



# The Emergence of South Carolina's New Tools for Surface Water Availability Assessment

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March 14, 2016



**CDM  
Smith**

WATER + ENVIRONMENT + TRANSPORTATION + ENERGY + FACILITIES



Myrtle Beach, SC

# Presentation Outline

- Project purpose and status
- Surface Water Allocation Model (SWAM) overview
- Project highlights...
  - Comparison of managed and unimpaired flows
  - Aspects of model development, calibration, and verification
- SWAM Demonstration



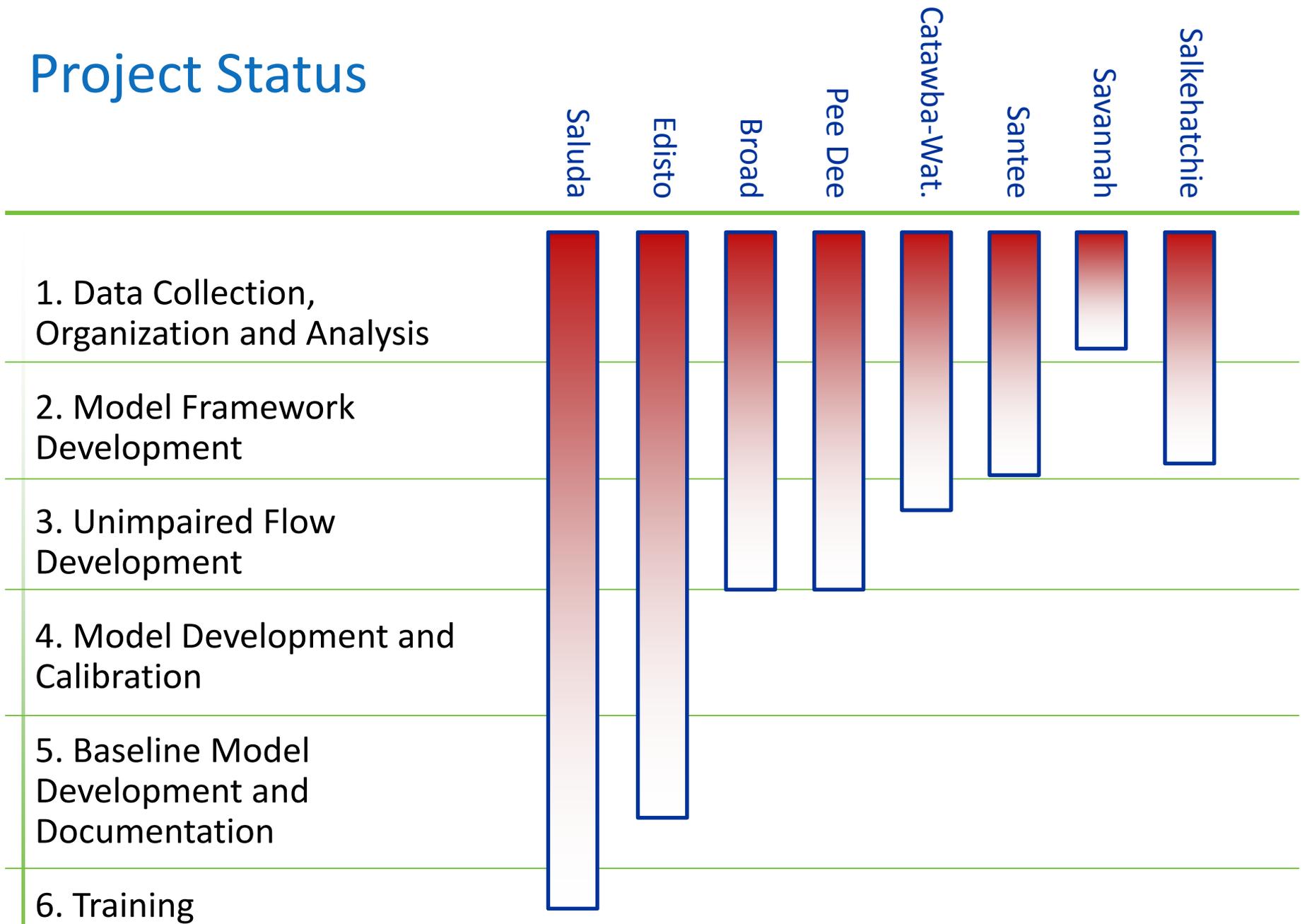
# What is the South Carolina Surface Water Availability Assessment?



**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.

# Project Status





# Technical Advisory Committee

- Advisory group consisting of representatives from:
  - Municipalities & industry
  - Non-governmental organizations
  - Energy
  - Agriculture
  - Consultants
- Engage in project meetings and model training
- Provide valuable technical feedback, insight, data analysis, and direction

# Clemson's Stakeholder Outreach Site

- <http://www.scwatermodels.com>

The screenshot shows the website's header with the Clemson University logo and navigation links (A-Z Index, Calendar, Campus Maps, CU Safety, Phonebook, Webcam, Search). The main title is "SOUTH CAROLINA SURFACE WATER AVAILABILITY ASSESSMENT" with "Public Service" on the right. A navigation bar includes "Home", "Process", "Model", "River Basins", and "Resources". The breadcrumb trail reads "CU > Public Service > Water Assessment > Home".

The main content area features a large photo of a public meeting with a "GET INVOLVED!" overlay. Below the photo is a navigation bar with buttons for "Stakeholders", "Upcoming Meetings", "Get Involved!", "DNR Assessment Site", and "Next".

Two columns of text are present:

- PROCESS & ASSESSMENT**  
The responsible management of the state's water resources is beyond the scope of any one agency or organization and requires cooperation and shared responsibility amongst all agencies and water users. Stakeholder involvement and feedback is critical to this process. [READ MORE >>](#)
- RIVER BASINS**  
Did you know that only two of South Carolina's eight major river basins are not shared with other states? This is also the first time that South Carolina will have surface water models developed individually for each basin that can work together for a state assessment. [READ MORE >>](#)

On the right side, there is a "ASSESSMENT VIDEOS" section with a video player showing "South Carolina Surface Water Availability Assessment: The Purpose" and a "PLAY ALL" button. Below that is a "SIGNUP FOR EMAIL NEWS" form with fields for "Email Address", "First Name", "Last Name", "Affiliation", and "Website", and a "Subscribe" button.

# 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". The main navigation menu lists various activities: Boating, Education, Fishing, Hunting, Land, Maps, Regulations, Water, and Wildlife. The page title is "Surface Water Modeling and Assessments".

**Information**

**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](#).

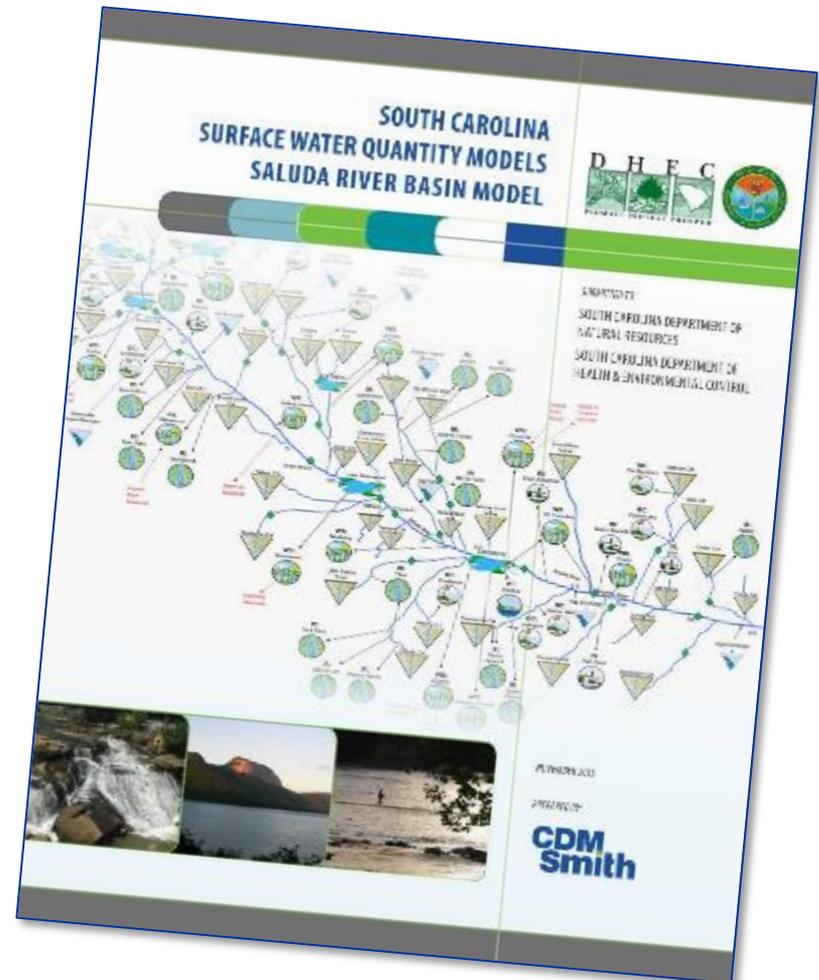
For information about stakeholder meetings, please visit [www.swatermodels.com](http://www.swatermodels.com).

(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](#)

At the bottom of the page, there are social media icons for Facebook, RSS Feed, Twitter, and YouTube. The footer contains the address: South Carolina Department of Natural Resources - P.O. Box 17000 | Columbia, SC 29216 | 2014

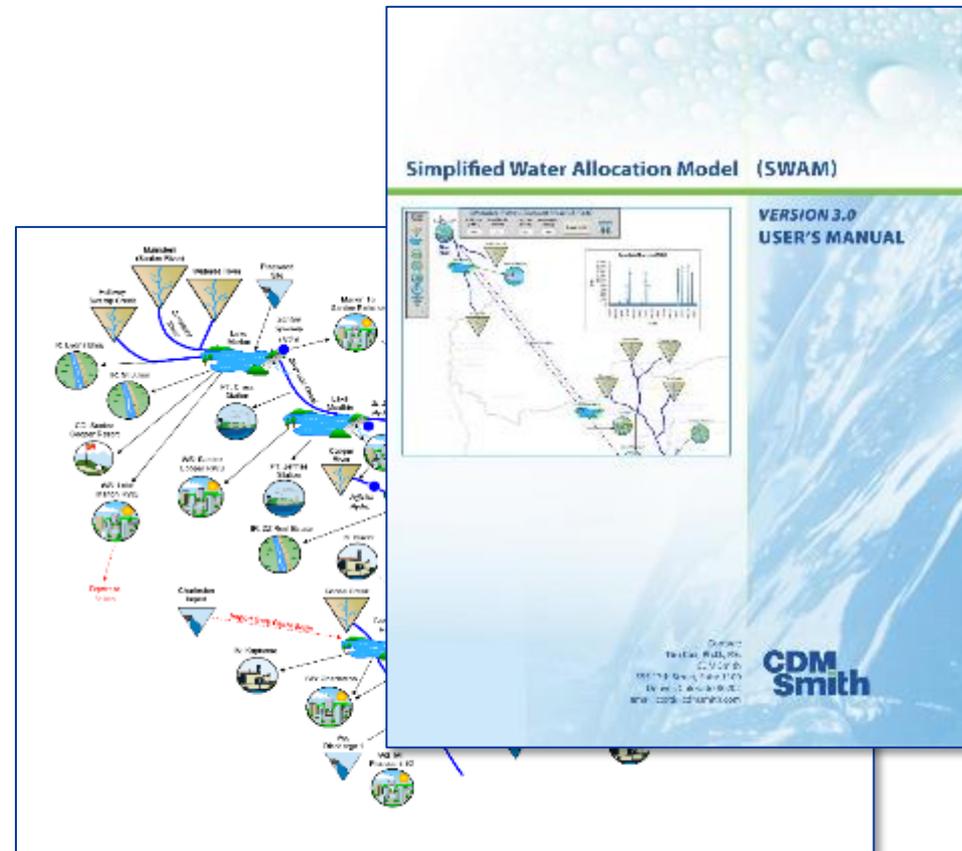




# Simplified Water Allocation Model (SWAM)

# Simplified Water Allocation Model (SWAM)

- Developed in response to an increasing need for a desktop tool to facilitate regional and statewide water allocation analysis
- Calculates physically and legally available water, diversions, storage, consumption and return flows at user-defined nodes
- Used to support large-scale planning studies in Colorado, Oklahoma, Arkansas, and Texas



# The Simplified Water Allocation Model is...

- A water accounting tool
- A WHAT-IF simulation model
- A network flow model that traces water through a natural stream network, simulating withdrawals, discharges, storage, and hydroelectric operations
- Not a 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)



# 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
- Consolidate hydrologic data
- 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
- Evaluate and test complex reservoir operating rules



# Unimpaired Flows and Model Development



# UIF Definition and Uses

- Definition: Estimate of natural historic streamflow in the absence of human intervention

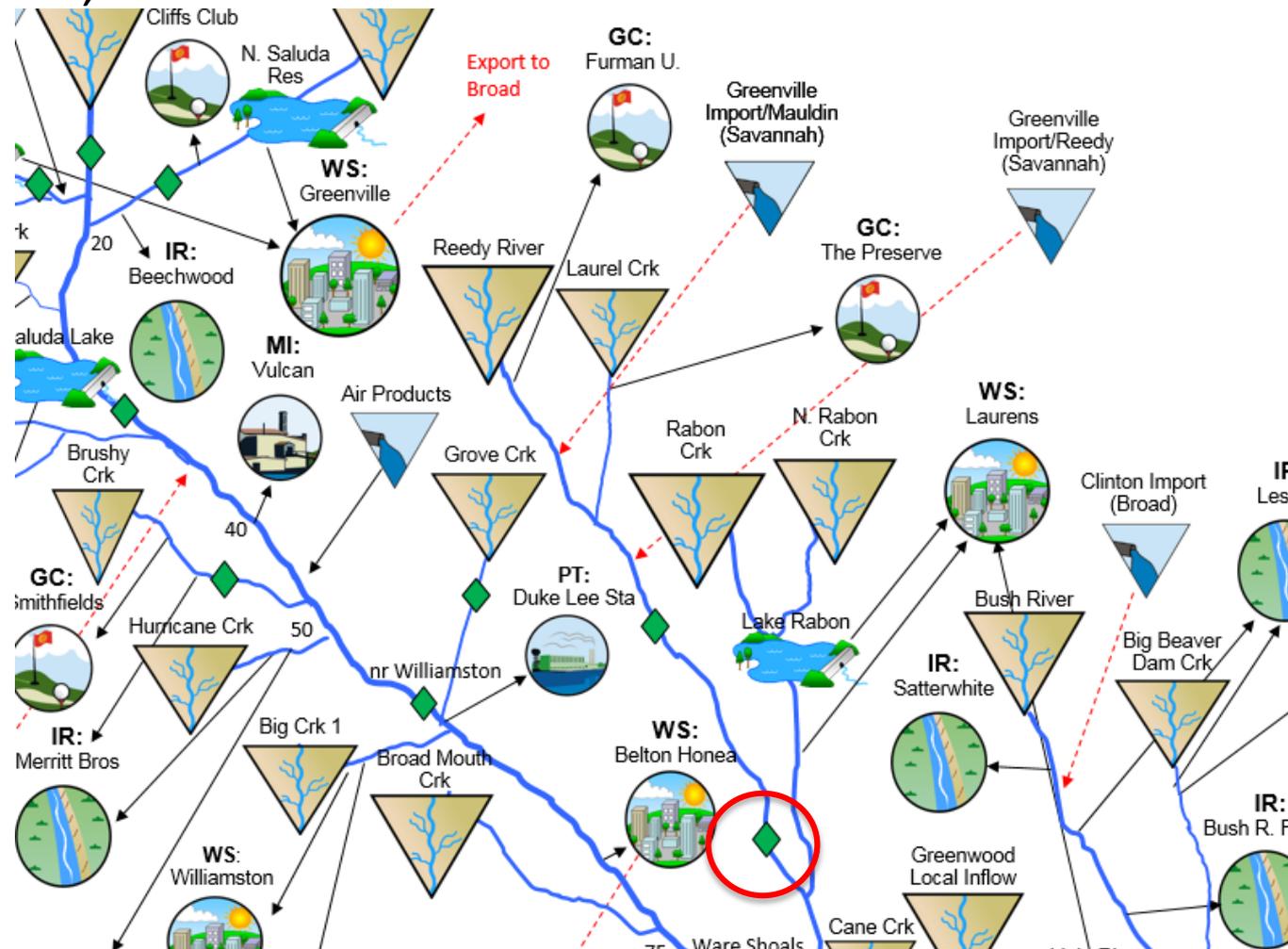
- Unimpaired Flow =

*Measured Gage Flow + River Withdrawals + Reservoir Withdrawals – Discharge to Reservoirs – Return Flow + Reservoir Surface Evaporation – Reservoir Surface Precipitation + Upstream change in Reservoir Storage + Runoff from Previously Unsubmerged Area*

- Fundamental input to the model at headwater nodes and tributary nodes
- Comparative basis for model results

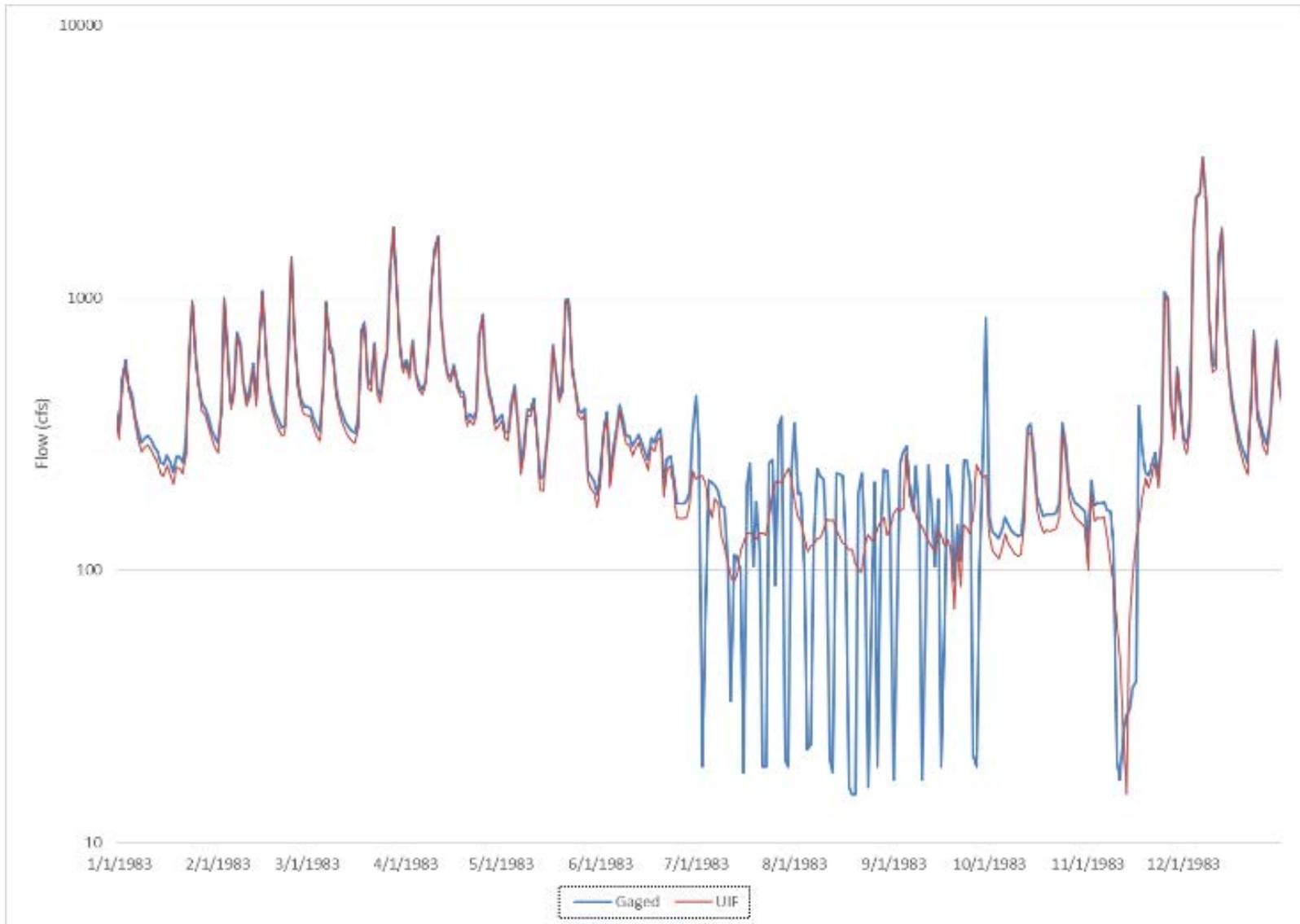
# Saluda UIF Example

- USGS streamflow gage 02165000 on Reedy River near Ware Shoals, SC





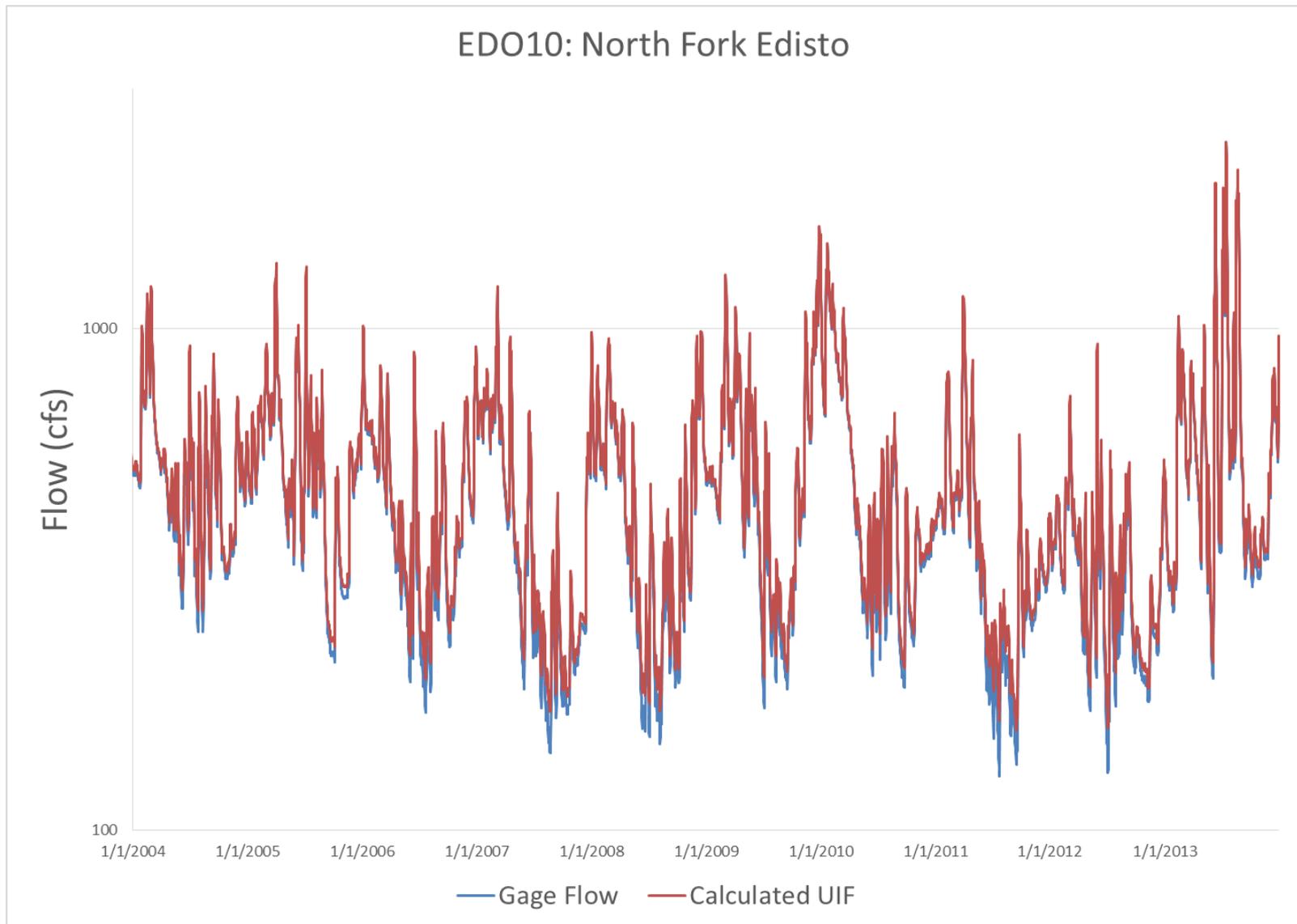
# Saluda UIF Example





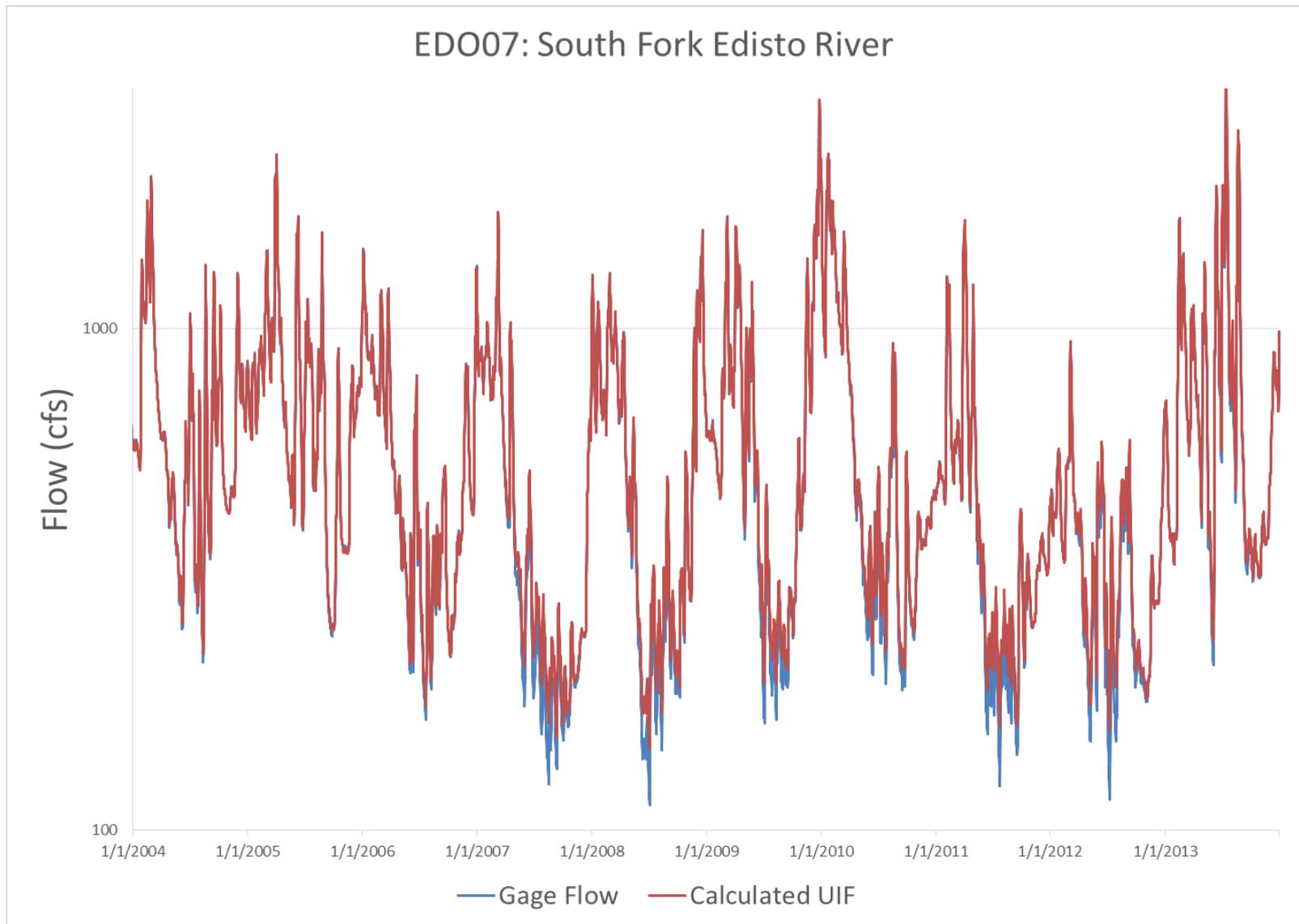


# Edisto UIF Examples

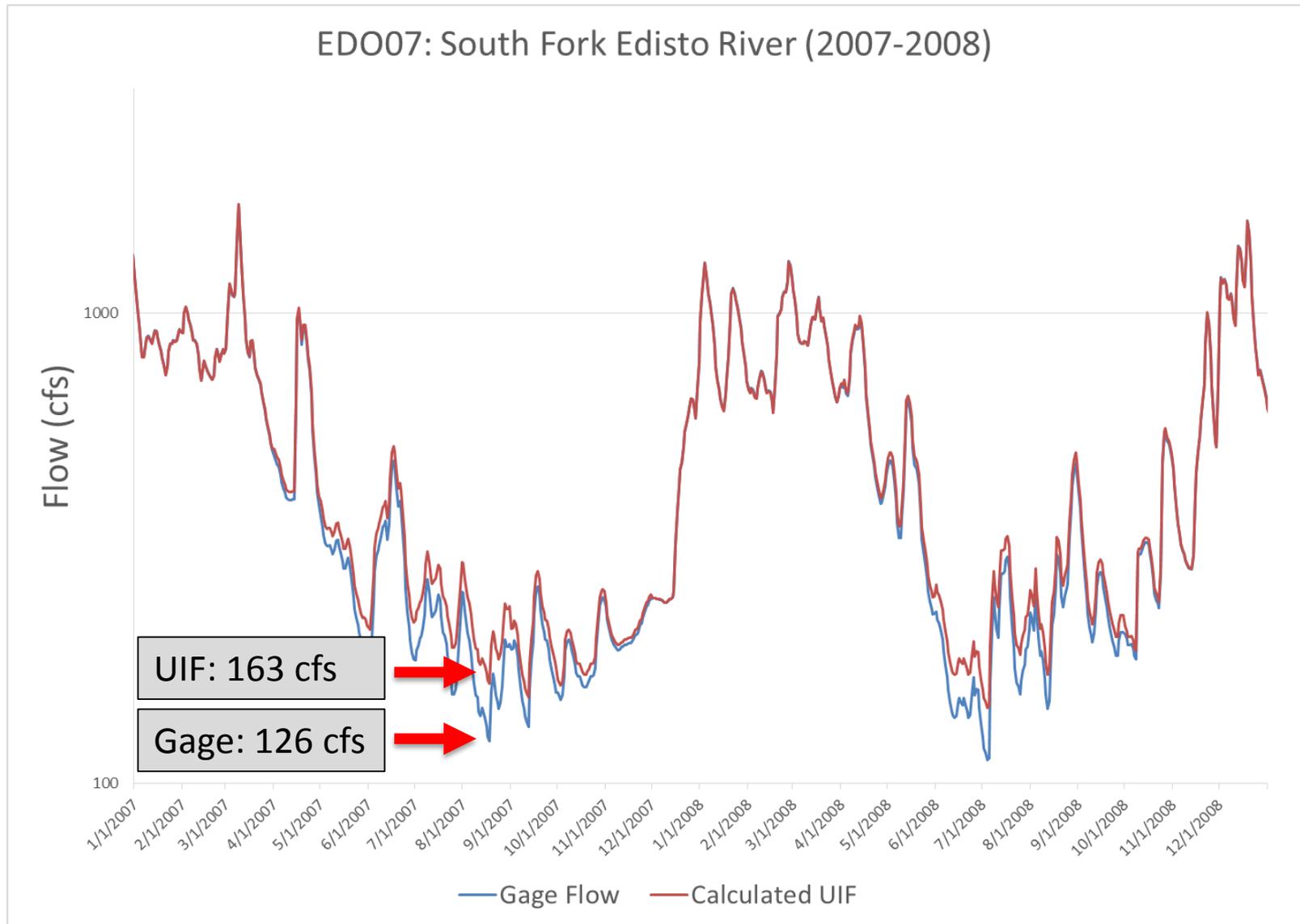




# Edisto UIF Examples



# Edisto UIF Examples



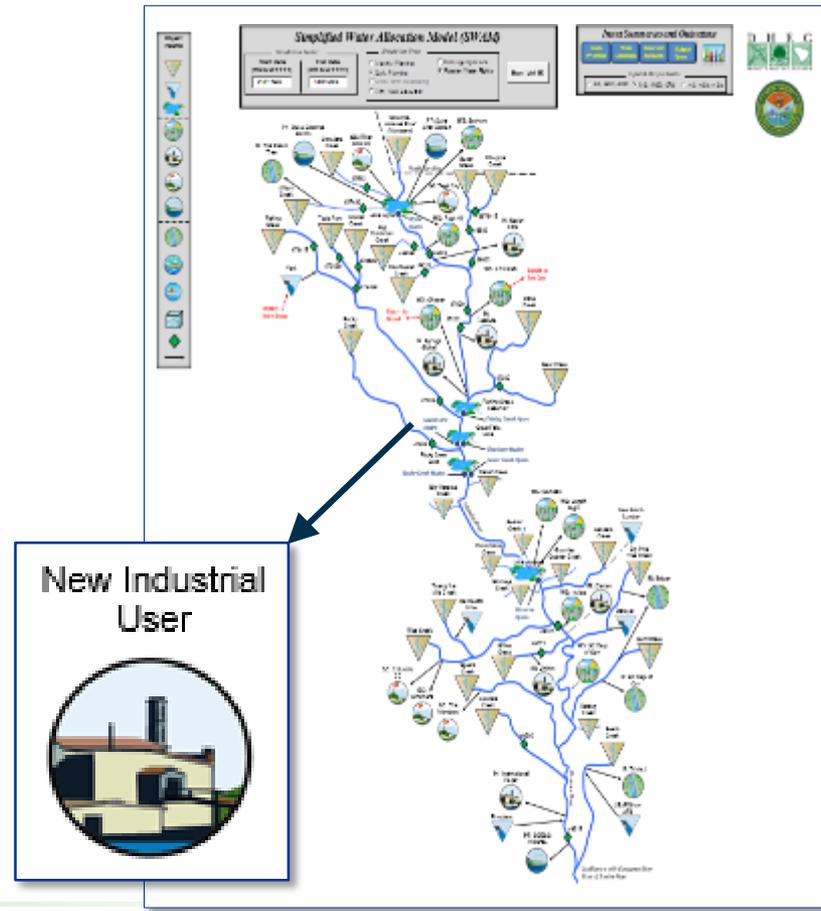
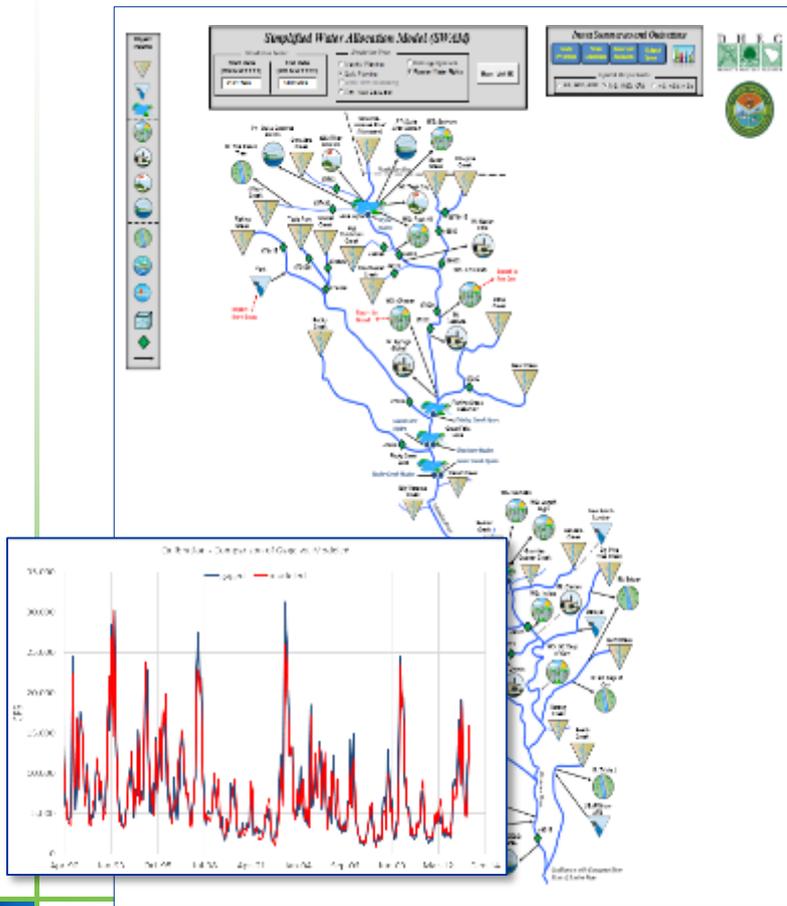


# Model Development, Calibration, and Verification

# Two Versions of Every Model

- Calibration with UIFs and historic use records

- Baseline: planning with UIFs, current uses, and user-defined future uses



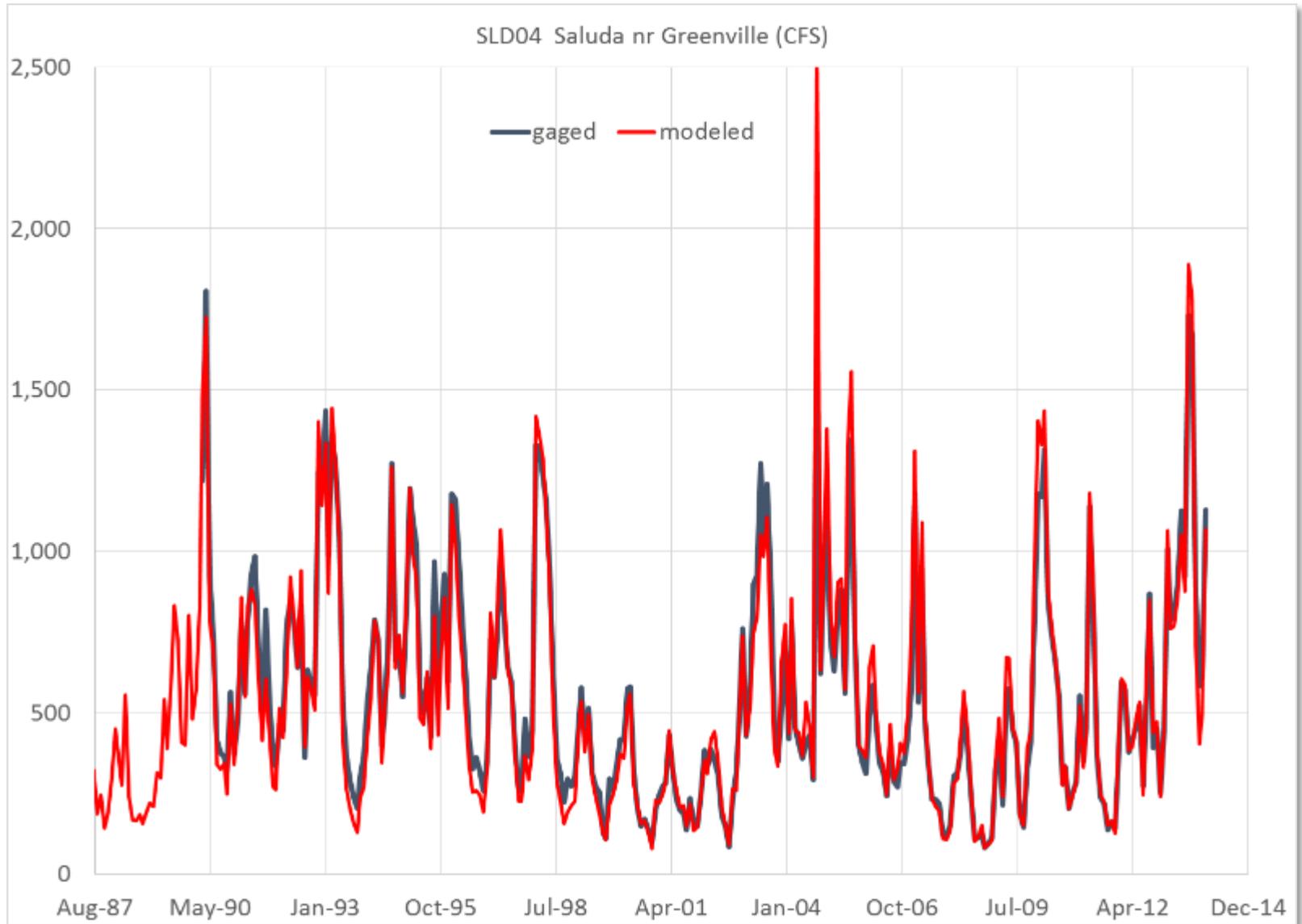
# Calibration/Validation General Approach

- 1983 – 2013 hindcast period; monthly timestep first
  - Includes droughts in both early and late 2000's
- Comparison to gaged (measured) flow data
  - Operations and impairments are implicit in that data
- Assess performance at (subject to gage data availability):
  - Multiple mainstem locations
  - 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)

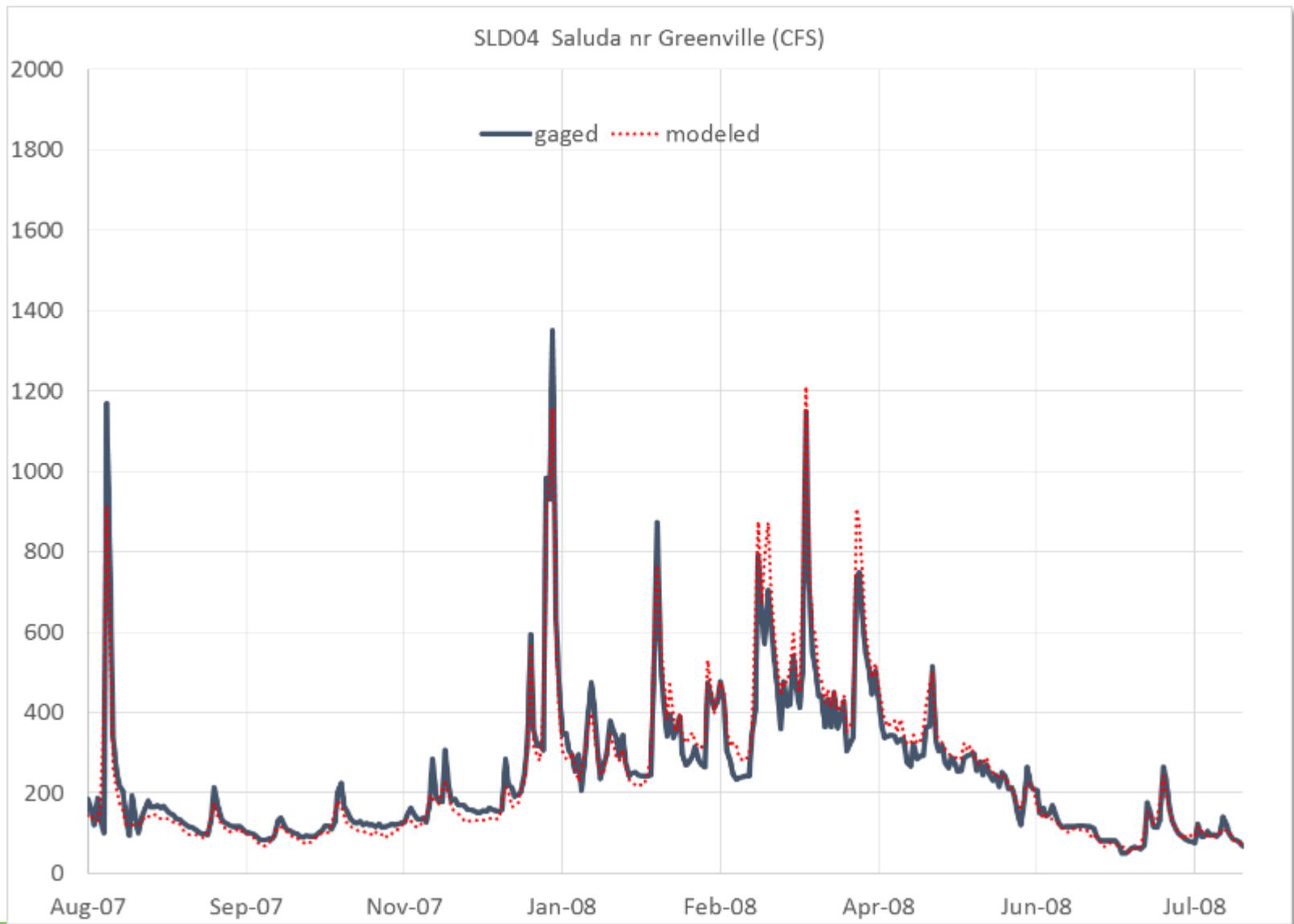
# Potential Sources of Model Error & Uncertainty

- Gaged flow data
- Gaged reservoir levels
- Basin climate and hydrologic variability
- Reported withdrawal and discharge data
- Hindcasted withdrawal and discharge data
- Return flow locations and lag times (if applicable, e.g. outdoor use)
- Reservoir operations (operator decision making)
- Reach hydrology: gains, losses, local runoff and inflow

# Monthly Flow Comparison

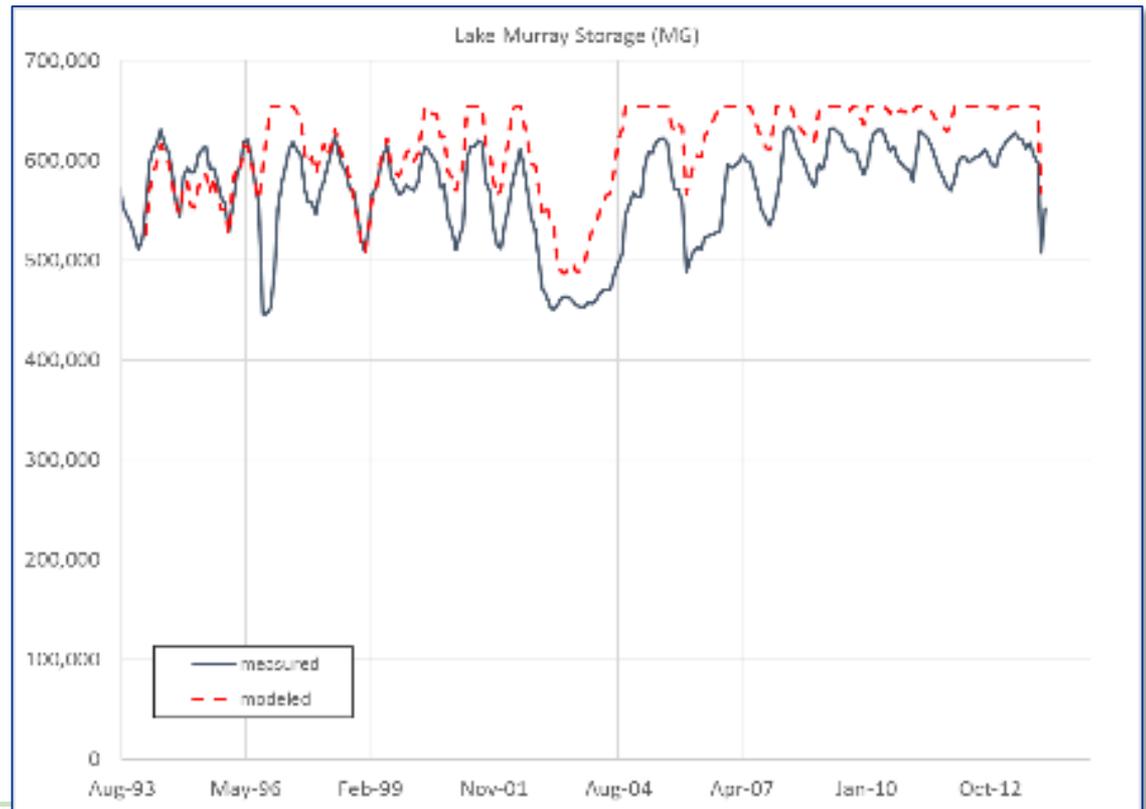


# Daily Flow Comparison – Drought Period



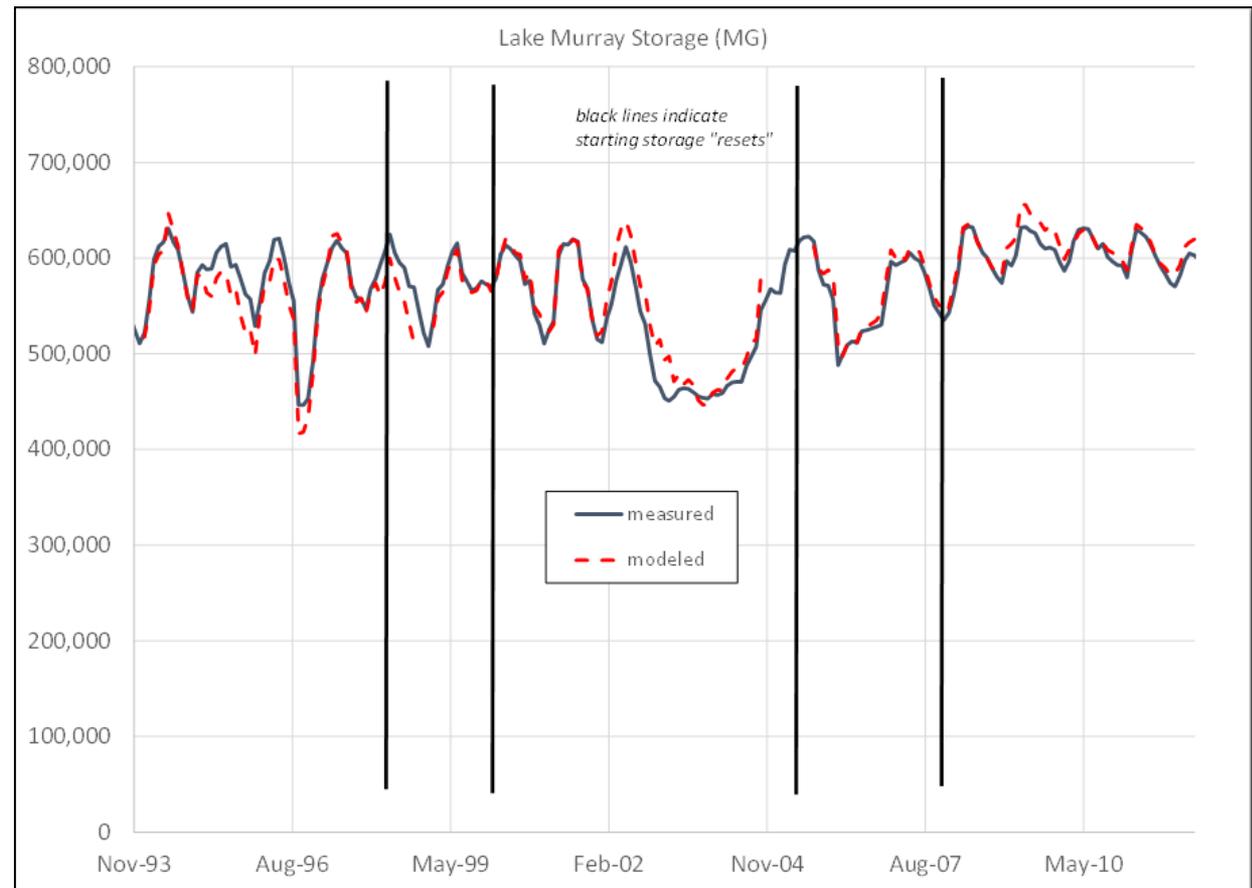
# Lake Murray Verification Exercise

- **Approach:** Set the Lake Murray release equal to the historical release, then run the model to check that the combination of inflow, evaporation, and withdrawals/discharges result in a reasonable match of historical lake levels/storage.
- **Observations:** Modeled lake storage was higher than observed storage for certain years



# Lake Murray Verification Exercise

- **Adjustments:** Adjust inflow by selecting alternative reference gages for headwater inputs at select, ungaged tributaries
- **Results:** Better match of modeled and measured Lake Murray storage



# Baseline Model

- Represents current demands and operations combined with an extended period of estimated hydrology
  - Most demands reflect 2005-2013 averages
  - Estimated hydrology from 1920's-30's to 2013
  - Current reservoir rules, guide curves, minimum releases
  - Rules can be adjusted
  - Inactive users are not included
- The baseline model serves as the starting point for future predictive simulations



# Example Use

## *Assessing a New M&I User – Edisto Example*

- Add model flow gage at proposed withdrawal location
  - Calculate minimum instream flows (20/30/40 Rule)
  
- Add a new M&I permittee
  - Demand = 500 MGY (0.6-2.6 MGD)
  - *Can the river sustain the new user?*
  
- Enter minimum instream flows in user object
  - *Are there shortages, i.e. does the withdrawal cause streamflow to drop below the minimum instream flow?*

***Note that this example does not necessarily represent how DHEC will use the model to evaluate a proposed withdrawal***

# Add Flow Gage from Palette

**Object Palette**

**Simplified Water Allocation Model (SWAM)**

Simulation Period  
**Start Date (MM/DD/YYYY)** 1/1/1932    **End Date (MM/DD/YYYY)** 12/1/2013

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

**Run (ctrl R)**

**Input Summaries and Outputting**

Input & Output Units  
 AF, AFM, AFD     MB, MBD, CFS     m8, m8/d, m3/s

Location of new user

Export to

Main
Node Output
Reservoir Output
Flow Gage Output
Aquifer Output

Edisto Aquif

# Add Industrial Water User Object from Palette

**Object Palette**

### Simplified Water Allocation Model (SWAM)

**Simulation Period**

Start Date (MM/DD/YYYY): 1/1/1932

End Date (MM/DD/YYYY): 12/1/2013

**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 Units**

AF, AFM, AFD     MB, MBD, CFS     m3, m3/d, m3/w

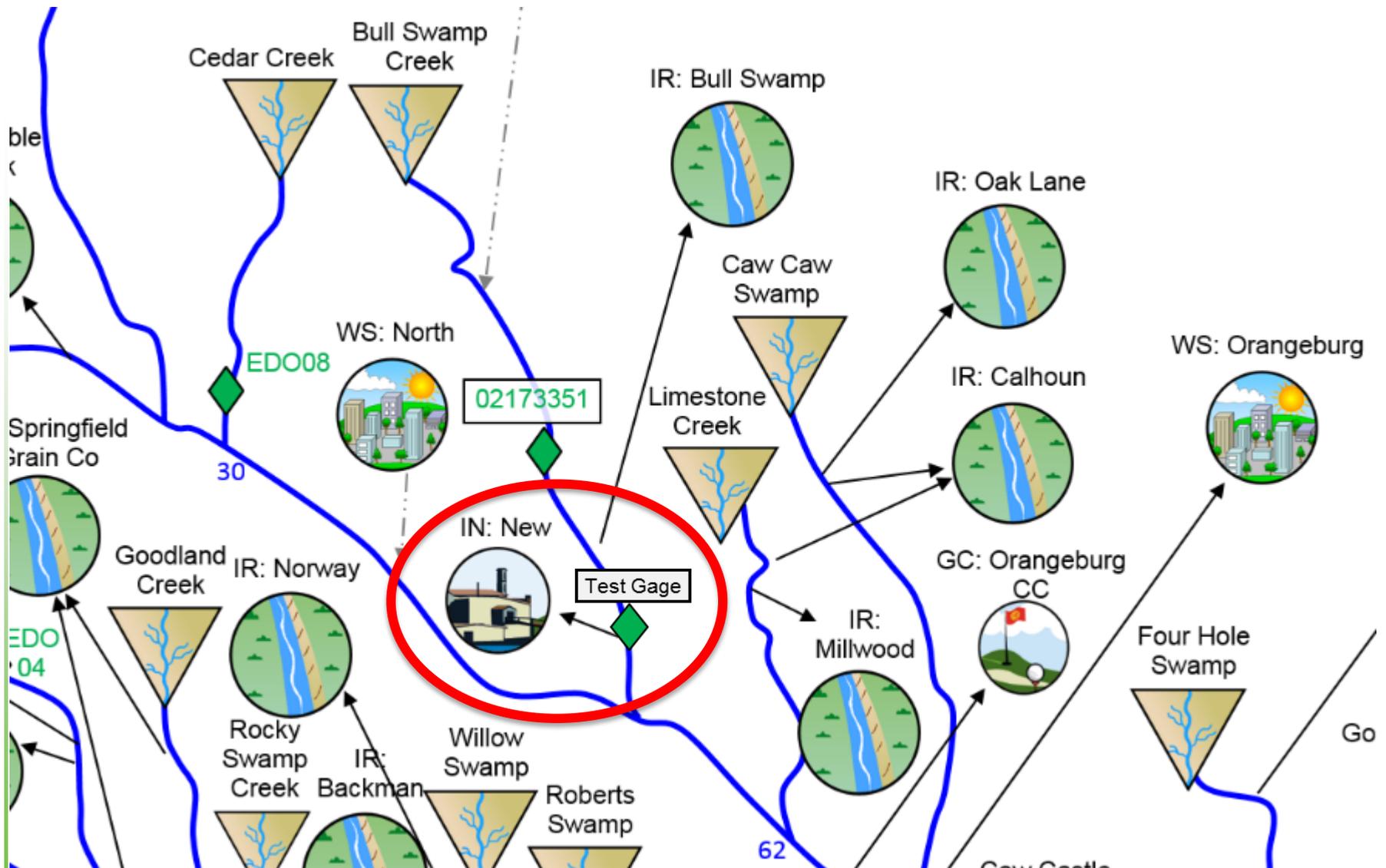
Location of new user

Export to

Main
Node Output
Reservoir Output
Flow Gage Output
Aquifer Output

Edisto Aquif

# Add Flow Gage & Industrial Water User Objects



# Specify Flow Gage Location

**Flow Gage**

**Gage Name or No.:** Test Gage

**Delete Gage**

**Target Stream:** Bull Swamp Creek

**Downstream Location (mi):** 15

**Save**

**Close**

Comments:

Map Labels: Cedar Creek, Bull Swamp Creek, WS: North, EDO08, Springfield Grain Co, 30, Goodland Creek, IR: Norway, IN: New, Test Gage, IR: Millwood, GC: Orangeburg CC, Rocky Swamp Creek, IR: Backman, Willow Swamp, Roberts Swamp, 62, Four Hole Swamp, Go

# Run the Model over the Entire Period of Record

**Simplified Water Allocation Model (SWAM)**

Simulation Period  
Start Date (MMDDYYYY): 1/1/1992  
End Date (MMDDYYYY): 12/1/2013

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 Units  
 AF, AFM, AFD    MD, M3D, CFS    m3, m3/d, m3/k

**SWAM**  
**Simplified Water Allocation Model (SWAM)**  
(Click on button:)  
**Run**   **Cancel**  
Simulation Year =  
CDM Smith

Object Palette  
Export to  
Main | Node Output | Reservoir Output | Flow Gage Output | Aquifer Output

D H E C  
PROMOTE PROTECT PROSPER  
EDIXTO AGUILE  
$$q = \frac{h - \mu}{\mu} \cdot \mu$$

# Calculate the Minimum Instream Flows

Model Output:

	<u>Reach / mi</u>
	<i>Bull Swamp Creek / 15</i>
Date	Test Gage Flow (CFS)
<b>Min</b>	<b>5</b>
<b>Max</b>	<b>96</b>
<b>Avg</b>	<b>25</b>
1/1/32	34.7
1/2/32	34.7
1/3/32	34.7
1/4/32	37.8
1/5/32	34.7
1/6/32	34.7
1/7/32	37.8
1/8/32	43.7
1/9/32	50.3
1/10/32	53.4
1/11/32	50.3
1/12/32	50.3
1/13/32	50.3
1/14/32	53.4
1/15/32	50.3
1/16/32	46.9
1/17/32	40.6
1/18/32	37.8
1/19/32	34.7



Minimum Flow Calculations:

	: 40%
	: 30%
	: 20%
Month	Instream Flow (cfs)
Jan	10.3
Feb	10.3
Mar	10.3
Apr	10.3
May	7.7
Jun	7.7
Jul	5.2
Aug	5.2
Sep	5.2
Oct	5.2
Nov	5.2
Dec	7.7

# Add the New User in the Water User Dialogue

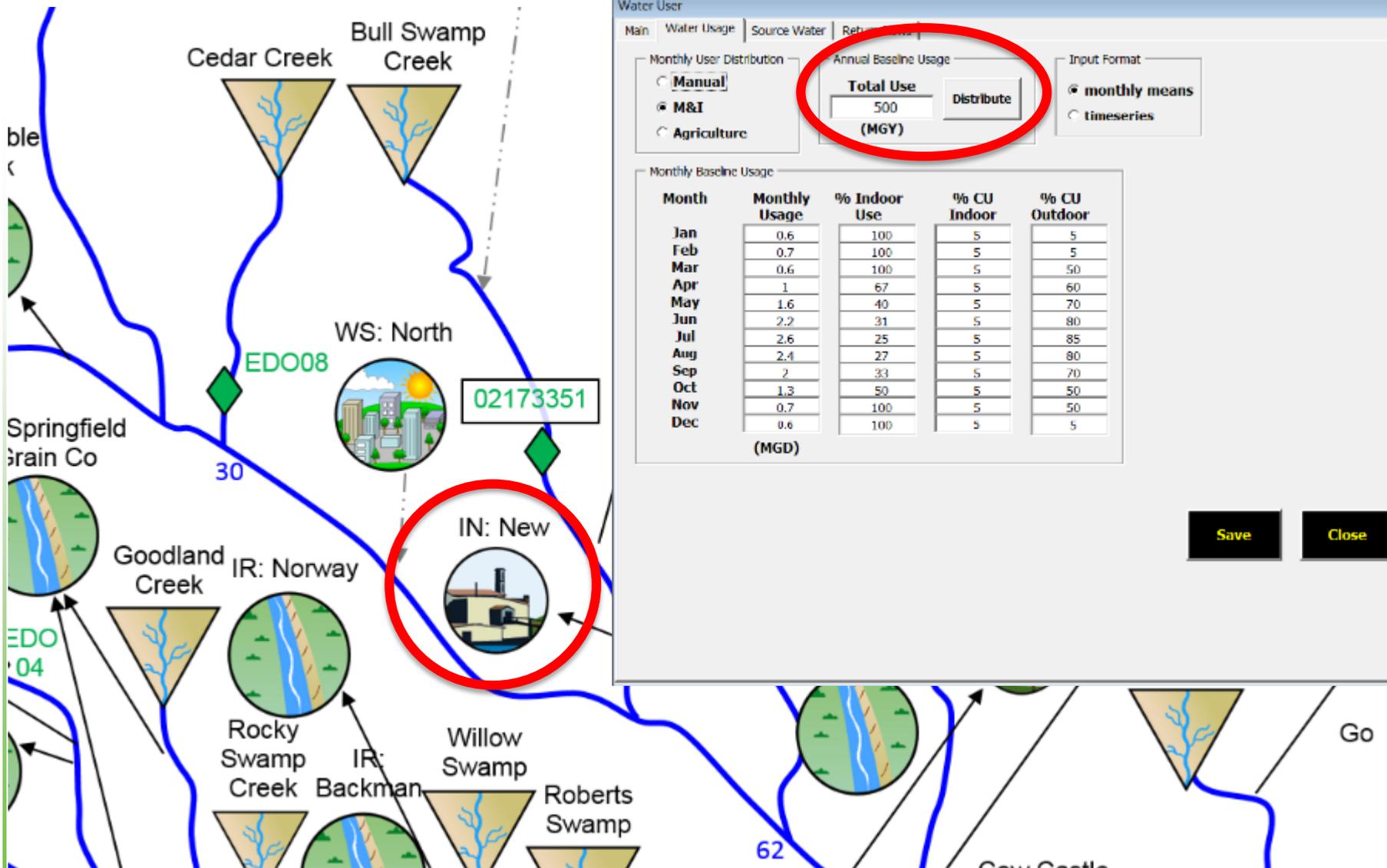
The image displays a water management software interface. On the left, a map shows a network of blue lines representing waterways. Key features include:

- Cedar Creek** and **Bull Swamp Creek** at the top.
- Springfield Grain Co** and **Goodland Creek** on the left side.
- Rocky Swamp Creek** and **Willow Swamp** at the bottom.
- IR: Norway** and **IR: Backman** labels.
- WS: North** and **02173351** (a green box) near the center.
- EDO08** and **EDO04** labels.
- Roberts Swamp** at the bottom right.
- A red circle highlights a node on the map labeled **IN: New** with a building icon.

On the right, the **Water User** dialog box is open, showing the following details:

- Tabbed interface: **Main** | **Water Usage** | **Source Water** | **Return Flows**.
- Water User Name:** A text field containing **IN: New**, circled in red. Next to it is a **Delete Node** button.
- Multiple Sources of Water?**
- Supplemental Supply/Demand Alternatives:**
  - Conservation**
  - Transbasin Import**
  - Recapture Reuse**
  - Water Exchange**
  - Ag Transfer**
- Comments:** A text area.
- Save** and **Close** buttons at the bottom right.

# Specify Water Use



# Specify the Source and Diversion Location

The map displays a network of waterways including Cedar Creek, Bull Swamp Creek, Goodland Creek, Rocky Swamp Creek, Willow Swamp, and Roberts Swamp. A red circle highlights a location labeled 'IN: New' on the main river. An inset window titled 'Water User' is overlaid on the map, showing configuration options for a water user. The 'Source Stream' is set to 'Bull Swamp Creek' and the 'Diversion Location (mi)' is set to '14.9'. Other options include 'Direct River', 'Reservoir', and 'Groundwater' for source water type, and 'Permit Limit', 'Seasonal Permit', and 'Minimum Flow' for diversion settings.

**Water User**

Man | Water Usage | Source Water | Return Flows

**Source Stream:** Bull Swamp Creek

Source Water Type:  Direct River  Reservoir  Groundwater

**Diversion Location (mi):** 14.9

Priority Date: 4/1901

Diversion Capacity: 1000 (CFS)

Permit Limit: 1000 (MGM)

Seasonal Permit

Minimum Flow

Identifying Notes:

Save

Close

# Designate the Return Location

The map displays a network of waterways including Cedar Creek, Bull Swamp Creek, Goodland Creek, Rocky Swamp Creek, Willow Swamp, and Roberts Swamp. It also shows various locations like Springfield Grain Co, WS: North, IR: Norway, and IR: Backman. A red circle highlights a location labeled 'IN: New' with a building icon. An inset window titled 'Water User' is open, showing the 'Return Flows' tab. In this window, the 'Receiving Stream' dropdown is set to 'Bull Swamp Creek', and the 'RF Location (mi)' is set to 15.5. A red circle highlights this section of the window.

Return Flow Locations	Receiving Stream	RF Location (mi)	RF Lag (months)
<input checked="" type="radio"/> single point	Bull Swamp Creek	15.5	
<input type="radio"/> multiple			

# Run the Model over the Entire Period of Record

The image displays the user interface of the Simplified Water Allocation Model (SWAM). At the top left is an 'Object Palette' with various icons. The main window is titled 'Simplified Water Allocation Model (SWAM)' and contains the following elements:

- Simulation Period:** Start Date (MMDDYYYY) set to 1/1/1992, End Date (MMDDYYYY) set to 12/1/2013.
- Simulation Type:** Includes checkboxes 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.
- Input Summaries and Outputting:** A panel with buttons for 'Node Priorities', 'Node Locations', 'Reservoir Accounts', and 'Output Specs', along with 'Input & Output Units' options.

In the center, a smaller dialog box titled 'Simplified Water Allocation Model (SWAM)' is open, showing a 'Run' button and a 'Cancel' button. Below the buttons, it says 'Simulation Year ='. The background shows a network diagram of water resources with nodes like 'IR: Titan (Chinquapin)', 'IR: Walter P. Rawl & Sons', 'IR: Kyzer', 'IN: Gaston', 'Cedar Creek', 'Bull Swamp Creek', 'IR: Bull Swamp', 'Caw Caw Swamp', 'IR: Oak Lane', 'IR: Celhoun', 'WS: Crangeburg', 'IR: Halgier', 'GC: Indian', 'Import from Saluda', 'EDWSA (Save)', 'Shaw Creek', 'IR: Smith WG III', 'WS: Aiken', 'KY-TN Clay', 'Rocky Spring (Imp) Creek', 'IN: JM Huber', 'Cedar Creek IR: M...', 'Furlock', 'Grain Co', 'Goodland Creek', 'IR: Norway', 'Rocky Swamp Creek', 'Willow Swamp', 'IR: Boland', 'IR: Walther', 'IR: New', 'Limestone Creek', 'IR: Millwood', 'GC: Crangeburg', 'Four Hole Swamp', 'Goodbys Swamp', 'Test Gage', 'ED003', 'ED004', 'ED005', 'Edisto Aquife', and 'Export to'. The bottom of the screen features a navigation bar with tabs: 'Main', 'Node Output', 'Reservoir Output', 'Flow Gage Output', and 'Aquifer Output'.

# Build a Shortage Plot for the New User

The screenshot displays the **Simplified Water Allocation Model (SWAM)** interface. At the top left is an **Object Palette** with various icons. The main window is divided into several panels:

- Simulation Period:** Start Date (MM/DD/YYYY) is 1/1/1992, and End Date (MM/DD/YYYY) is 12/1/2013.
- Simulation Type:** Includes checkboxes for Monthly Planning, Daily Planning, Short Term Forecasting, Firm Yield Calculator, Prior Appropriations, and Riparian Water Rights.
- Run (ctrl R):** A button to execute the simulation.
- Input Summaries and Outputting:** A panel with buttons for Node Priorities, Node Locations, Reservoir Accounts, and Output Specs. A red circle highlights the **Output Specs** button.
- Input & Output Units:** Includes checkboxes for AF, AFM, AFD, MB, MBD, CFS, and m8, m8/d, m3/s.

The central part of the interface shows a network map with various nodes and links. A **Test Gauge** is highlighted on the **IN: New** node. A **Output Plotting** dialog box is open, showing:

- Node:** IN: New
- Output Parameter:** Shortage (MGD)
- Plot Type:** Time Series (selected) and Exceedance.
- Buttons: Clear Exceedance Links, Create Dynamic Plot, and Close.

Below the map, a **Plot** window displays the **IN: New Shortage (MGD)** over time. The x-axis represents the **Date** from Jan-32 to May-10, and the y-axis represents the shortage in MGD, ranging from 0.0 to 1.0. The plot shows a constant shortage of 0.0 MGD throughout the entire period.

At the bottom, there is a navigation bar with tabs for **Main**, **Node Output**, **Reservoir Output**, **Flow Gage Output**, and **Aquifer Output**.



# Add Minimum Flows

The screenshot displays a water management software interface. On the left, a map shows a network of blue rivers and green reservoirs. Key locations include Cedar Creek, Bull Swamp Creek, Springfield Grain Co, Goodland Creek, Rocky Swamp Creek, Willow Swamp, and Roberts Swamp. A red circle highlights a 'Water User' icon labeled 'IN: New'. Another red circle highlights the 'Monthly Minimum Flow Requirements' table in the configuration window.

The 'Water User' configuration window is titled 'Water User' and has tabs for 'Main', 'Water Usage', 'Source Water', and 'Return Flows'. The 'Source Water' tab is active. It contains the following fields:

- Source Stream:** Bull Swamp Creek
- Source Water Type:**
  - Direct River
  - Reservoir
  - Groundwater
- Diversion Location (mi):** 14.9
- Priority Date:** 3/4/1901
- Diversion Capacity (CFS):** 1000
- Permit Limit (MGM):** 1000
- Seasonal Permit
- Minimum Flow

The 'Monthly Minimum Flow Requirements' table is circled in red and contains the following data:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10.3	10.3	10.3	10.3	7.7	7.7	5.2	5.2	5.2	5.2	5.2	7.7
CFS											

Below the table is an 'Identifying Notes' field.

# Re-Run the Model

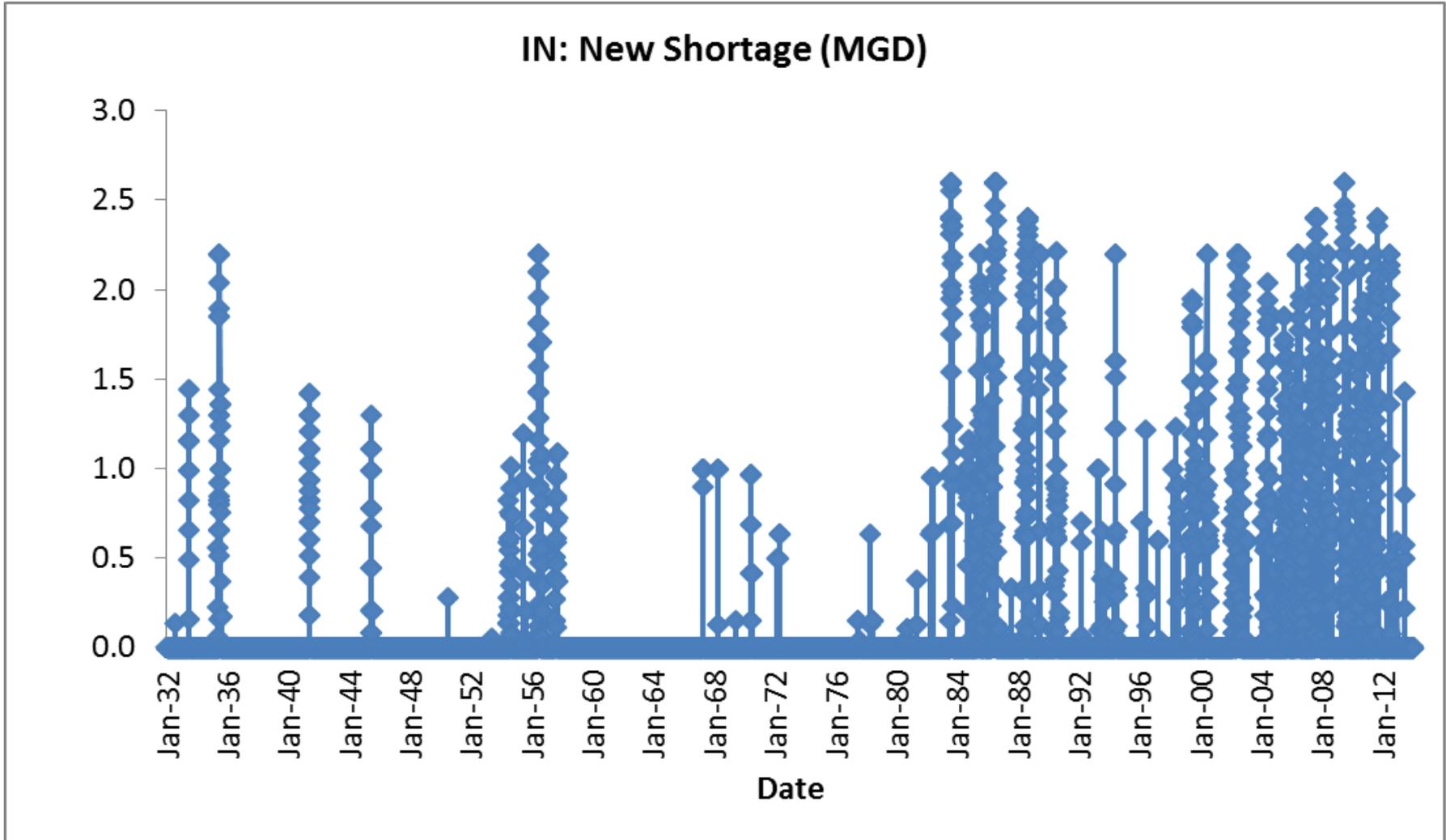
The image displays the user interface of the Simplified Water Allocation Model (SWAM) software. At the top, a control panel titled "Simplified Water Allocation Model (SWAM)" contains simulation parameters. The "Simulation Period" section shows a Start Date of 1/1/1992 and an End Date of 12/1/2013. The "Simulation Type" section includes options for Monthly Planning, Daily Planning, Short Term Forecasting, Firm Yield Calculator, Prior Appropriations, and Riparian Water Rights. A "Run (ctrl R)" button is highlighted with a red circle.

To the right, the "Input Summaries and Outputting" panel features buttons for Node Priorities, Node Locations, Reservoir Accounts, and Output Specs, along with a bar chart icon. Below these are "Input & Output Units" options: AF, AFM, APD; MD, MDD, CFS; and m0, m0d, m0k.

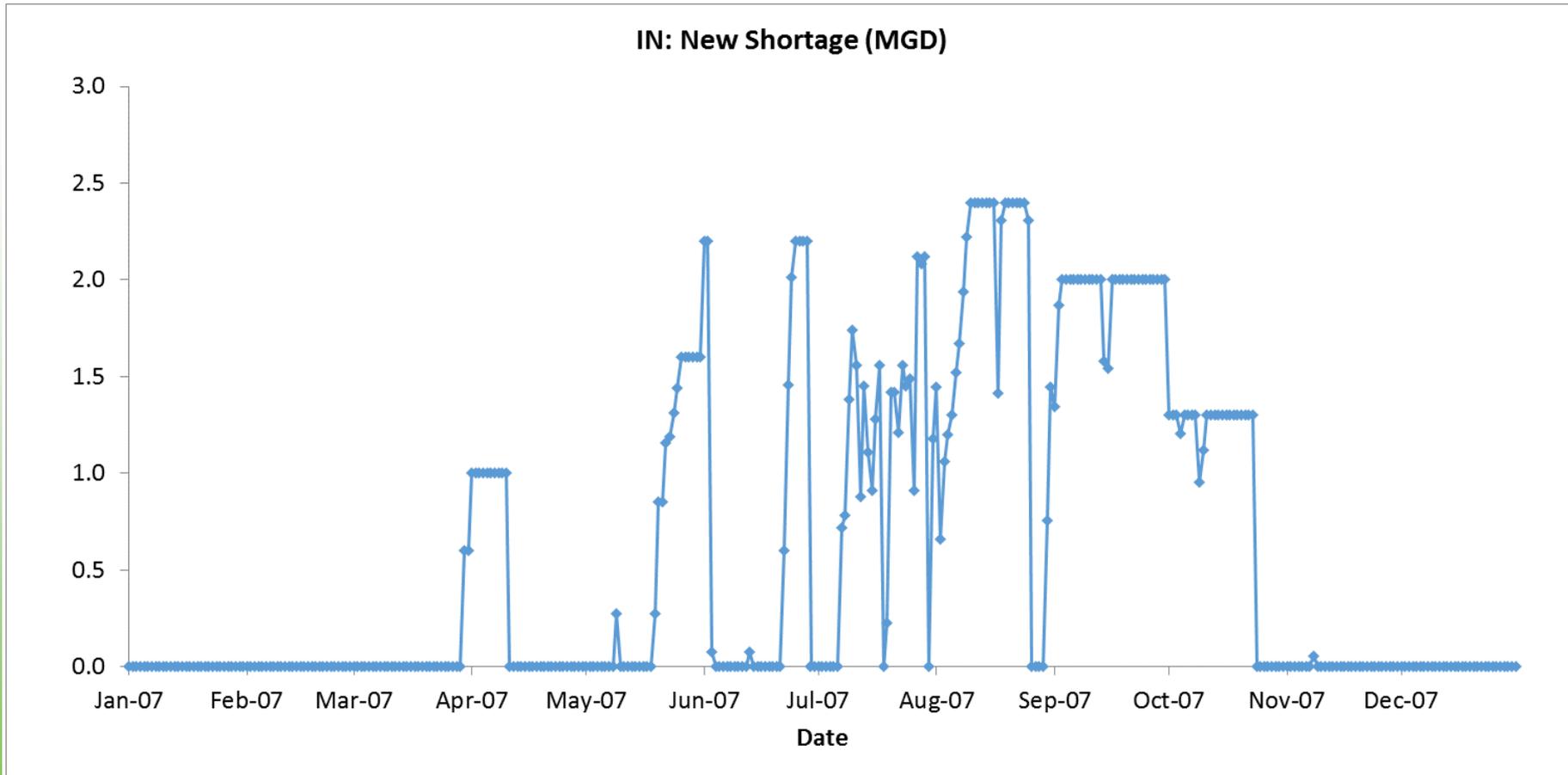
In the center, a modal dialog box titled "Simplified Water Allocation Model (SWAM)" is open, prompting the user to "Click on button:" with two large buttons: "Run" and "Cancel". Below the buttons, it says "Simulation Year =" and includes the CDM Smith logo.

The background shows a network diagram of water resources, including various Inflow Reservoirs (IR), Reservoirs (R), and Swamps (WS). A "Test Gage" is also indicated. The interface includes an "Object Palette" on the left and a bottom navigation bar with tabs for "Main", "Node Output", "Reservoir Output", "Flow Gage Output", and "Aquifer Output". Logos for DHEC and the University of Georgia are visible in the top right corner.

# Shortages with Min. Instream Flows Enforced



# Shortages with Min. Instream Flows Enforced: 2007



# Shortages also Available in Node Output Table

		<u>Priority Rank</u>	<u>Reach</u>	<u>Location</u>	<u>Permit Limit (MGM)</u>	<u>Ditch Capacity (CFS)</u>	<u>Storage Capacity (MG)</u>	<u>Storage Withdrawal Permit (MGM)</u>			
	<i>IN: New</i>	49	<i>Bull Swamp Creek</i>	15	1000	1000	0	325829			
<u>Date</u>	<u>Physically Avail. (MGD)</u>	<u>Legally Avail. (MGD)</u>	<u>Diverted (MGD)</u>	<u>Storage (MG)</u>	<u>GW Pumping (MGD)</u>	<u>Demand (MGD)</u>	<u>Shortage (MGD)</u>	<u>Return Flow (MGD)</u>	<u>Release (MGD)</u>	<u>Evap Losses (MGD)</u>	
<b>Min</b>	2	0	0	0	0	1	0	0	0	0	
<b>Max</b>	67	36	3	0	0	3	2	1	0	0	
<b>Avg</b>	17	11	1	0	0	1	0	1	0	0	
1/31/06	17	8	1	0	0	1	0	1	0	0	
2/28/06	15	5	1	0	0	1	0	1	0	0	
3/31/06	10	0	0	0	0	1	1	0	0	0	
4/30/06	8	0	0	0	0	1	1	0	0	0	
5/31/06	5	1	1	0	0	2	1	0	0	0	
6/30/06	17	13	2	0	0	2	0	1	0	0	
7/31/06	7	4	3	0	0	3	0	1	0	0	
8/31/06	11	9	2	0	0	2	0	1	0	0	
9/30/06	11	8	2	0	0	2	0	1	0	0	
10/31/06	9	6	1	0	0	1	0	1	0	0	
11/30/06	17	14	1	0	0	1	0	1	0	0	
12/31/06	16	10	1	0	0	1	0	1	0	0	
1/31/07	20	11	1	0	0	1	0	1	0	0	
2/28/07	18	8	1	0	0	1	0	1	0	0	
3/31/07	17	6	1	0	0	1	0	1	0	0	
4/30/07	10	0	0	0	0	1	1	0	0	0	
5/31/07	7	2	2	0	0	2	0	1	0	0	
6/30/07	11	7	2	0	0	2	0	1	0	0	
7/31/07	6	4	3	0	0	3	0	1	0	0	
8/31/07	5	3	2	0	0	2	0	1	0	0	
9/30/07	2	0	0	0	0	2	2	0	0	0	
10/31/07	5	2	1	0	0	1	0	1	0	0	
11/30/07	6	3	1	0	0	1	0	1	0	0	
12/31/07	17	11	1	0	0	1	0	1	0	0	



## Other Example Uses

- 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
- Consolidate hydrologic data



Questions?

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