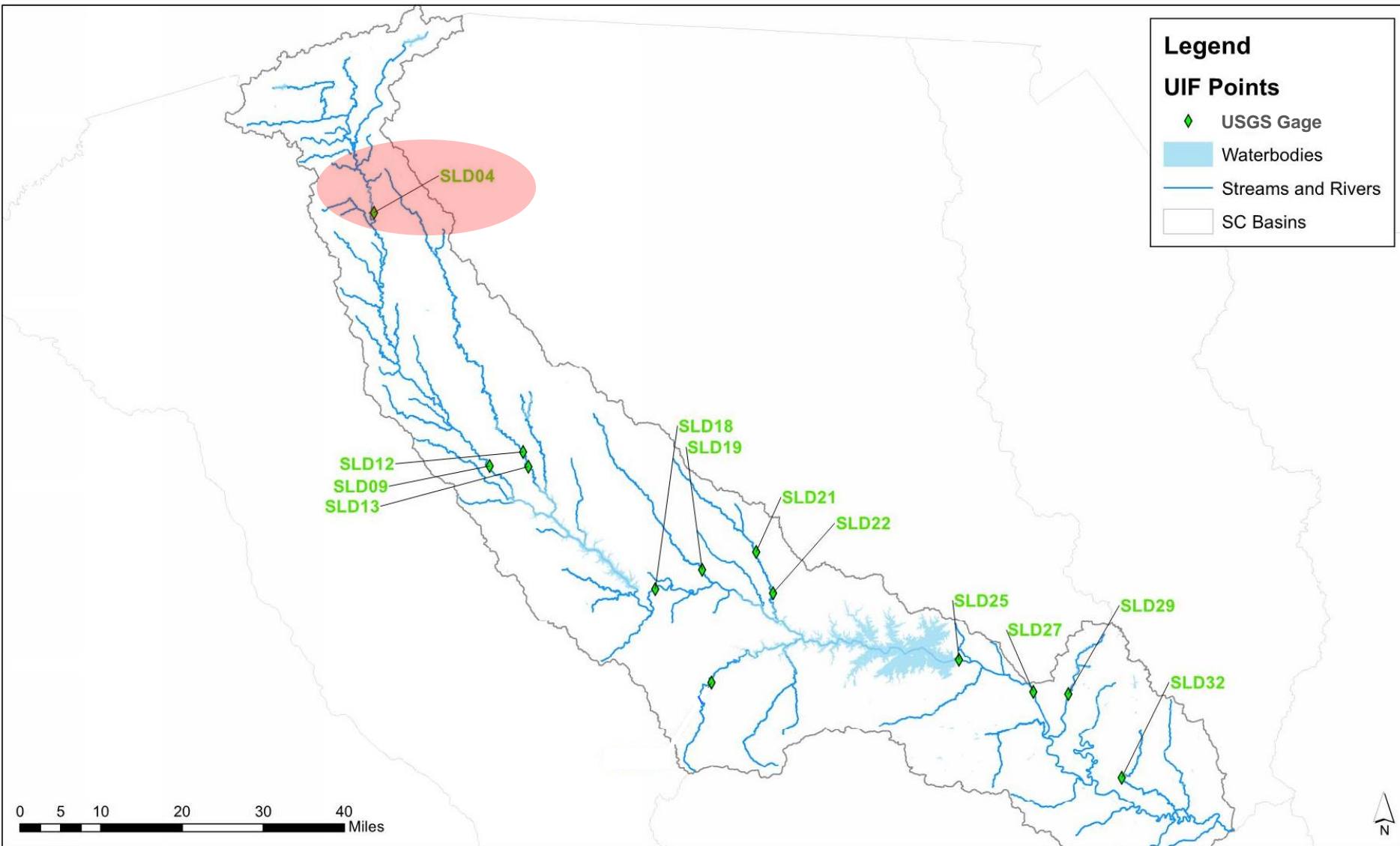
- 1983 – 2013 hindcast period; monthly timestep
  - Includes droughts in both early and late 2000's
- Comparison to gaged (measured) flow data only
  - operations and impairments are implicit in that data
- Assess performance at (subject to gage data availability):
  - multiple mainstem locations
  - all tributary confluence locations
  - major reservoirs
- Multiple model performance metrics, including:
  - timeseries plots (monthly and daily variability)
  - annual and monthly means (water balance and seasonality)
  - percentile plots (extremes and frequency)



# Calibration/Validation Locations

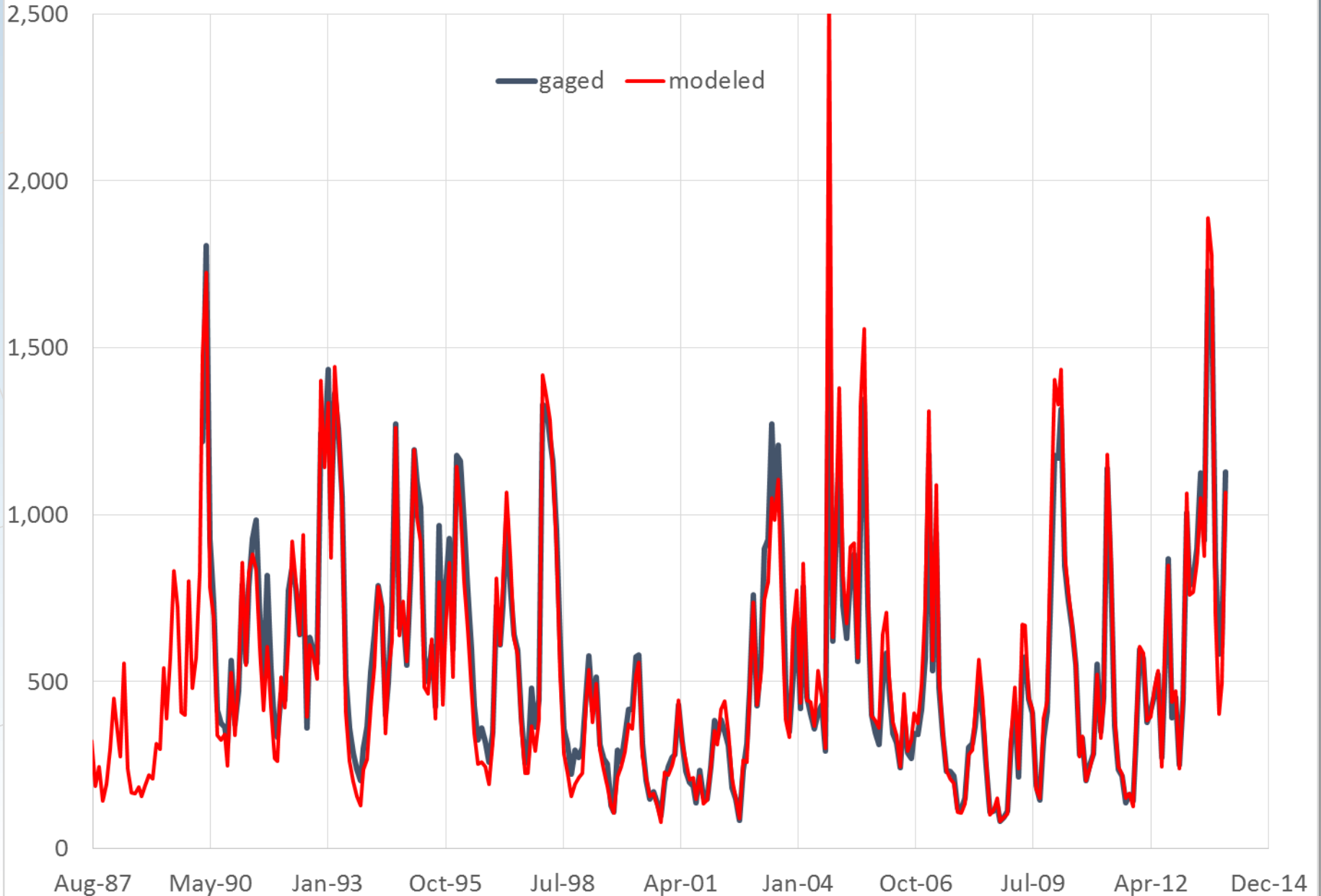


# Saluda River Near Greenville



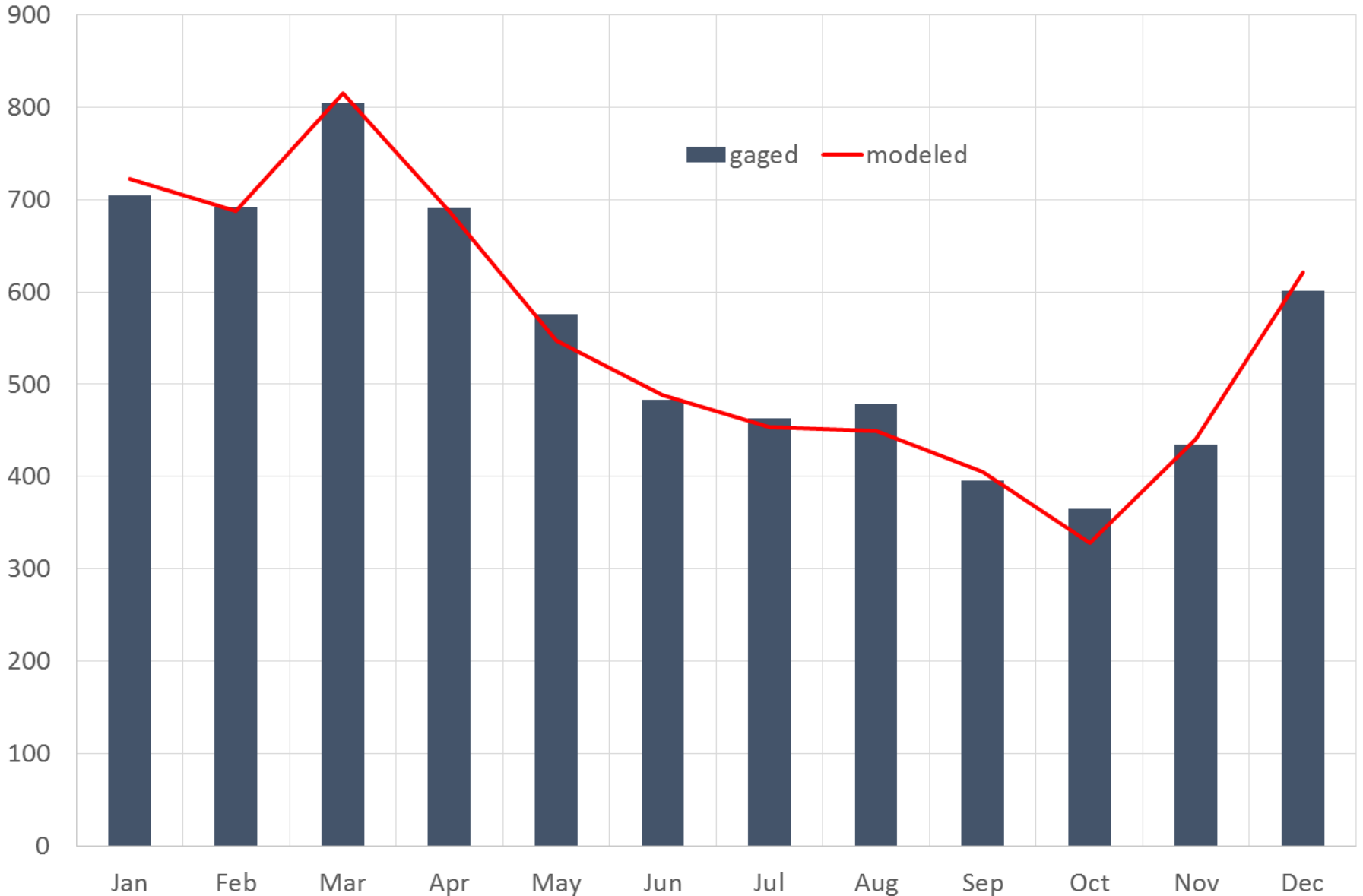
# Monthly Flow Comparison

SLD04 Saluda nr Greenville (CFS)



# Monthly Mean Flow Comparison

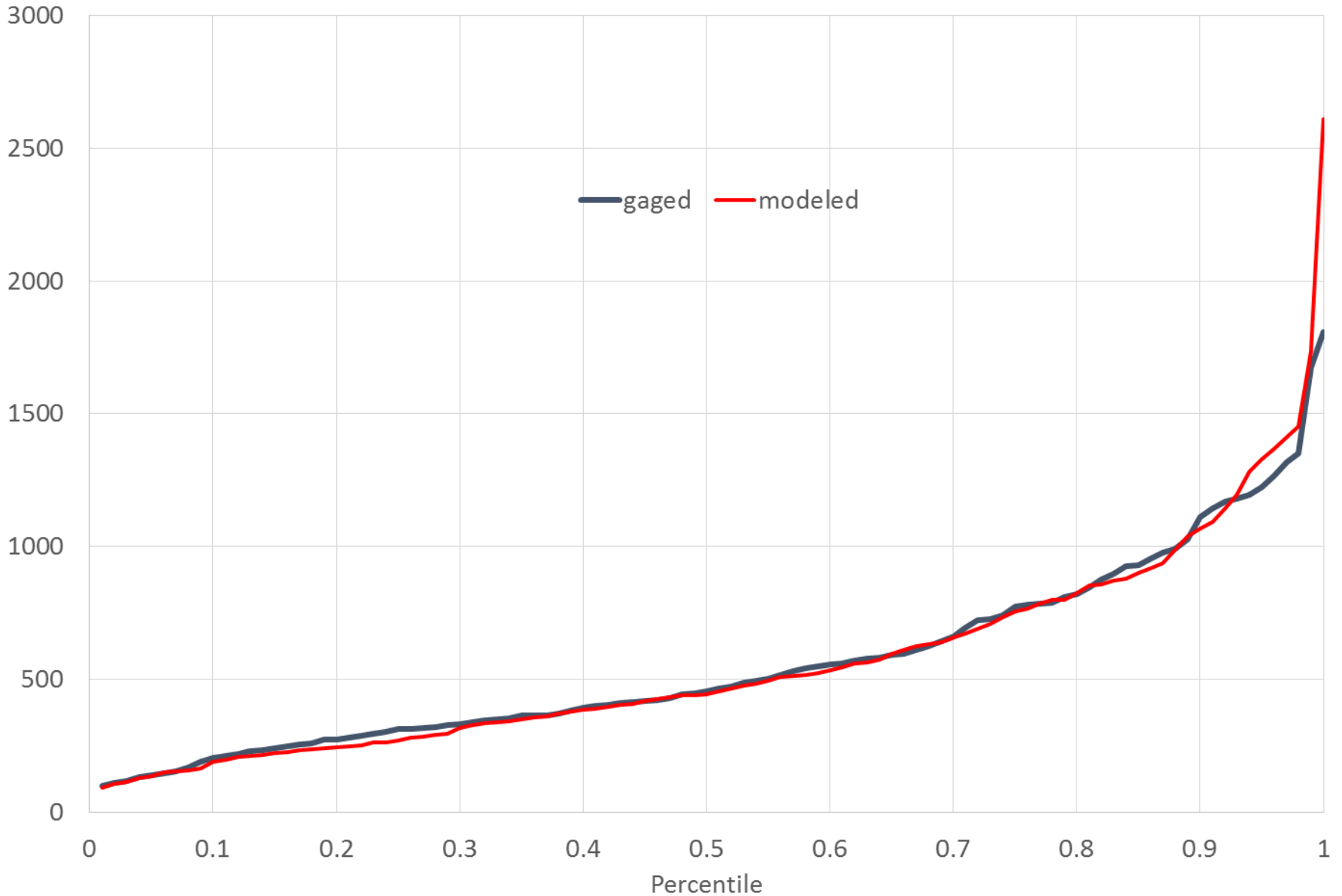
SLD 04 Saluda River nr Greenville  
Monthly Mean Flow (CFS)





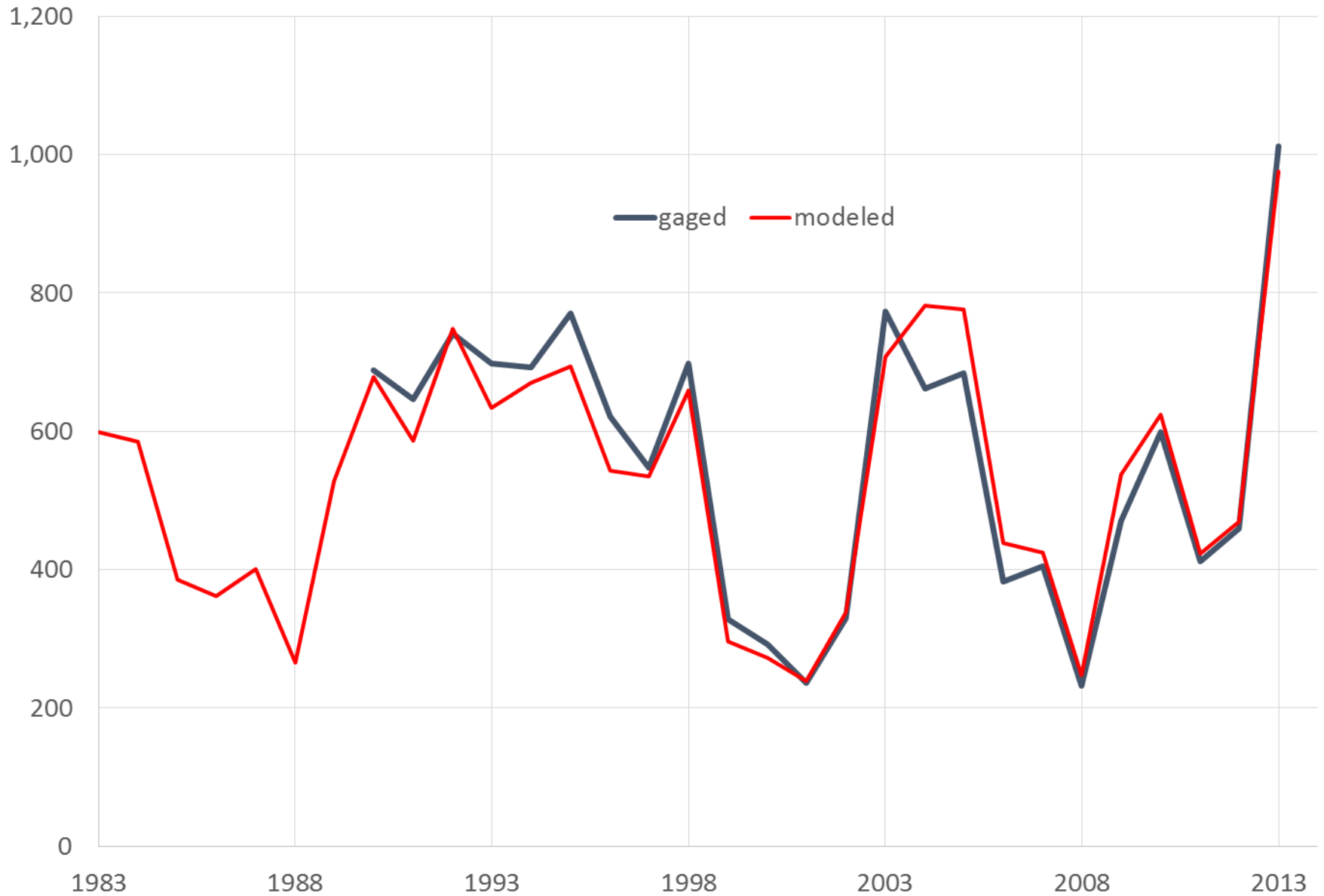
# Monthly Flow Percentiles Comparison

SLD04 Saluda River nr Greenville  
Monthly Flow Percentiles (CFS)

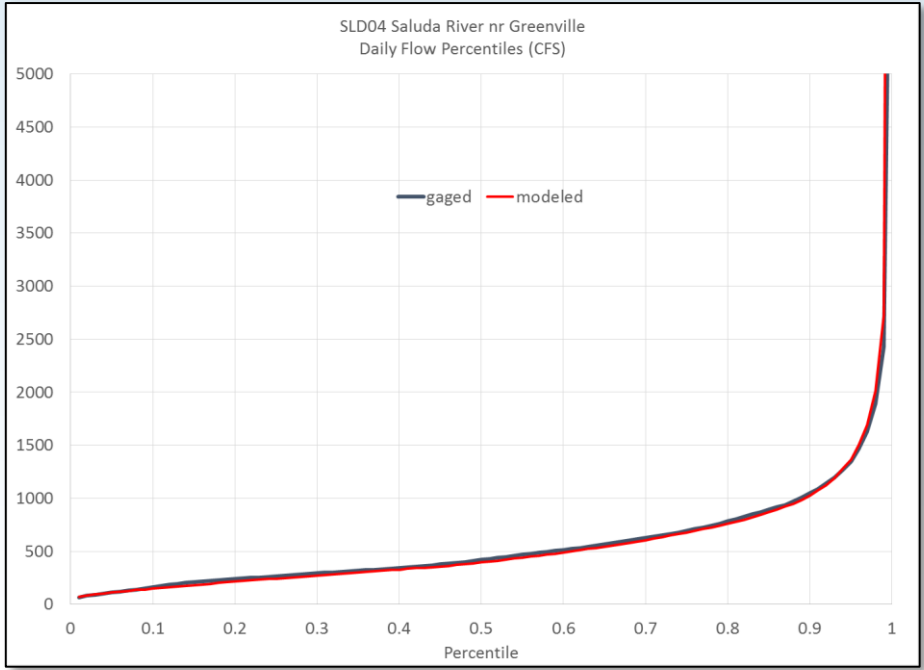
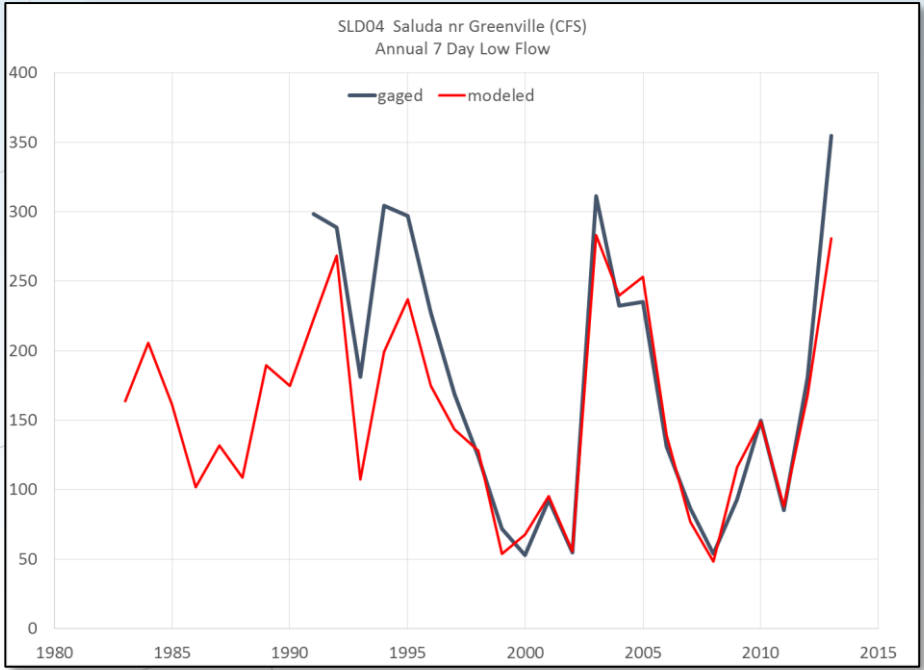
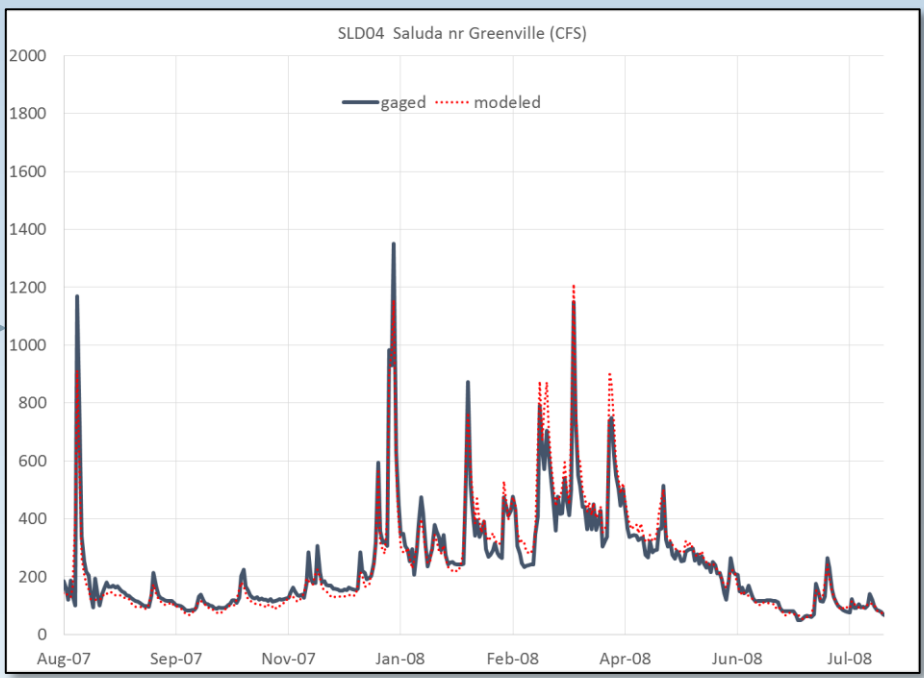
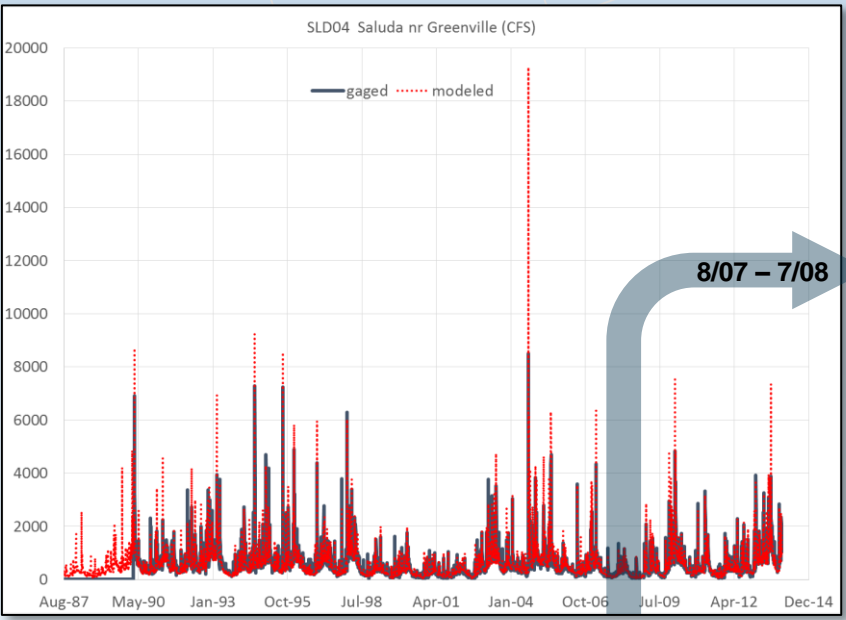


# Annual Average Flow Comparison

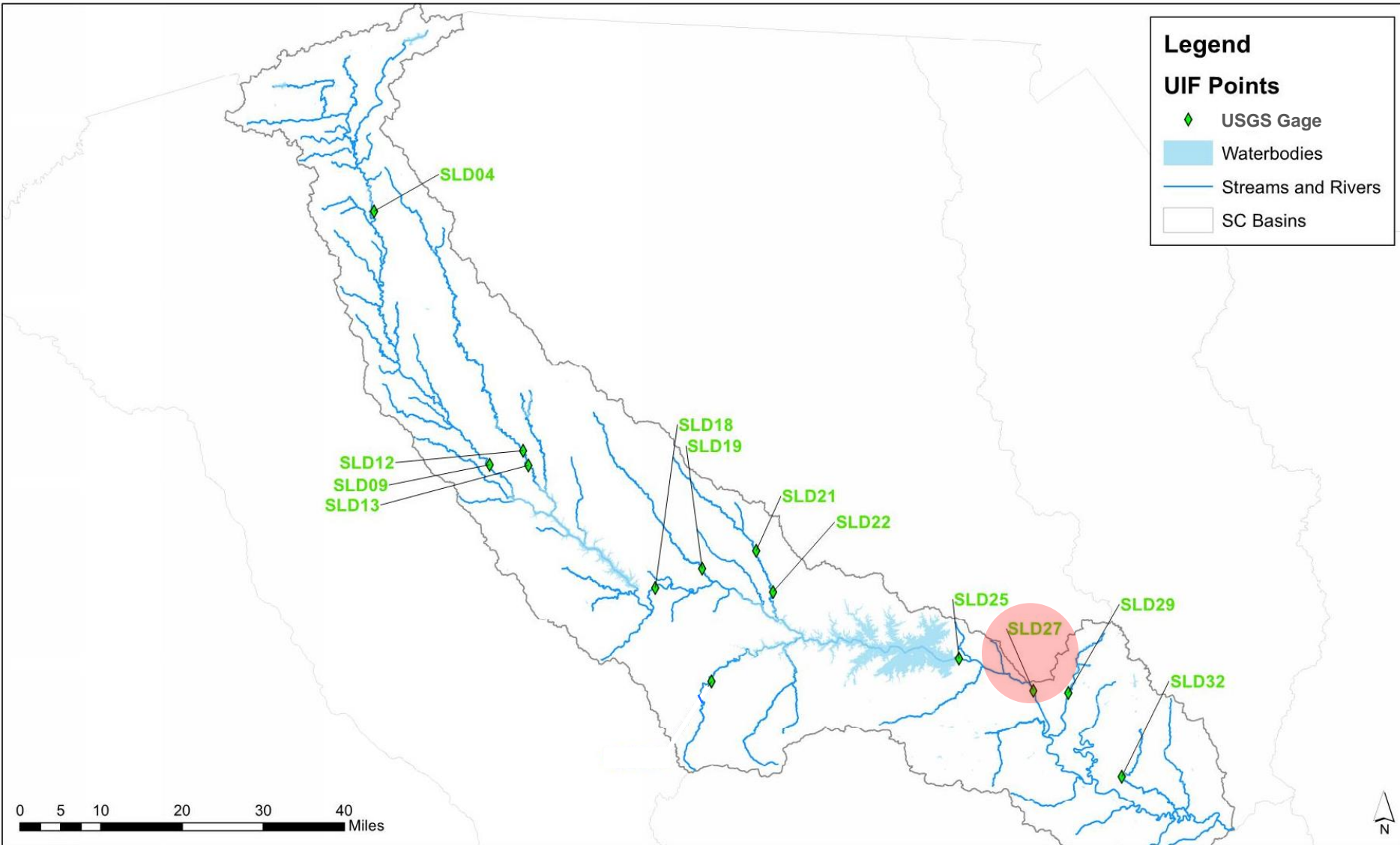
SLD 04 nr Greenville (CFS)  
Annual Average Flow



# Daily Comparison



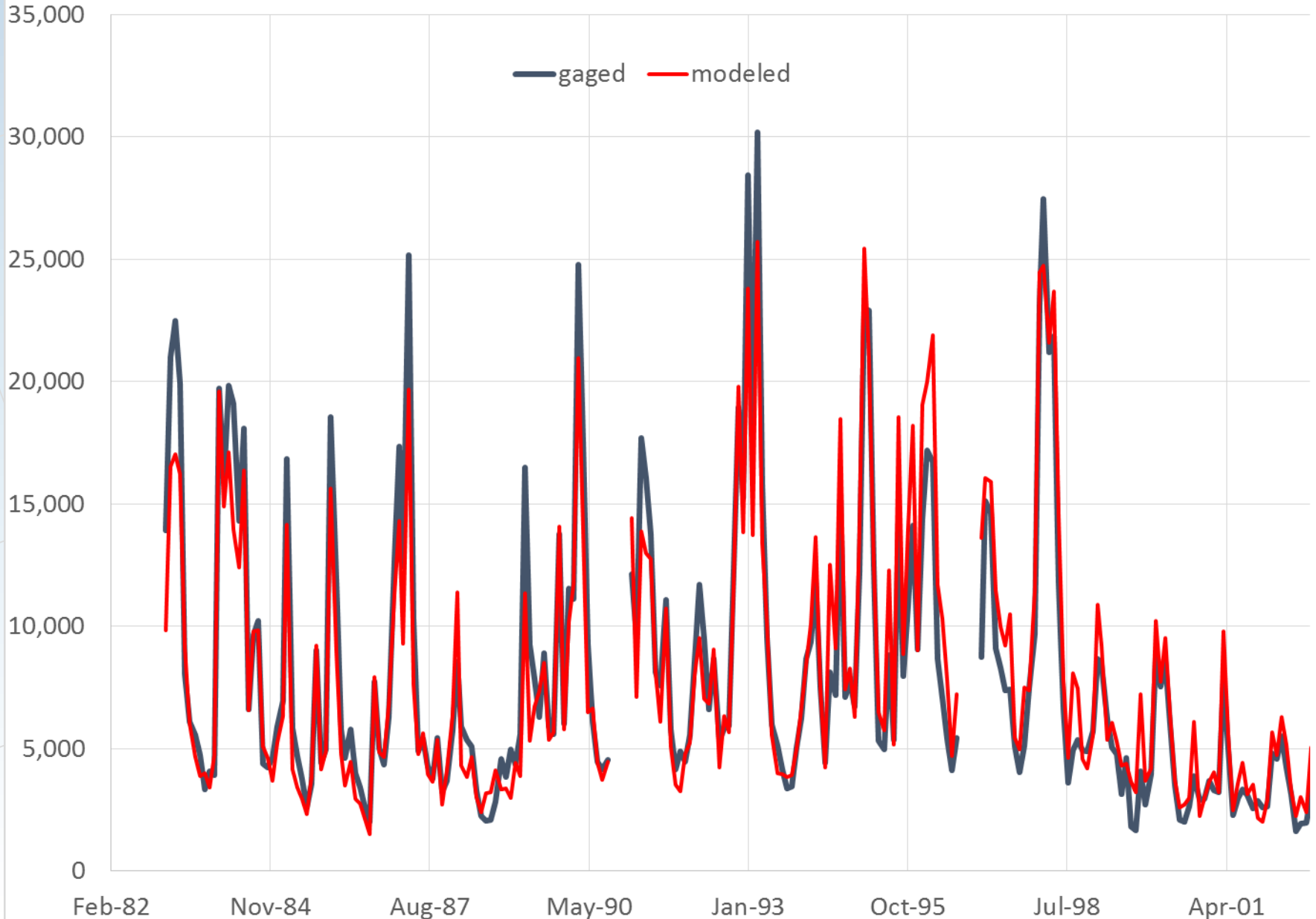
# Congaree River at Columbia





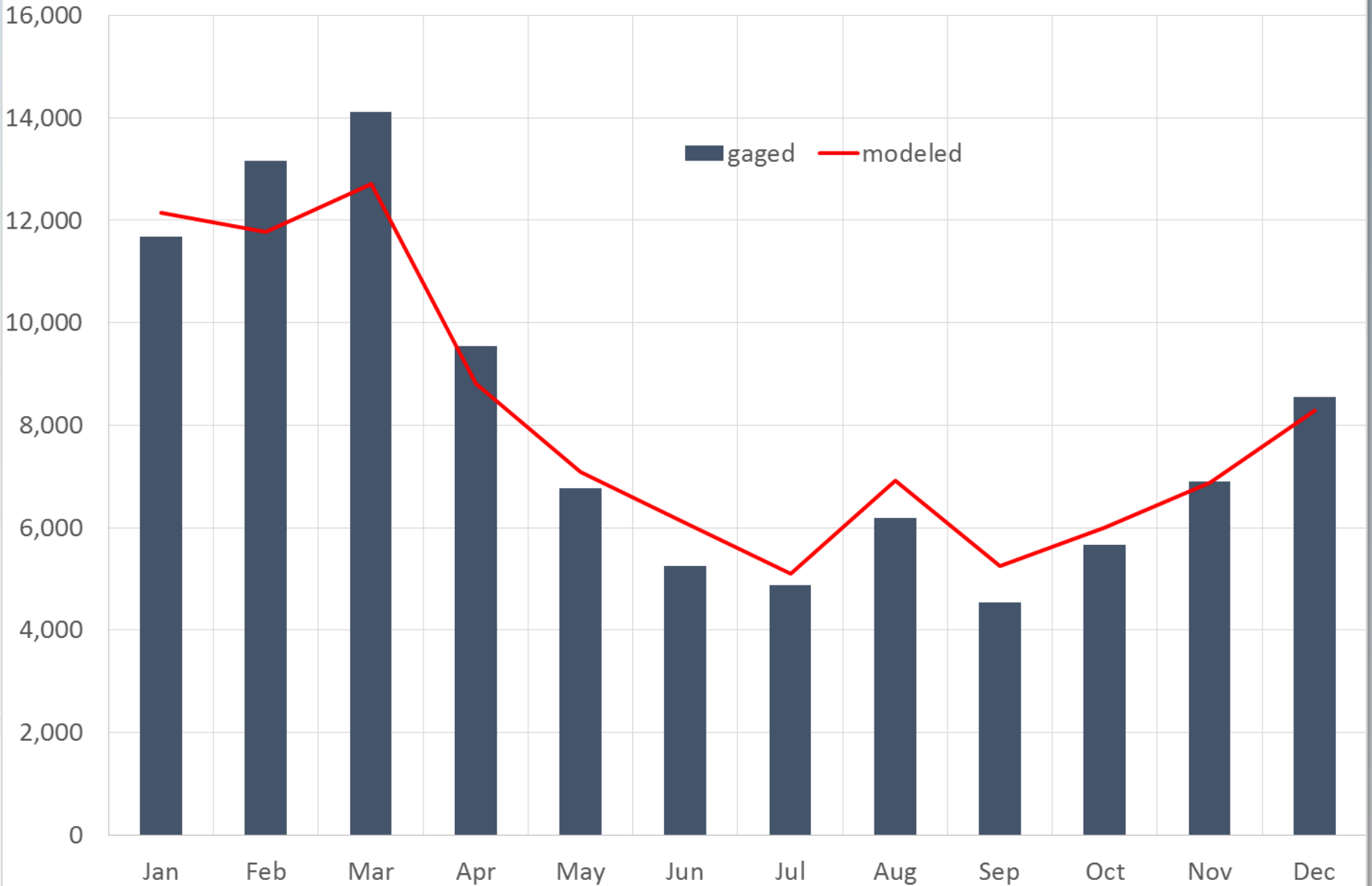
# Monthly Flow Comparison

SLD 27 Congaree River at Columbia (CFS)



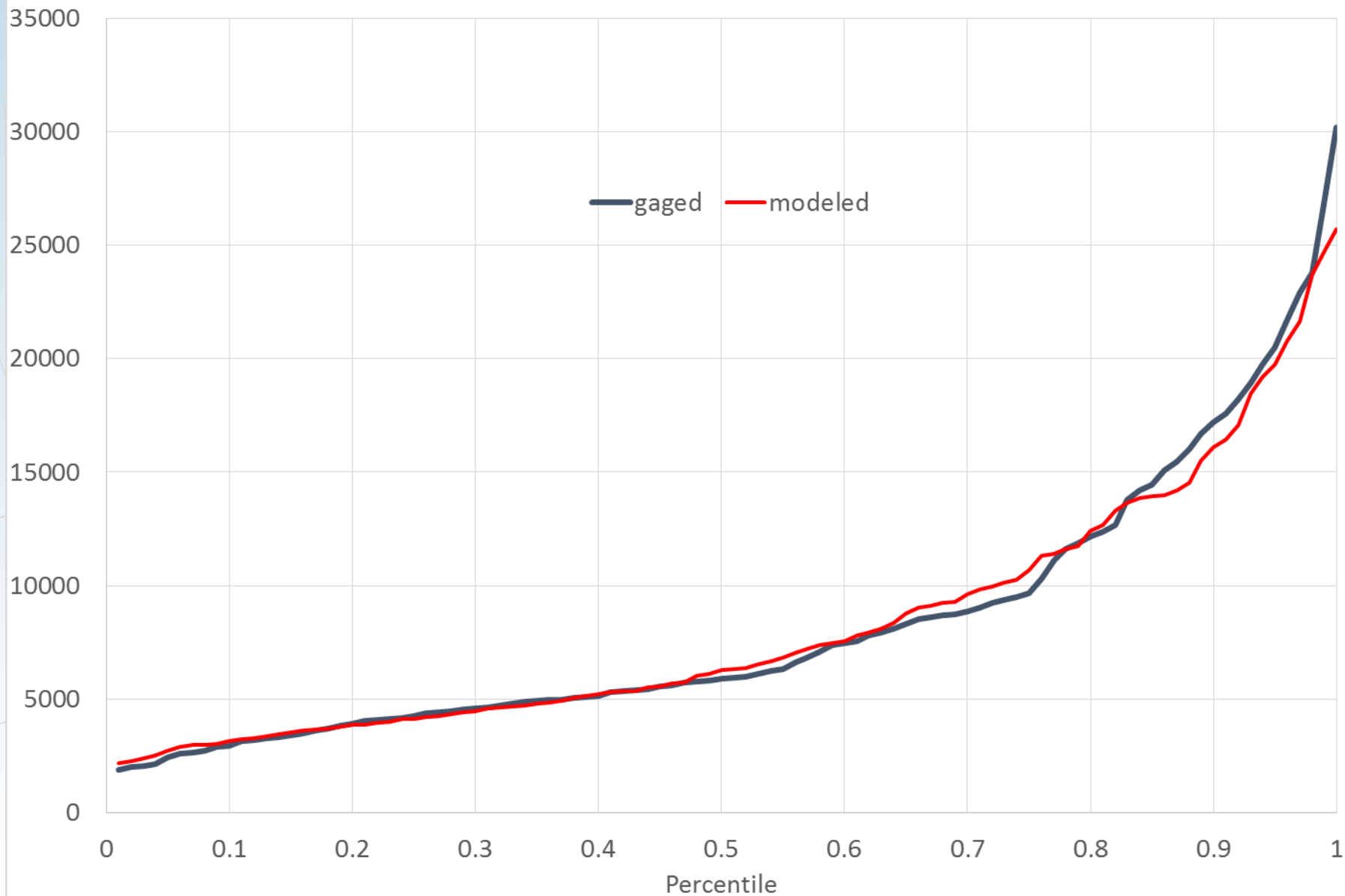
# Monthly Mean Flow Comparison

SLD 27 Congaree River at Columbia  
Monthly Mean Flow (CFS)



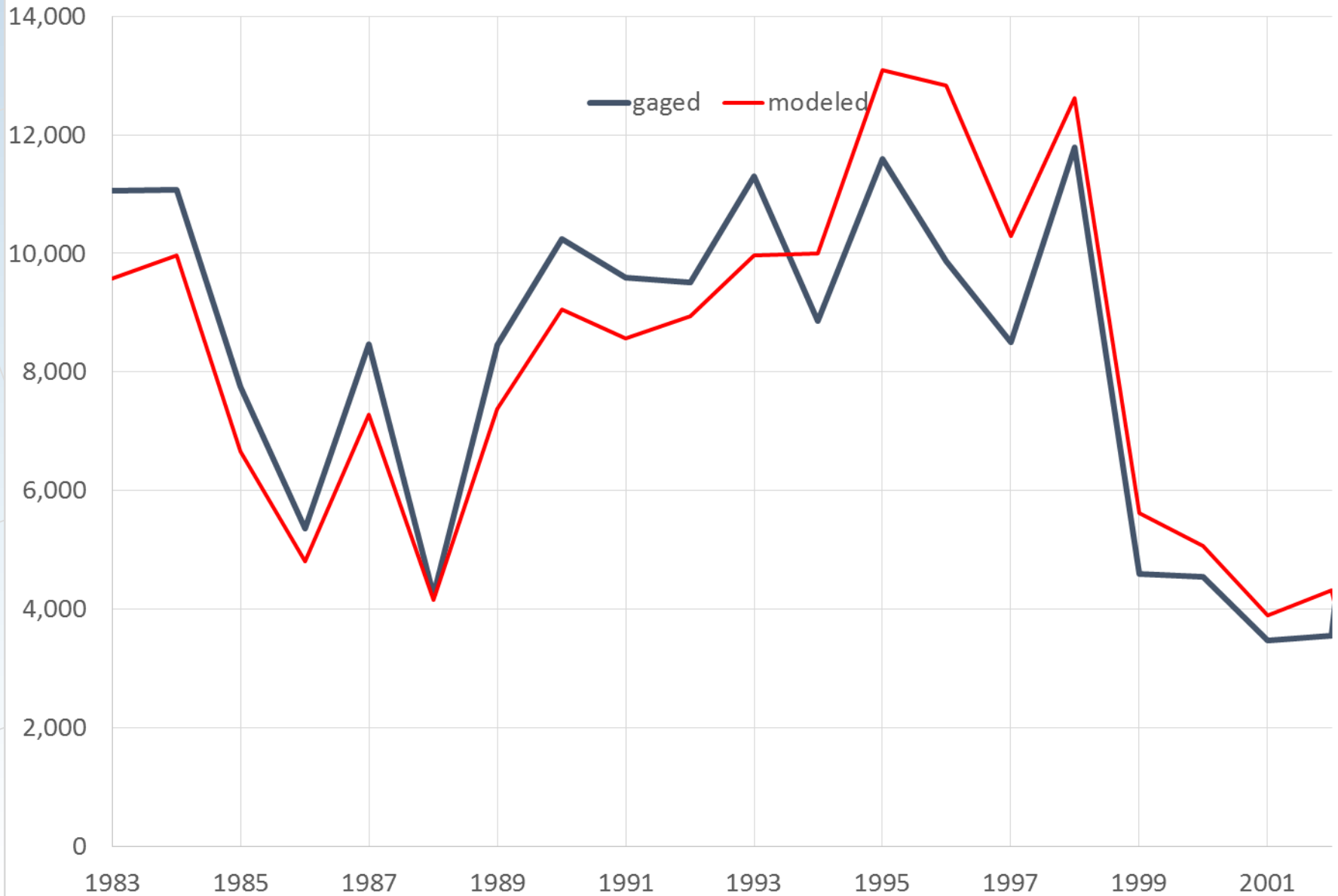
# Monthly Flow Percentiles Comparison

SLD27 Congaree River at Columbia  
Monthly Flow Percentiles (CFS)

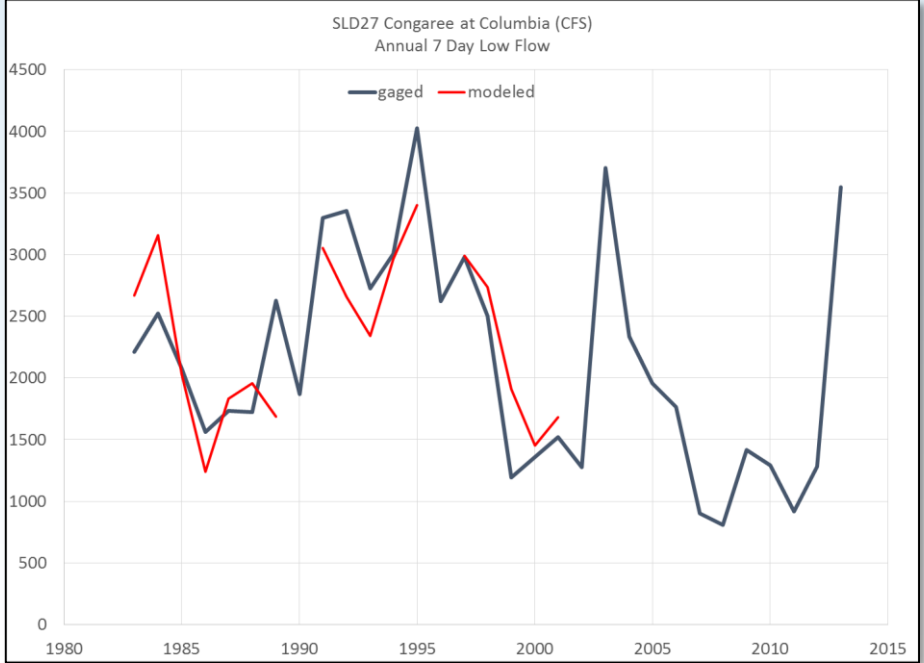
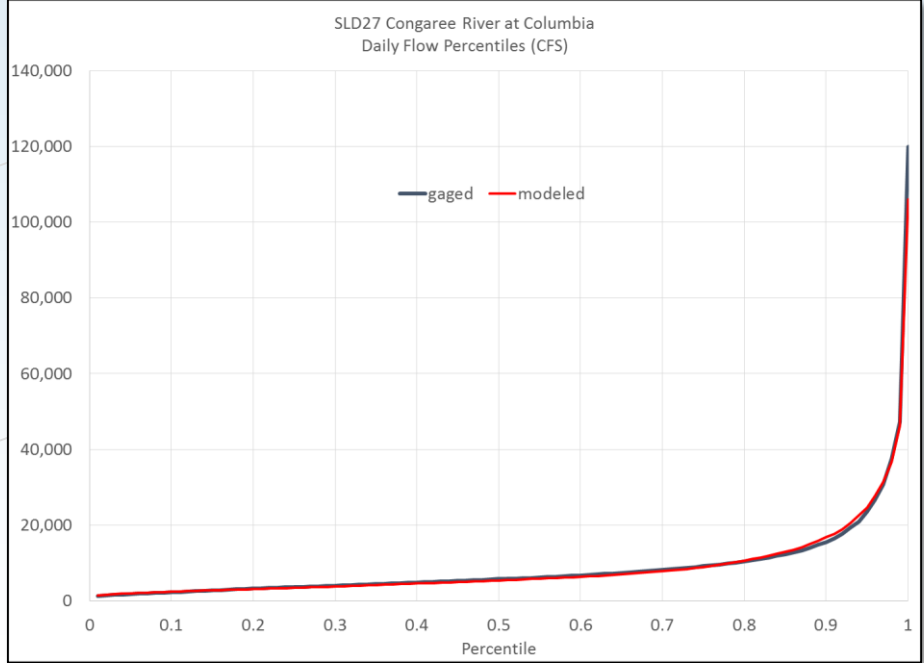
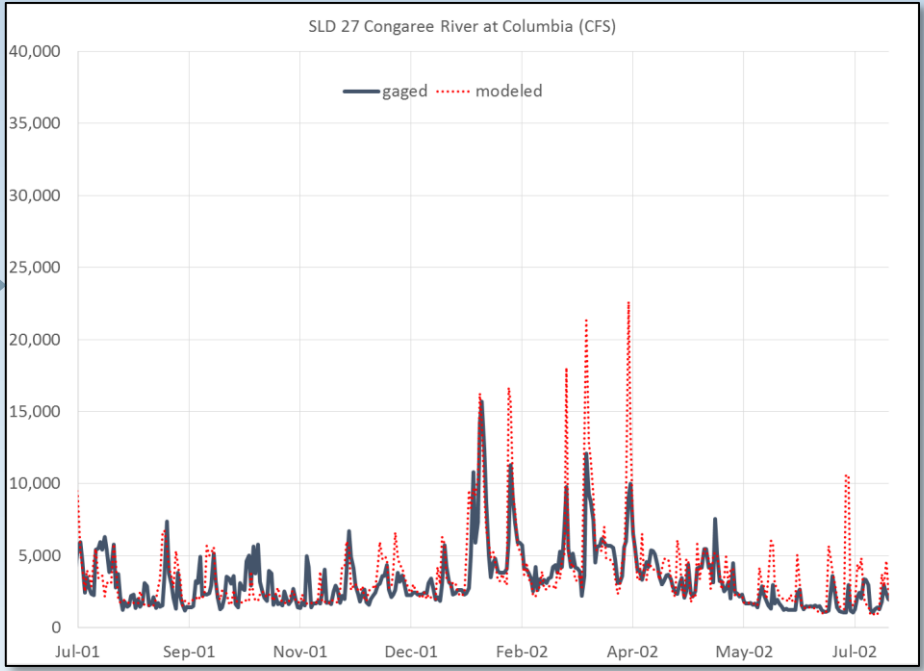
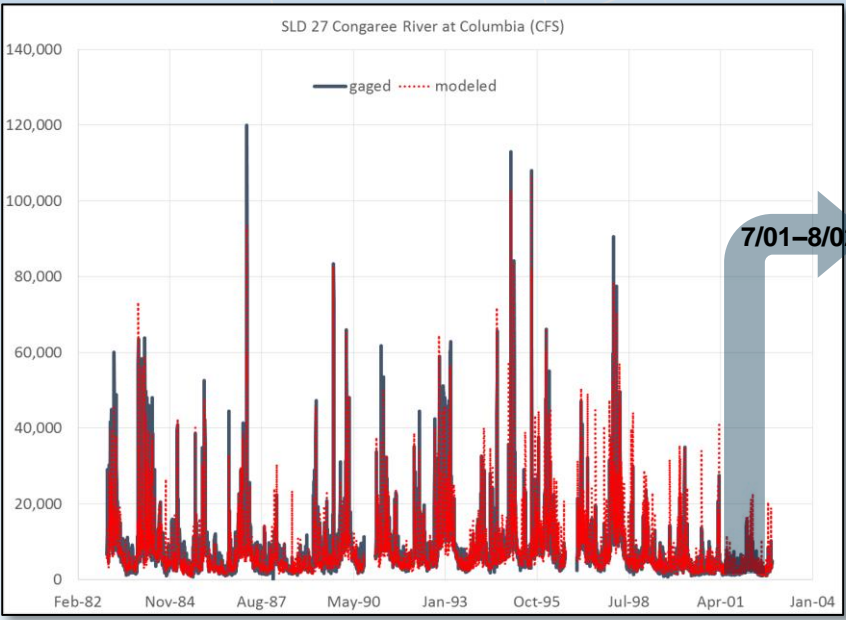


# Annual Average Flow Comparison

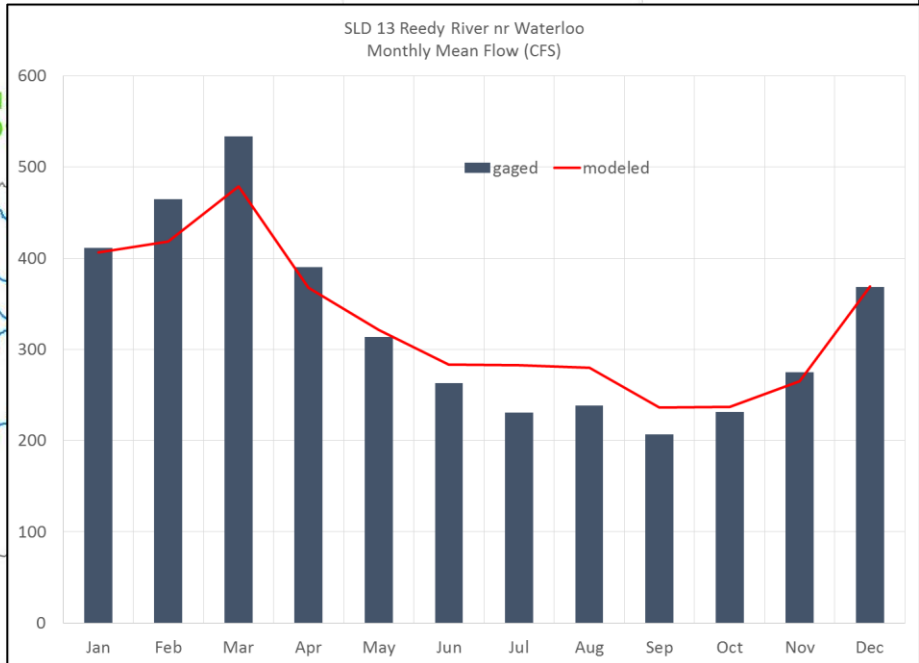
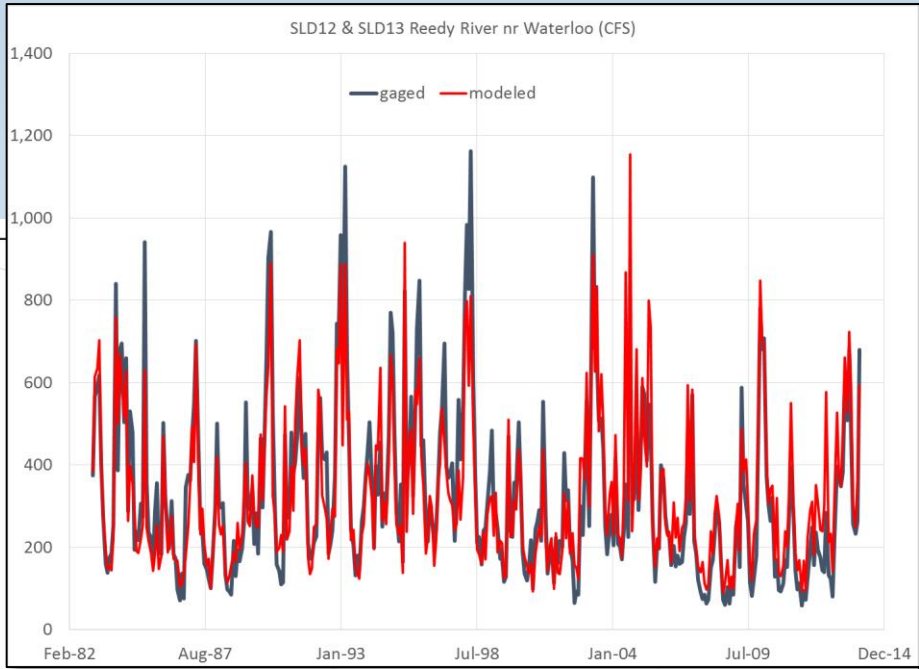
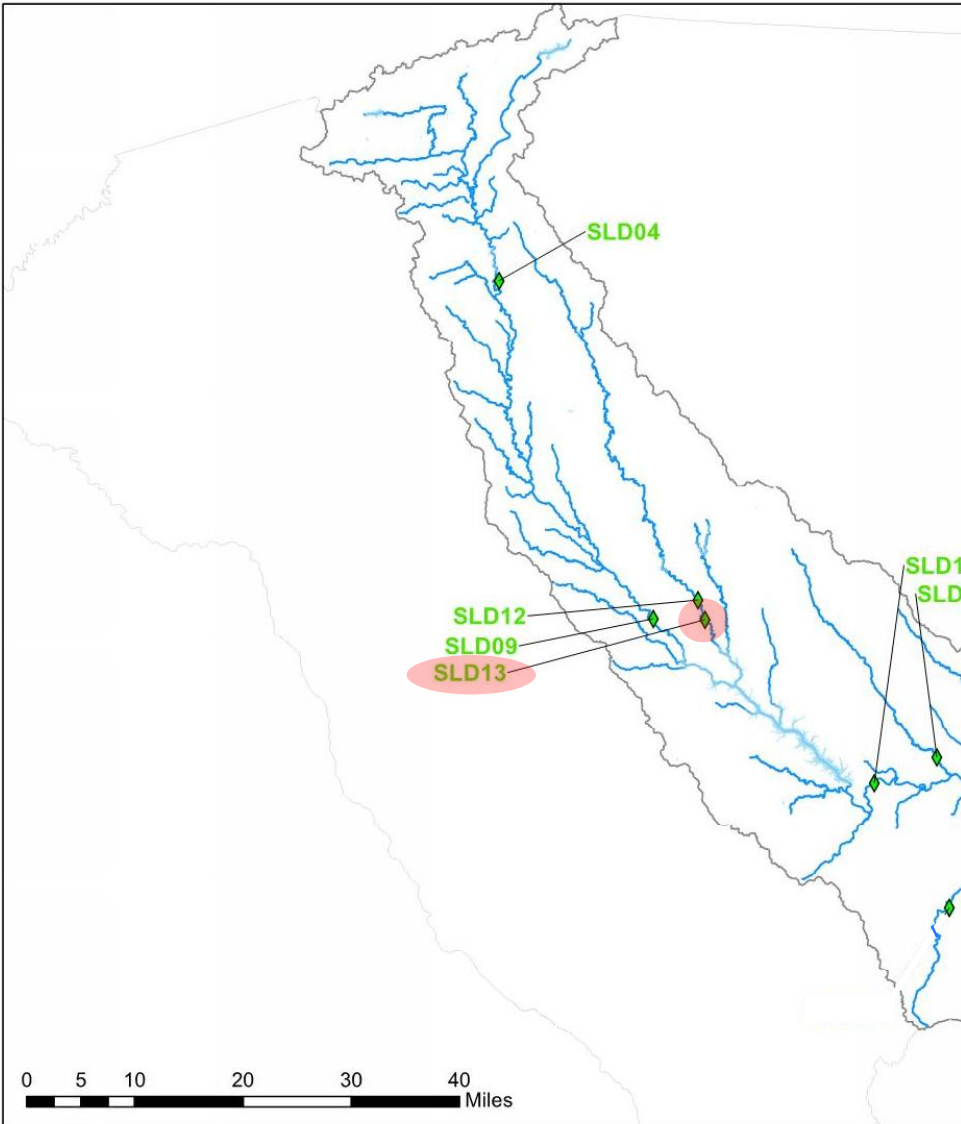
SLD 27 Congaree River at Columbia (CFS)  
Annual Average Flow



# Daily Comparison

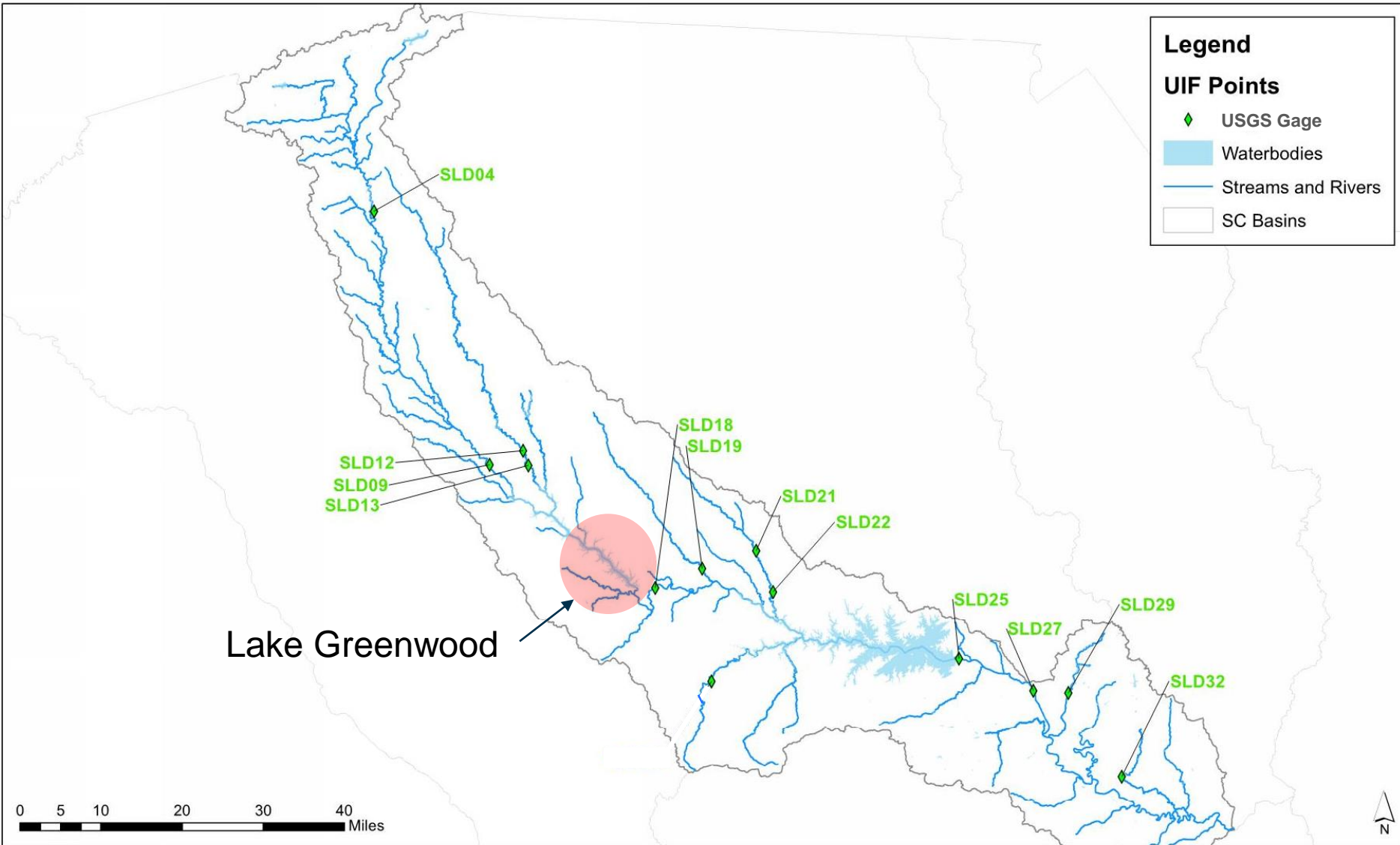


# Reedy River Near Waterloo



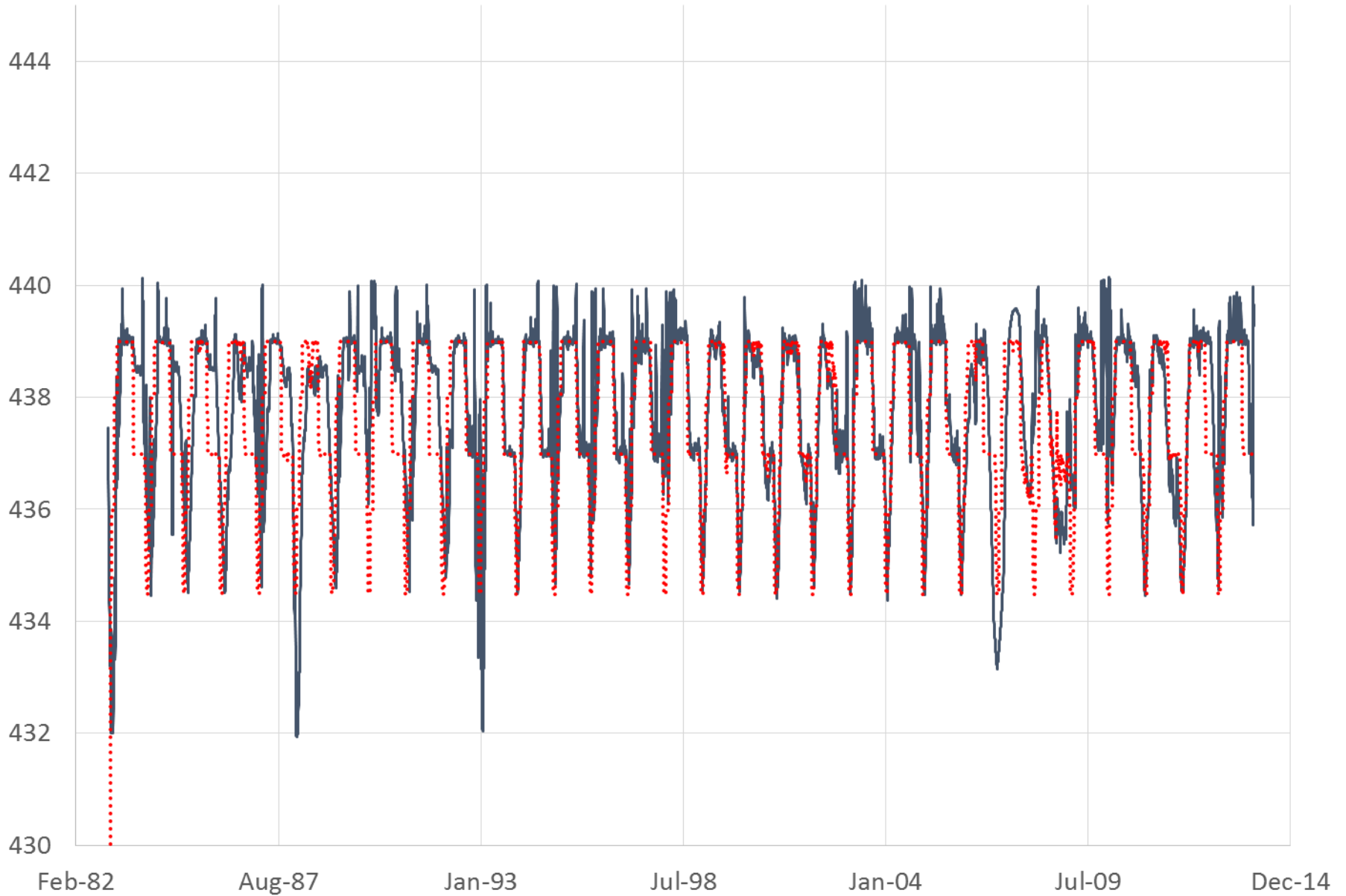


# Lake Greenwood

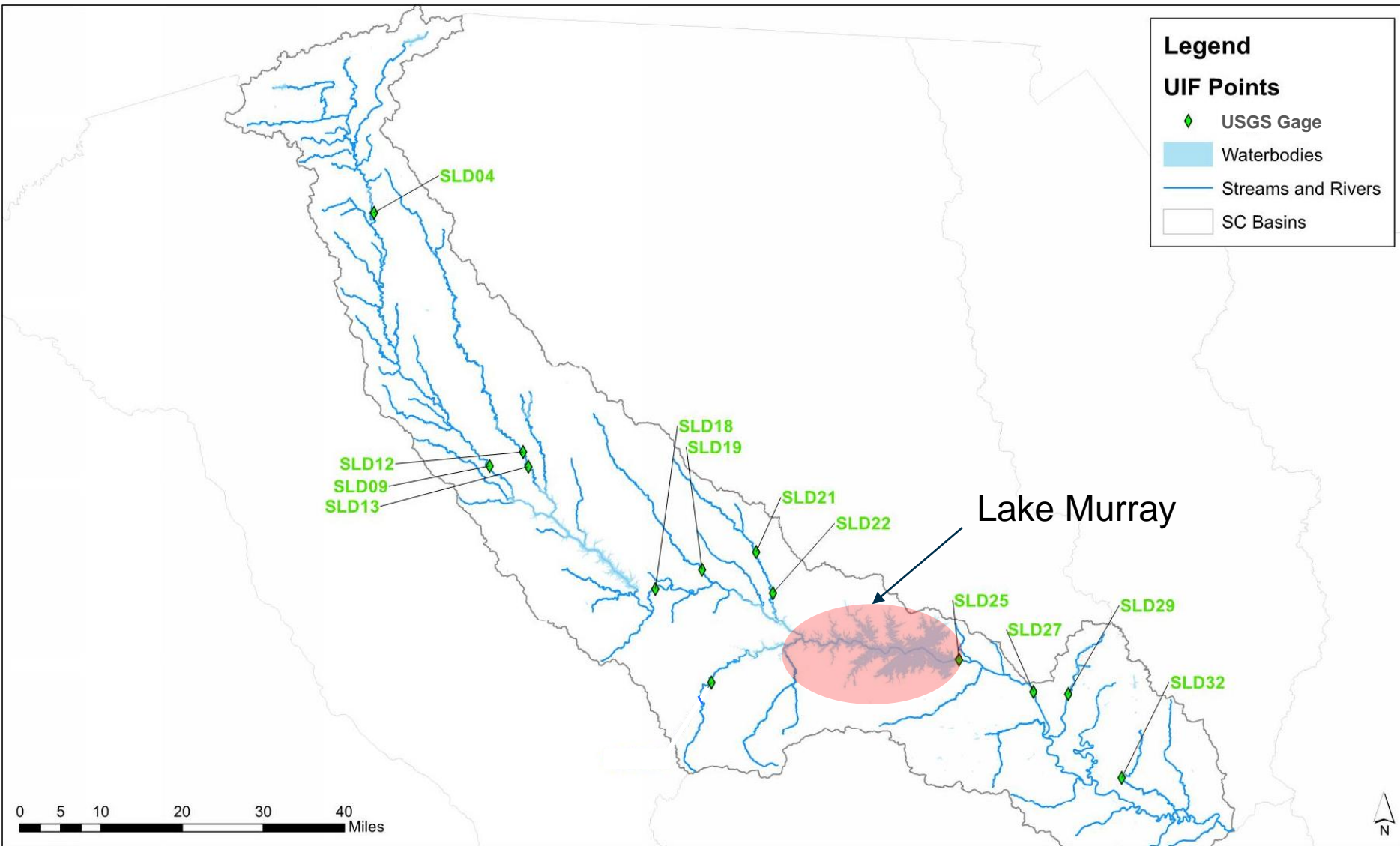


# Storage (Lake Level) Comparison

Lake Greenwood Levels (ft)

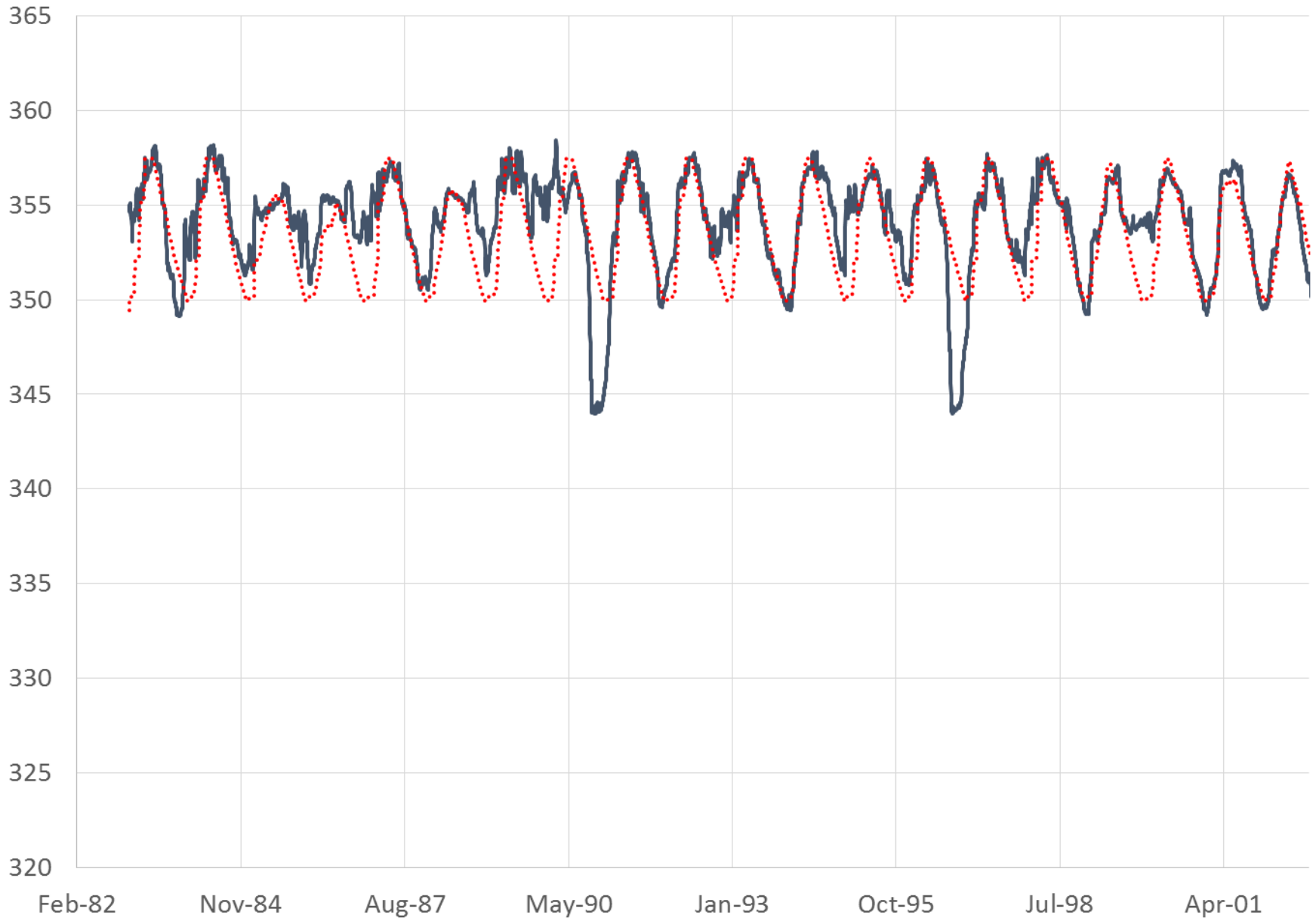


# Lake Murray



# Storage (Lake Level) Comparison

Lake Murray NAVD88 Levels (ft)



# SWAM Calibration/Validation Summary

- For all sites, modeled mean flow values, averaged over the full period of record, are within 1% of measured mean flows
- Monthly mean flows percentile deviations are all generally within 10-20% with no clear bias
- Modeled low flow values (as represented by 7Q10 flows) are within 2% of measured values at mainstem gages SLD04, SLD18, and SLD25, and 35% at SLD09 and SLD27.
- The model adequately hindcasts delivered water supply for each water user in the model (no significant shortfalls).

Saluda River Basin

# BASELINE MODEL



# Baseline Model

- Represents current demands and operations combined with an extended period of estimated hydrology
  - Most demands reflect 2005-2014 averages
  - Estimated hydrology from 1925 to 2014
  - Current reservoir rules, guide curves, minimum releases
  - Future rules (e.g., Lake Murray Striped Bass) can be toggled on/off
  - Inactive users are not included
- The baseline model serves as the starting point for future predictive simulations

## The Models Can Be Used To...

- Determine surface water availability
- Predict where and when future water shortages would occur
- Test alternative water management strategies, new operating rules, and “what-if” scenarios
- Evaluate the impacts of future withdrawals on instream flow needs
- Evaluate interbasin transfers
- Support development of Drought Management Plans
- Compare managed flows to natural flows
- Consolidate hydrologic data

# Example Use

## *Adding a New User*

- Add a new M&I permittee near Ware Shoals
  - Demand = 20,000 MGY (55 mgd)
  - *Can the river sustain the new permit, without impacting downstream users?*
- Add a new Instream Flow Object downstream
  - Instream Flow Target = 100 cfs
  - *Are there shortages?*

# Add a Municipal Water User Object from the Palette

**Object Palette**

### Simplified Water Allocation Model (SWAM)

*Simulation Period*

**Start Date (MM/DD/YYYY)**  
08/01/1995

**End Date (MM/DD/YYYY)**  
12/31/2013

*Simulation Type*

Monthly Planning  
 Daily Planning  
 Short Term Forecasting  
 Firm Yield Calculator

Prior Appropriations  
 Riparian Water Rights

**Run (ctrl R)**

### Input Summaries and Outputting

**Node Priorities**

AF, AFM, AFD

**Node Locations**

MG, MGD, CFS

**Reservoir Accounts**

m3, m3/d, m3/s

**Output Specs**

*Input & Output*

Main | 
 Node Output | 
 Reservoir Output | 
 Flow Gage Output



# Add a Municipal Water User Object from the Palette

**Simplified Water Allocation Model (SWAM)**

Simulation Period  
 Start Date (MM/DD/YYYY): 08/01/1995  
 End Date (MM/DD/YYYY): 12/31/2013

Simulation Type  
 Monthly Planning  
 Daily Planning  
 Short Term Forecasting  
 Firm Yield Calculator  
 Prior Appropriations  
 Riparian Water Rights

Run (ctrl R)

**Input Summaries and Outputting**

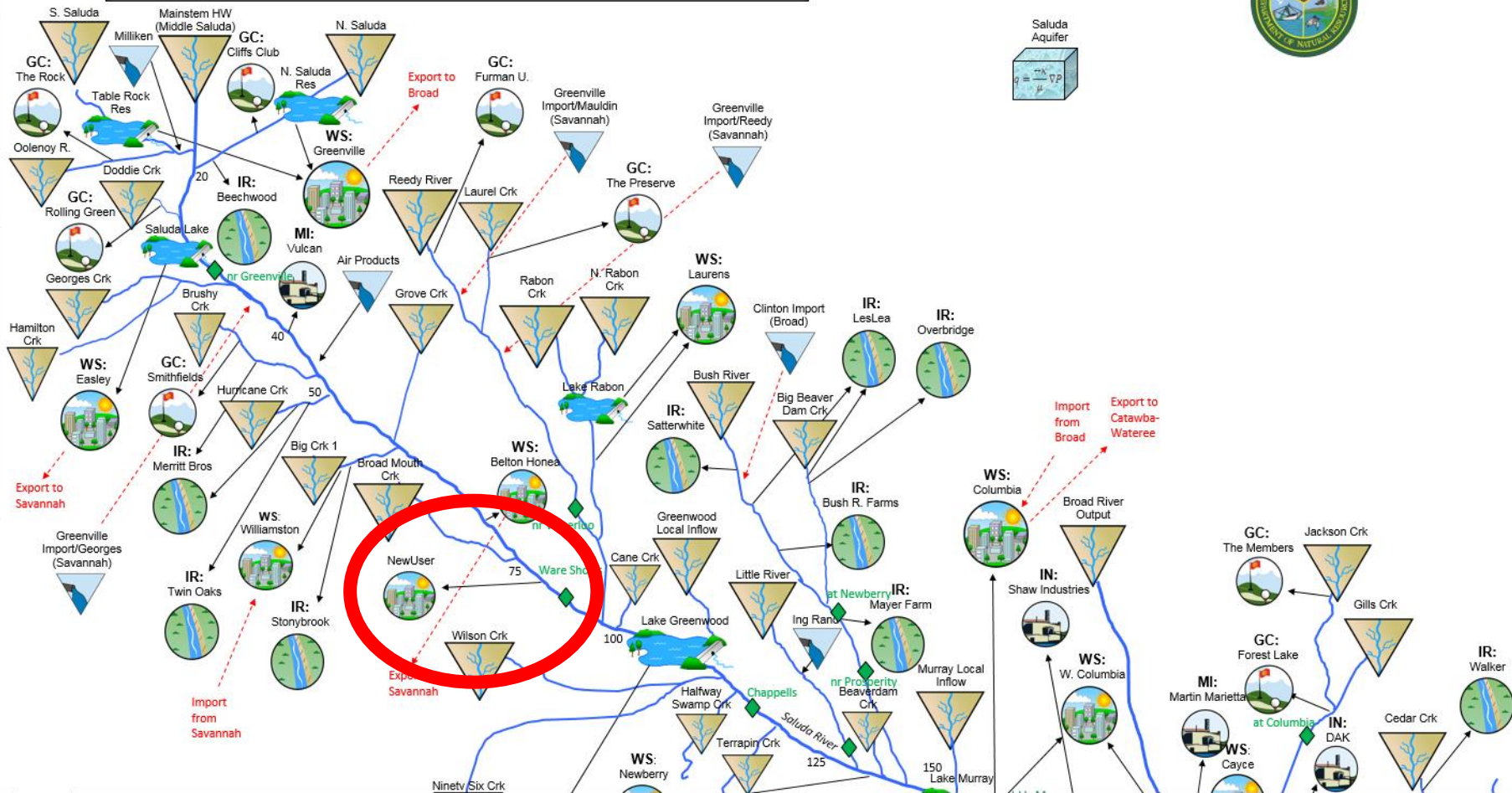
Node Priorities | Node Locations | Reservoir Accounts | Output Specs

Input & Output  
 AF, AFM, AFD |  MG, MGD, CFS |  m3, m3/d, m3/s



**Object Palette**

- Reservoir
- Canal
- Stream
- Wetland
- Water User (Municipal)
- Water User (Industrial)
- Water User (Agricultural)
- Water User (Livestock)
- Water User (Other)
- Water User (Municipal) - **Selected**
- Water User (Industrial)
- Water User (Agricultural)
- Water User (Livestock)
- Water User (Other)



# Add the New User in the Water User Dialogue

The image shows the 'Simplified Water Allocation Model (SWAM)' software interface. The main window displays a complex network diagram of water users and reservoirs. A dialog box titled 'Water User' is open, showing the 'Main' tab. The 'Water User Name' field is highlighted with a red circle and contains the text 'WS: New User'. To the right of this field is a 'Delete Node' button. Below the name field are several checkboxes for 'Supplemental Supply/Demand Alternatives': 'Conservation', 'Recapture Reuse', 'Ag Transfer', 'Transbasin Import', and 'Water Exchange'. The 'Multiple Sources of Water?' checkbox is also present. At the bottom of the dialog are 'Save' and 'Close' buttons. The background interface includes a simulation period (08/01/1995 to 12/31/2013), simulation type options (Monthly Planning, Daily Planning, Short Term Forecasting, Firm Yield Calculator), and an 'Input Summaries and Outputting' section with buttons for Node Priorities, Node Locations, Reservoir Accounts, and Output Specs. The DHEC logo is visible in the top right corner.



# Specify Water Use

## Simplified Water Allocation Model (SWAM)

**Simulation Period**  
 Start Date (MM/DD/YYYY): 08/01/1995  
 End Date (MM/DD/YYYY): 12/31/2013

**Simulation Type**  
 Monthly Planning  
 Daily Planning  
 Short Term Forecasting  
 Firm Yield Calculator

Prior Appropriations  
 Riparian Water Rights

**Run (ctrl R)**

## Input Summaries and Outputting

Node Priorities | Node Locations | Reservoir Accounts | Output Specs

Input & Output



**Water User**

Main | Water Usage | Source Water | Return Flows

Monthly User Distribution:  
 Manual  
 M&I  
 Agriculture

Annual Baseline Usage:  
 Total Use: 20000 (MGY)  
 Distribute

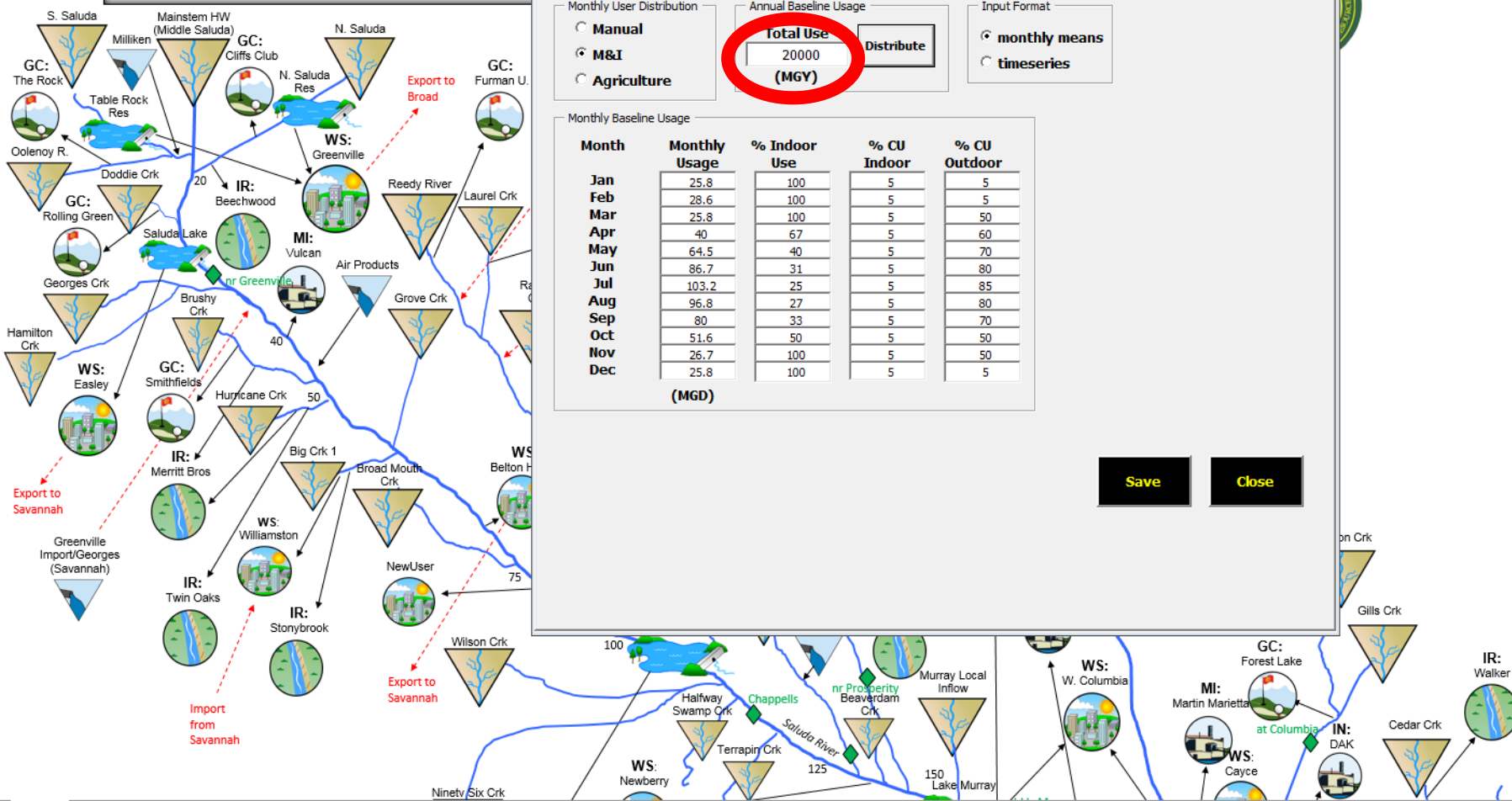
Input Format:  
 monthly means  
 timeseries

Monthly Baseline Usage

Month	Monthly Usage	% Indoor Use	% CU Indoor	% CU Outdoor
Jan	25.8	100	5	5
Feb	28.6	100	5	5
Mar	25.8	100	5	50
Apr	40	67	5	60
May	64.5	40	5	70
Jun	86.7	31	5	80
Jul	103.2	25	5	85
Aug	96.8	27	5	80
Sep	80	33	5	70
Oct	51.6	50	5	50
Nov	26.7	100	5	50
Dec	25.8	100	5	5

(MGD)

Save Close



# Specify the Source and Diversion Location

### Simplified Water Allocation Model (SWAM)

Simulation Period  
Start Date (MM/DD/YYYY): 08/01/1995  
End Date (MM/DD/YYYY): 12/31/2013

Simulation Type  
 Monthly Planning  
 Daily Planning  
 Short Term Forecasting  
 Firm Yield Calculator

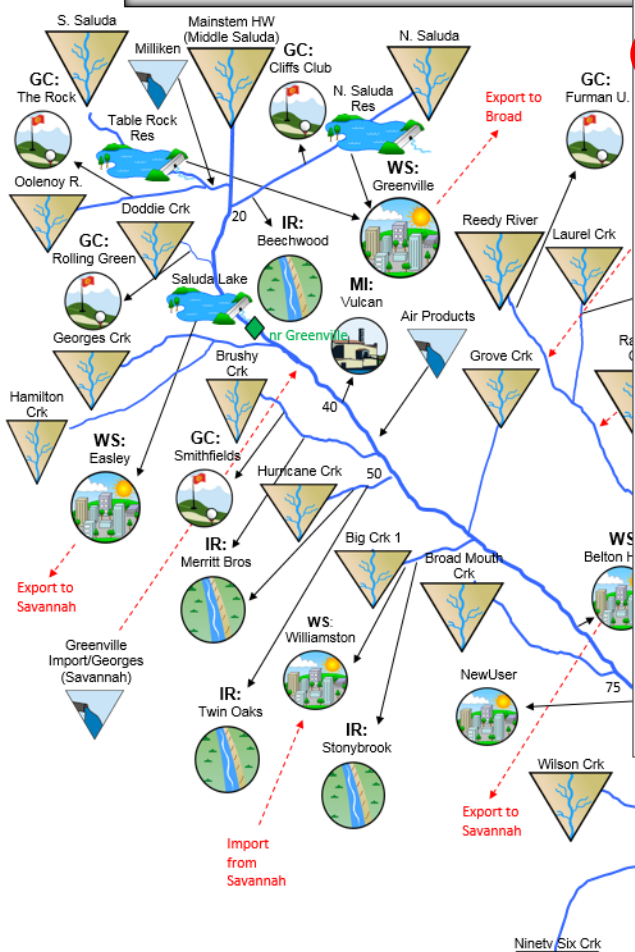
Prior Appropriations  
 Riparian Water Rights

Run (ctrl R)

### Input Summaries and Outputting

Node Priorities | Node Locations | Reservoir Accounts | Output Specs

Input & Output



### Water User

Main | Water Usage | Source Water | Return Flows

Source Water Type  
 Direct River  
 Reservoir  
 Groundwater

Source Stream: Mainstem

Diversion Location (mi): 80

Priority Date: 1/1/2008

Diversion Capacity (CFS): 10000

Permit Limit (MGM): 10000

Seasonal Permit  
 Minimum Flow Requirements

Save  
Close

Identifying Notes:

# Specify the Return Location

## Simplified Water Allocation Model (SWAM)

Simulation Period  
Start Date (MM/DD/YYYY): 08/01/1995  
End Date (MM/DD/YYYY): 12/31/2013

Simulation Type  
 Monthly Planning  
 Daily Planning  
 Short Term Forecasting  
 Firm Yield Calculator

Prior Appropriations  
 Riparian Water Rights

Run (ctrl R)

### Input Summaries and Outputting

Node Priorities | Node Locations | Reservoir Accounts | Output Specs

Input & Output



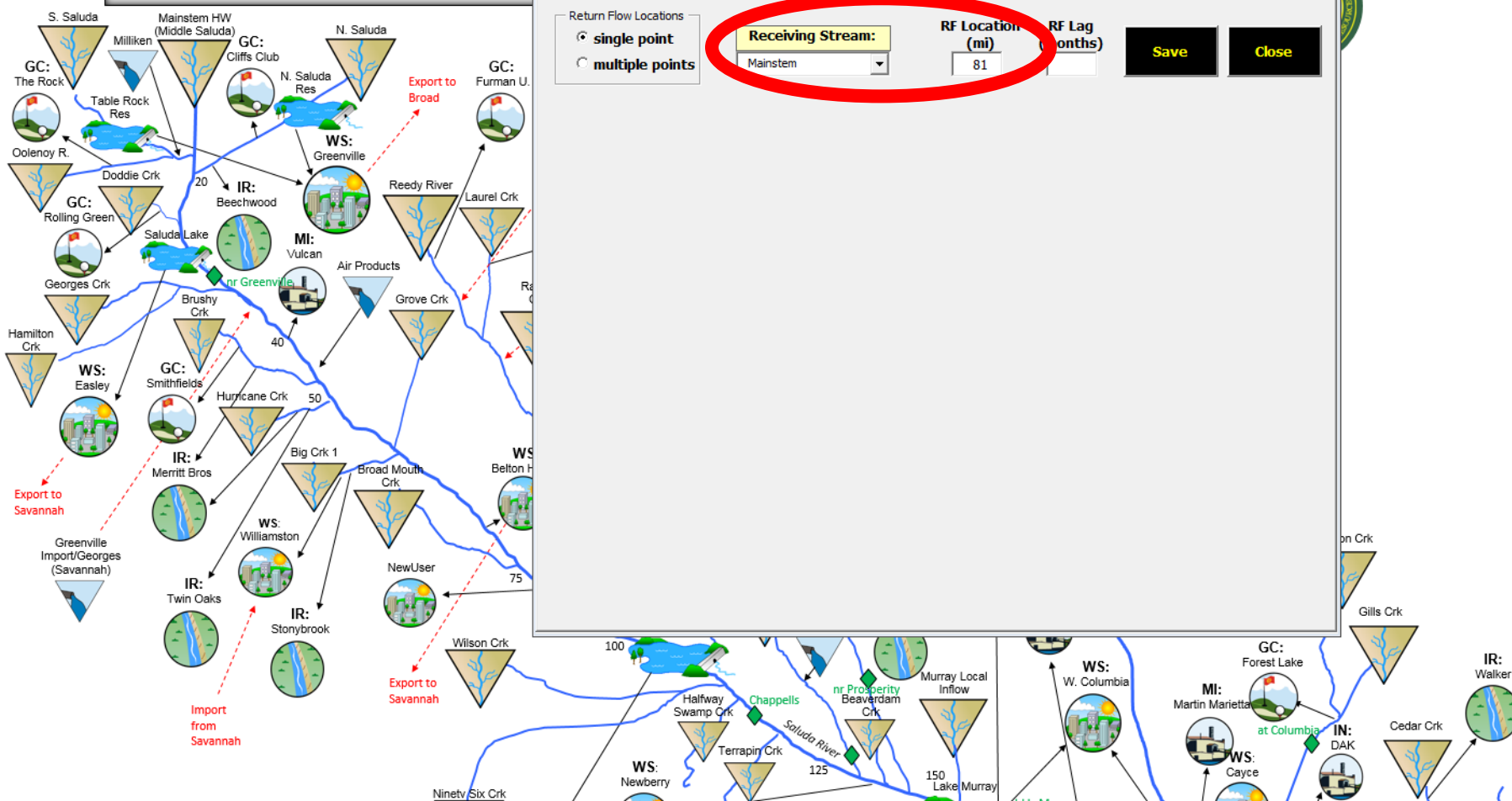
### Water User

Main | Water Usage | Source Water | Return Flows

Return Flow Locations  
 single point  
 multiple points

Receiving Stream: Mainstem  
RF Location (mi): 81  
RF Lag (months):

Save Close





# Add an Instream Flow Object from the Palette

**Simplified Water Allocation Model (SWAM)**

**Simulation Period**  
Start Date (MM/DD/YYYY): 08/01/1995  
End Date (MM/DD/YYYY): 12/31/2013

**Simulation Type**  
 Monthly Planning  Prior Appropriations  
 Daily Planning  Riparian Water Rights  
 Short Term Forecasting  
 Firm Yield Calculator

**Run (ctrl R)**

**Input Summaries and Outputting**  
Node Priorities | Node Locations | Reservoir Accounts | Output Specs

**Input & Output**  
 AF, AFM, AFD  MG, MGD, CFS  m3, m3/d, m3/s

**Object Palette**  
Icons for various water management objects: Reservoir, Inflow, Instream Flow, Outflow, etc.

**Saluda Aquifer**  
$$q = \frac{-\mu K}{\mu} \nabla p$$

**Saluda River Network Diagram**  
The diagram shows a complex network of water bodies and infrastructure. Key features include:

- Reservoirs:** Table Rock Res, Doddie Crk, Saluda Lake, Lake Rabon, Lake Greenwood, etc.
- Instream Flow Objects (IFOs):** Various locations along the river, many highlighted with circular icons. A red circle highlights a specific IFO near the 'Ware Shoals Saluda' area.
- Other Objects:** Inflows (IN), Outflows (OUT), and various management points (GC, WS, IR, MI).
- Flow Indicators:** Red dashed arrows indicate 'Export to Savannah', 'Import from Savannah', 'Import from Broad', and 'Export to Catawba-Wateree'.

**Logos:** D H E C (Division of Hydrologic Earth and Atmospheric Sciences) and the South Carolina Department of Natural Resources logo.

**Navigation:** Main | Node Output | Reservoir Output | Flow Gage Output

# Specify the Instream Flow Amount and Target Stream

**Simplified Water Allocation Model (SWAM)**

Simulation Period: Start Date (MM/DD/YYYY) 08/01/1995, End Date (MM/DD/YYYY) 12/31/2013

Simulation Type:  Monthly Planning,  Daily Planning,  Short Term Forecasting,  Firm Yield Calculator,  Prior Appropriations,  Riparian Water Rights

Run (ctrl R)

**Input Summaries and Outputting**

Node Priorities, Node Locations, Reservoir Accounts, Output Specs

Input & Output:  AF, AFM, AFD,  MG, MGD, CFS,  m3, m3/d, m3/s

**Water Right Dialog:**

Instream Flow Name: Saluda ISF

Target Stream: Mainstem

Downstream Location (mi): 85

Priority Date: 1/1/2008

Flow Right: 100 (CFS)

Rules:  Seasonal WR,  TNC IHA Methodology

Buttons: Delete Node, Save, Close

Object Palette: [Icons for various water features]

Log: Main, Node Output, Reservoir Output, Flow Gage Output

Logos: DHEC, SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES

# Run the Model Scenario

**Simplified Water Allocation Model (SWAM)**

Simulation Period  
Start Date (MM/DD/YYYY): 08/01/1995  
End Date (MM/DD/YYYY): 12/31/2013

Simulation Type  
 Monthly Planning  
 Daily Planning  
 Short Term Forecasting  
 Firm Yield Calculator

Prior Appropriations  
 Riparian Water Rights

**Run (ctrl R)**

**Input Summaries and Outputting**

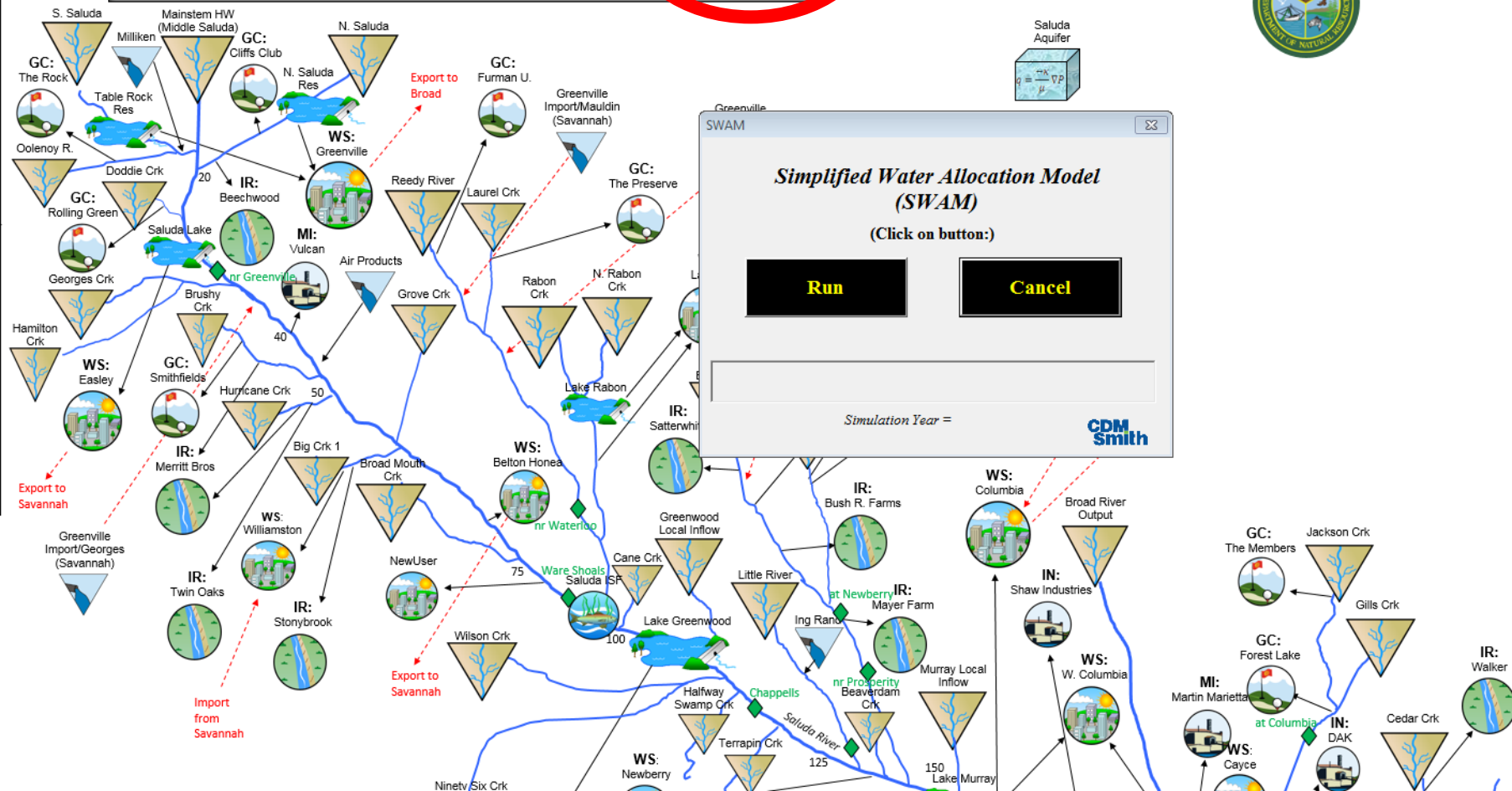
Node Priorities Node Locations Reservoir Accounts Output Specs

Input & Output  
 AF, AFM, AFD  MG, MGD, CFS  m3, m3/d, m3/s



**Object Palette**

- Reservoir
- Flow Gage
- Water Treatment Plant
- Water Distribution Node
- Water Intake Node
- Water Outlet Node
- Water Storage Node
- Water Diversion Node
- Water Pump Node
- Water Inflow Node
- Water Outflow Node
- Water Loss Node
- Water Source Node
- Water Sink Node
- Water Transfer Node
- Water Allocation Node
- Water Management Node
- Water Control Node
- Water Regulation Node
- Water Distribution Node
- Water Intake Node
- Water Outlet Node
- Water Storage Node
- Water Diversion Node
- Water Pump Node
- Water Inflow Node
- Water Outflow Node
- Water Loss Node
- Water Source Node
- Water Sink Node
- Water Transfer Node
- Water Allocation Node
- Water Management Node
- Water Control Node
- Water Regulation Node



**Simplified Water Allocation Model (SWAM)**

(Click on button:)

**Run** **Cancel**

Simulation Year =

**CDM Smith**



# Build a Shortage Plot for the New User

The image displays the Simplified Water Allocation Model (SWAM) software interface. At the top center is the title "Simplified Water Allocation Model (SWAM)". Below it are simulation controls including "Simulation Period" (Start Date: 08/01/1995, End Date: 12/31/2013) and "Simulation Type" (Monthly Planning, Daily Planning, Short Term Forecasting, Firm Yield Calculator, Prior Appropriations, Riparian Water Rights). A "Run (ctrl R)" button is present.

To the right is the "Input Summaries and Outputs" panel with buttons for "Node Priorities", "Node Locations", "Reservoir Accounts", and "Output Specifications". A red circle highlights the "Output Specifications" button. Below these are "Input & Output" options for various models and units.

The main area is a network diagram of the Saluda River system, showing various nodes (GC, WS, IR, MI, IN) and their connections. A "New User" node is highlighted with a green diamond. A "Saluda Aquifer" box is also visible.

An "Output Plotting" window is open, showing "Node: WS: New User" and "Output Parameter: Shortage (MGD)". The "Plot Type" is set to "Time Series". Buttons for "Clear Exceedance Links", "Create Dynamic Plot", and "Close" are visible.

At the bottom, there is a navigation bar with "Main", "Node Output", "Reservoir Output", and "Flow Gage Output" tabs. The "Main" tab is selected.

Logos for "D H E C" (Department of Health, Environment & Community) and "SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES" are in the top right corner.



# Build a Shortage Plot

### Simplified Water Allocation Model (SWAM)

**Simulation Period**  
 Start Date (MM/DD/YYYY): 08/01/1995  
 End Date (MM/DD/YYYY): 12/31/2013

**Simulation Type**

- Monthly Planning
- Daily Planning
- Short Term Forecasting
- Firm Yield Calculator
- Prior Appropriations
- Riparian Water Rights

**Run (ctrl R)**

### Input Summaries and Outputting

**Node Priorities** **Node Locations** **Reservoir Accounts** **Output Specs**

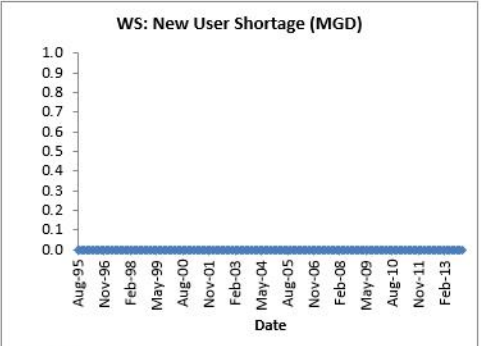
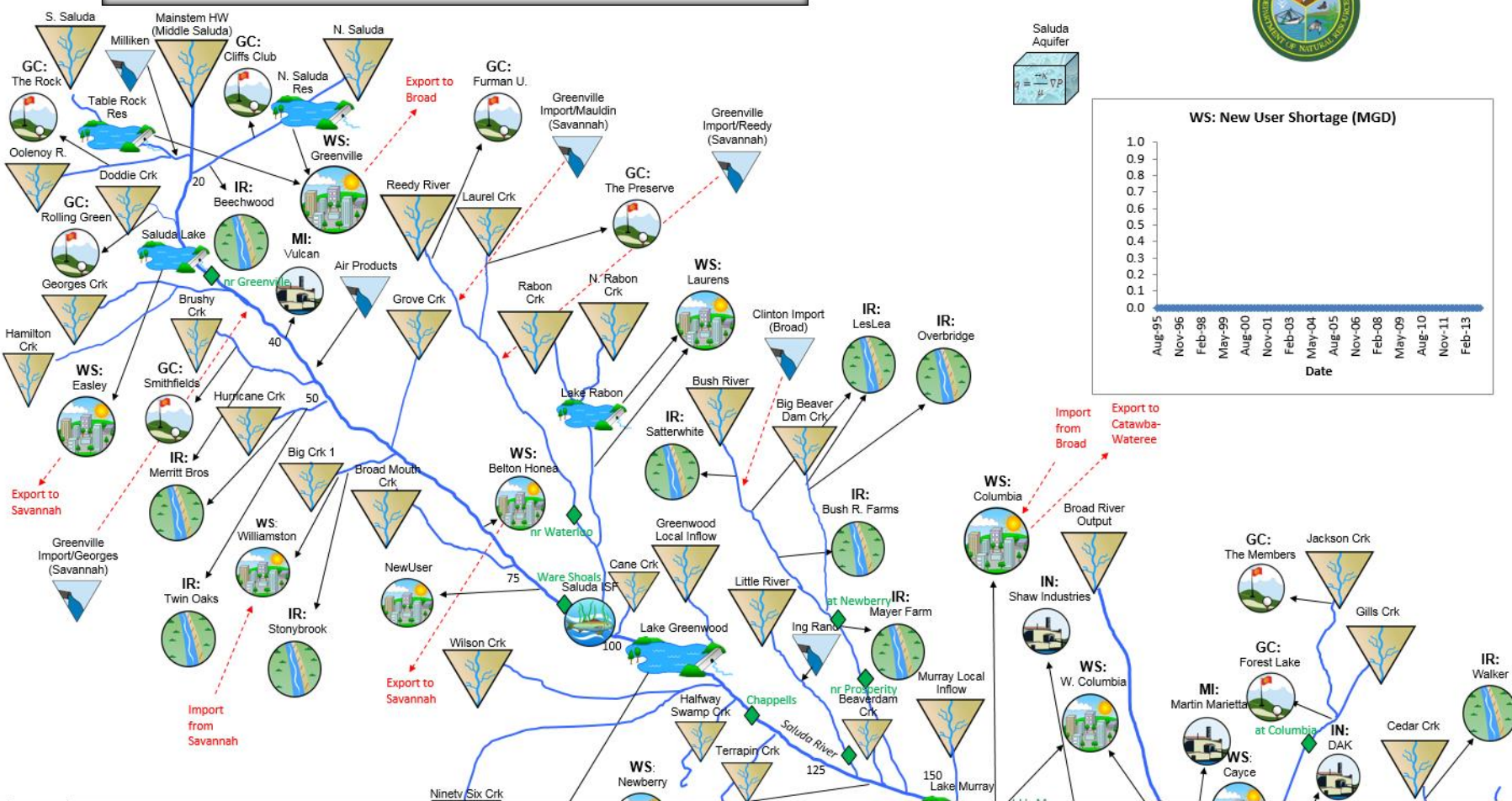
**Input & Output**

AF, AFM, AFD  MG, MGD, CFS  m3, m3/d, m3/s



**Object Palette**

- Reservoir
- Flow Gage
- Conduit
- Node
- Import/Export
- Local Inflow
- Local Outflow
- Saluda Aquifer



# Shortages are Also Listed in the Node Output Table

	A	B	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK
Output							Permit Limit (MGM)	Ditch Capacity (CFS)	Storage Capacity (MG)	Storage Withdrawal Permit (MGM)								Permit Limit (MGM)
1			Priority Rank	Reach	Location		10000	10000	0	325829				Saluda ISF	51	Mainstem	85	2003
2		WS: New User	49	Mainstem	80													
3	Date	Physically Avail. (MGD)	Legally Avail. (MGD)	Diverted (MGD)	Storage (MG)	GW Pumping (MGD)	Demand (MGD)	Shortage (MGD)	Return Flow (MGD)	Release (MGD)	Evap Losses (MGD)			Physically Avail. (MGD)	Legally Avail. (MGD)	Diverted (MGD)	Storage (MG)	GW Pumping (MGD)
4	Min	87	87	26	0	0	26	0	25	0	0			44	44	44	0	0
5	Max	2368	357	103	0	0	103	0	41	0	0			2338	65	65	0	0
6	Avg	543	298	55	0	0	55	0	32	0	0			523	64	64	0	0
7	8/31/95	904	323	97	0	0	97	0	39	0	0			850	65	65	0	0
8	9/30/95	442	333	80	0	0	80	0	41	0	0			405	65	65	0	0
9	10/31/95	630	323	52	0	0	52	0	37	0	0			619	65	65	0	0
10	11/30/95	850	333	27	0	0	27	0	25	0	0			852	65	65	0	0
11	12/31/95	530	323	26	0	0	26	0	25	0	0			531	65	65	0	0
12	1/31/96	1141	323	26	0	0	26	0	25	0	0			1144	65	65	0	0
13	2/28/96	1103	357	29	0	0	29	0	27	0	0			1106	65	65	0	0
14	3/31/96	948	323	26	0	0	26	0	25	0	0			951	65	65	0	0
15	4/30/96	710	333	40	0	0	40	0	31	0	0			704	65	65	0	0
16	5/31/96	573	323	65	0	0	65	0	36	0	0			547	65	65	0	0
17	6/30/96	404	333	87	0	0	87	0	37	0	0			357	65	65	0	0
18	7/31/96	309	309	103	0	0	103	0	36	0	0			244	65	65	0	0
19	8/31/96	326	323	97	0	0	97	0	39	0	0			270	65	65	0	0
20	9/30/96	311	311	80	0	0	80	0	41	0	0			274	65	65	0	0
21	10/31/96	241	241	52	0	0	52	0	37	0	0			228	65	65	0	0
22	11/30/96	376	333	27	0	0	27	0	25	0	0			377	65	65	0	0
23	12/31/96	797	323	26	0	0	26	0	25	0	0			800	65	65	0	0
24	1/31/97	654	323	26	0	0	26	0	25	0	0			656	65	65	0	0
25	2/28/97	845	357	29	0	0	29	0	27	0	0			847	65	65	0	0
26	3/31/97	1081	323	26	0	0	26	0	25	0	0			1084	65	65	0	0
27	4/30/97	867	333	40	0	0	40	0	31	0	0			862	65	65	0	0
28	5/31/97	664	323	65	0	0	65	0	36	0	0			638	65	65	0	0
29	6/30/97	616	333	87	0	0	87	0	37	0	0			569	65	65	0	0
30	7/31/97	427	323	103	0	0	103	0	36	0	0			362	65	65	0	0
31	8/31/97	266	266	97	0	0	97	0	39	0	0			211	65	65	0	0
32	9/30/97	268	268	80	0	0	80	0	41	0	0			231	65	65	0	0
33	10/31/97	461	323	52	0	0	52	0	37	0	0			449	65	65	0	0
34	11/30/97	390	333	27	0	0	27	0	25	0	0			391	65	65	0	0
35	12/31/97	490	323	26	0	0	26	0	25	0	0			491	65	65	0	0
36	1/31/98	1461	323	26	0	0	26	0	25	0	0			1465	65	65	0	0
37	2/28/98	1413	357	29	0	0	29	0	27	0	0			1416	65	65	0	0
38	3/31/98	1306	323	26	0	0	26	0	25	0	0			1309	65	65	0	0
39	4/30/98	1277	333	40	0	0	40	0	31	0	0			1272	65	65	0	0
40	5/31/98	945	323	65	0	0	65	0	36	0	0			921	65	65	0	0
41	6/30/98	575	333	87	0	0	87	0	37	0	0			529	65	65	0	0
42	7/31/98	338	323	103	0	0	103	0	36	0	0			273	65	65	0	0
43	8/31/98	281	281	97	0	0	97	0	39	0	0			225	65	65	0	0
44	9/30/98	214	214	80	0	0	80	0	41	0	0			176	65	65	0	0
45	10/31/98	258	258	52	0	0	52	0	37	0	0			245	65	65	0	0
46	11/30/98	270	270	27	0	0	27	0	25	0	0			270	65	65	0	0
47	12/31/98	202	202	26	0	0	26	0	25	0	0			202	65	65	0	0



# Build a Shortage Plot for the Instream Flow Object

**Simplified Water Allocation Model (SWAM)**

Simulation Period  
 Start Date (MM/DD/YYYY): 08/01/1995  
 End Date (MM/DD/YYYY): 12/31/2013

Simulation Type  
 Monthly Planning  
 Daily Planning  
 Short Term Forecasting  
 Firm Yield Calculator

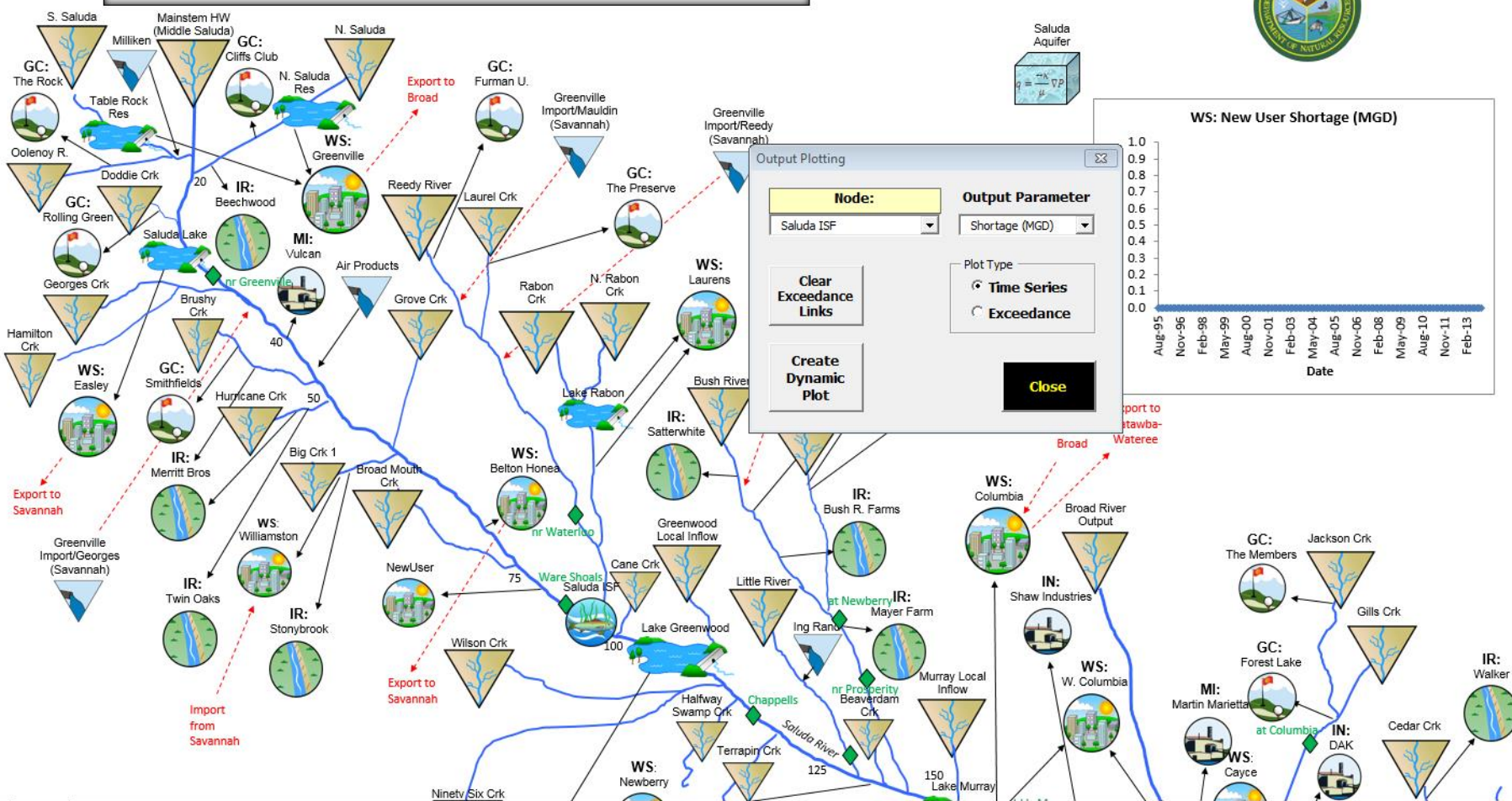
Prior Appropriations  
 Riparian Water Rights

Run (ctrl R)

**Input Summaries and Outputs**

Node Priorities | Node Locations | Reservoir Accounts | Output Specifications

Input & Output  
 AF, AFM, AFD |  MG, MGD, CFS |  m3, m3/d, m3/s



**Output Plotting**

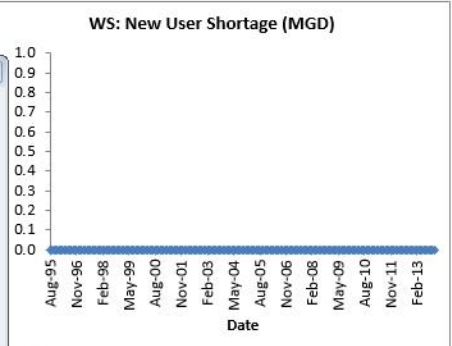
Node: Saluda ISF

Output Parameter: Shortage (MGD)

Plot Type  
 Time Series  
 Exceedance

Clear Exceedance Links  
 Create Dynamic Plot

Close



# Build a Shortage Plot for the Instream Flow Object

### Simplified Water Allocation Model (SWAM)

Simulation Period

Start Date (MM/DD/YYYY): 08/01/1995  
End Date (MM/DD/YYYY): 12/31/2013

Simulation Type

- Monthly Planning
- Daily Planning
- Short Term Forecasting
- Firm Yield Calculator
- Prior Appropriations
- Riparian Water Rights

Run (ctrl R)

### Input Summaries and Outputting

Node Priorities Node Locations Reservoir Accounts Output Specs

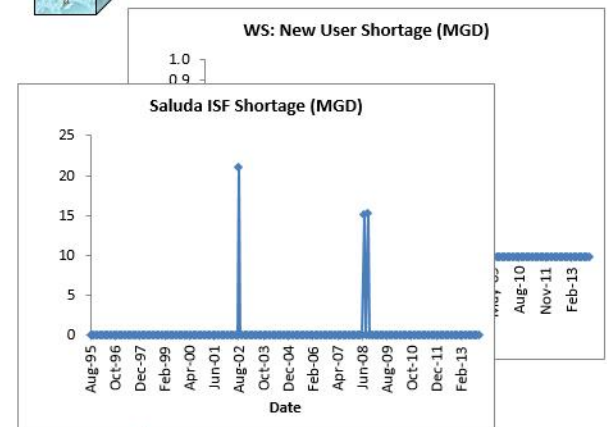
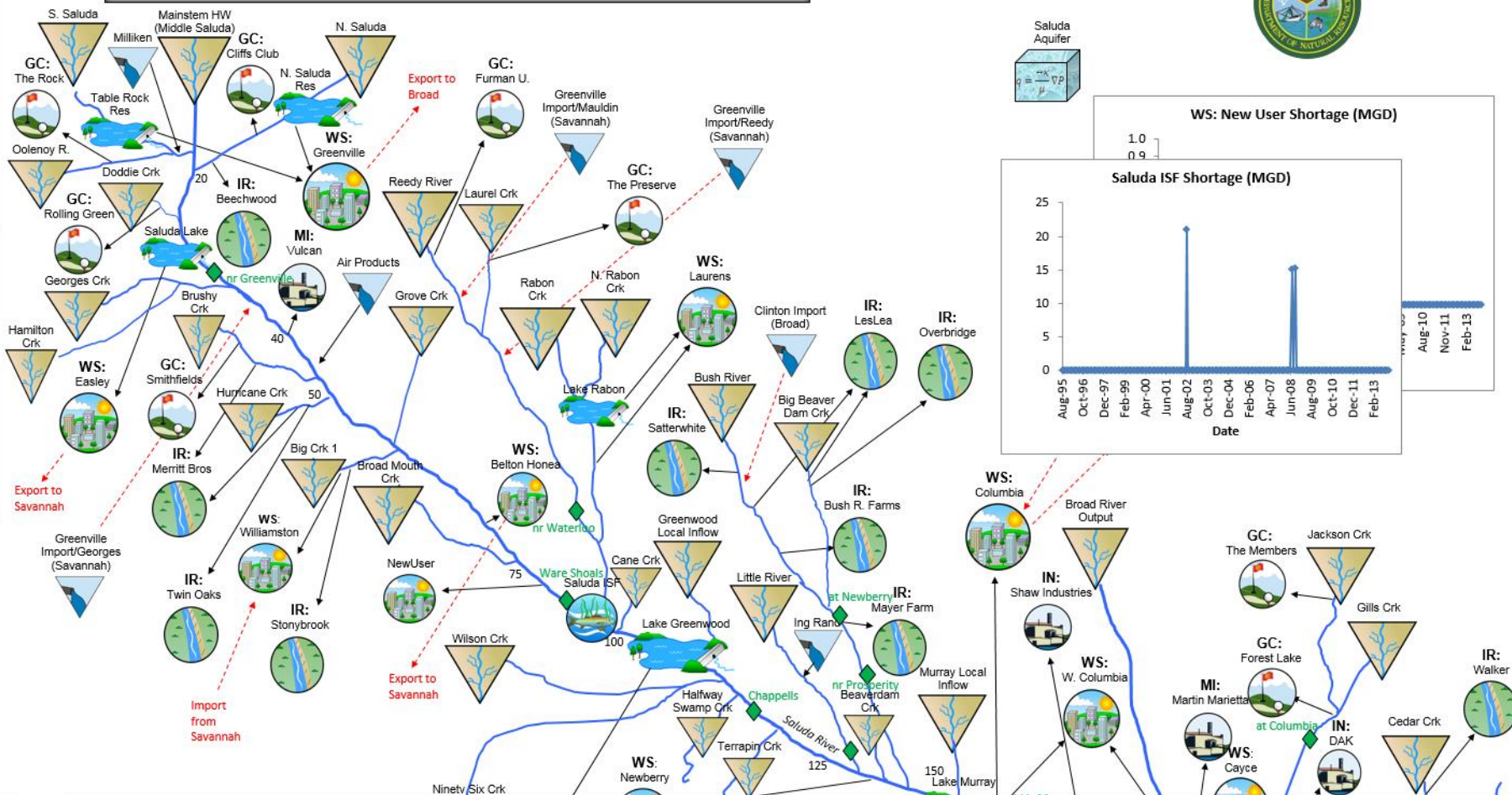
Input & Output

- AF, AFM, AFD
- MG, MGD, CFS
- m3, m3/d, m3/s



### Object Palette

- Water Reservoir
- Water Inflow
- Water Outflow
- Water Inflow/Outflow
- Water Reservoir
- Water Inflow
- Water Outflow
- Water Inflow/Outflow
- Water Reservoir
- Water Inflow
- Water Outflow
- Water Inflow/Outflow
- Water Reservoir
- Water Inflow
- Water Outflow
- Water Inflow/Outflow





# Reduce the New Users Total Water User

**Simplified Water Allocation Model (SWAM)**

Simulation Period: Start Date (MM/DD/YYYY) 08/01/1995, End Date (MM/DD/YYYY) 12/31/2013

Simulation Type:
 

- Monthly Planning
- Daily Planning
- Short Term Forecasting
- Firm Yield Calculator

Input & Output:
 

- Prior Appropriations
- Riparian Water Rights

Run (ctrl R)

**Water User**

Main | Water Usage | Source Water | Return Flows

Monthly User Distribution:
 

- Manual
- M&I
- Agriculture

Annual Baseline Usage:
 

- Total Use: 10000 (MGY)
- Distribute

Input Format:
 

- monthly means
- timeseries

Monthly Baseline Usage (MGD)

Month	Monthly Usage	% Indoor Use	% CU Indoor	% CU Outdoor
Jan	12.9	100	5	5
Feb	14.3	100	5	5
Mar	12.9	100	5	50
Apr	20	67	5	60
May	32.3	40	5	70
Jun	43.3	31	5	80
Jul	51.6	25	5	85
Aug	48.4	27	5	80
Sep	40	33	5	70
Oct	25.8	50	5	50
Nov	13.3	100	5	50
Dec	12.9	100	5	5

(MGD)

Save Close

Object Palette

Main | Node Output | Reservoir Output | Flow Gage Output

# Rerun the Model Scenario

The image shows the **Simplified Water Allocation Model (SWAM)** interface. At the top, there are two main panels:

- Simulation Period:** Start Date (MM/DD/YYYY) is 08/01/1995, and End Date (MM/DD/YYYY) is 12/31/2013.
- Simulation Type:** Includes radio buttons for Monthly Planning, Daily Planning, Short Term Forecasting, Firm Yield Calculator, Prior Appropriations, and Riparian Water Rights.
- Run (ctrl R):** A button highlighted with a red circle.

To the right is the **Input Summaries and Outputting** panel, which includes buttons for Node Priorities, Node Locations, Reservoir Accounts, and Output Specs. Below these are radio buttons for Input & Output: AF, AFM, AFD; MG, MGD, CFS; and m3, m3/d, m3/s.

The main area is a detailed simulation map of the Saluda River basin, showing various nodes (GC, WS, IR, MI, IN), reservoirs (e.g., Table Rock Res, Saluda Lake), and water flows. Red dashed arrows indicate 'Export to Savannah' and 'Import from Savannah'. A 'Saluda Aquifer' icon is also present.

A modal dialog box titled **Simplified Water Allocation Model (SWAM)** is overlaid on the map. It contains the text '(Click on button:)' and two large buttons: **Run** and **Cancel**. Below the buttons, it says 'Simulation Year ='. The CDM Smith logo is in the bottom right corner of the dialog.

At the bottom of the screen is a navigation bar with tabs: **Main**, **Node Output**, **Reservoir Output**, and **Flow Gage Output**.

Logos for the Department of Health and Environmental Control (DHEC) and the South Carolina Department of Natural Resources are visible in the top right corner.



# Dynamic Shortage Plots Update Automatically

## Simplified Water Allocation Model (SWAM)

**Simulation Period**  
 Start Date (MM/DD/YYYY): 08/01/1995  
 End Date (MM/DD/YYYY): 12/31/2013

**Simulation Type**

- Monthly Planning
- Daily Planning
- Short Term Forecasting
- Firm Yield Calculator
- Prior Appropriations
- Riparian Water Rights

**Run (ctrl R)**

## Input Summaries and Outputting

**Node Priorities** **Node Locations** **Reservoir Accounts** **Output Specs**

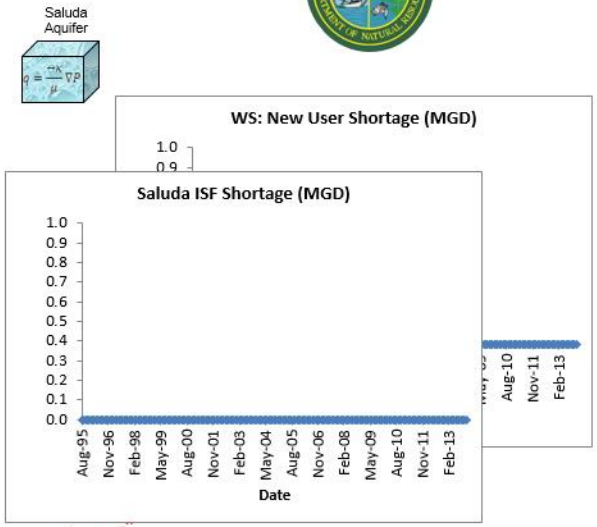
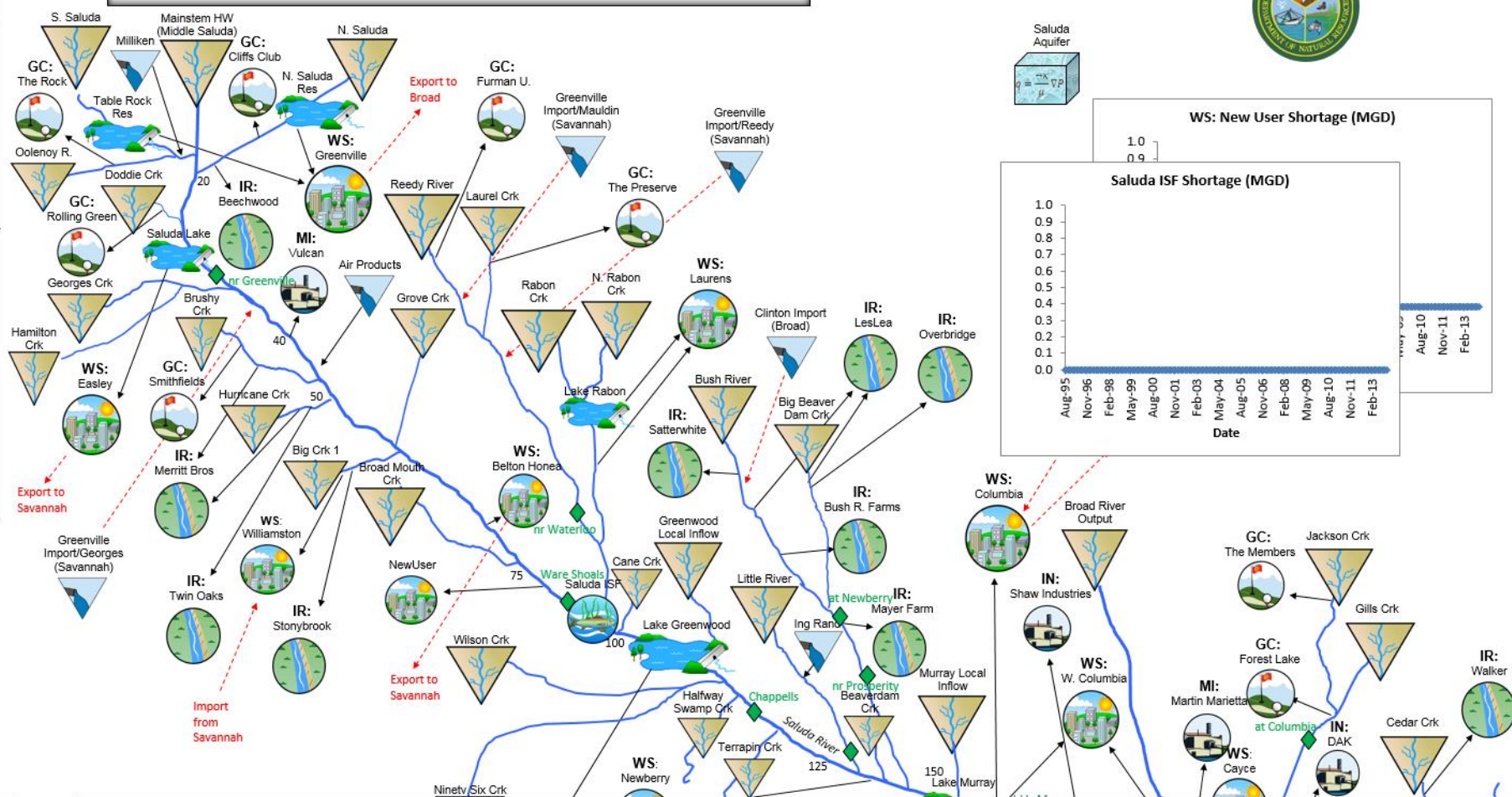
**Input & Output**

- AF, AFM, AFD
- MG, MGD, CFS
- m3, m3/d, m3/s



**Object Palette**

- Reservoir
- Canal
- Stream
- Dam
- Structure
- Node
- Flow Gage
- Export
- Import
- Saluda Aquifer



# Demonstrations and Q&A

- Station 1 (Tim)

Evaluating an increase in WS User demands

- Station 2 (John)

Evaluating a withdrawal with a minimum instream flow constraint

- Station 3 (Kirk)

Adding new M&I user and an instream flow object

Saluda River Basin

THANK YOU