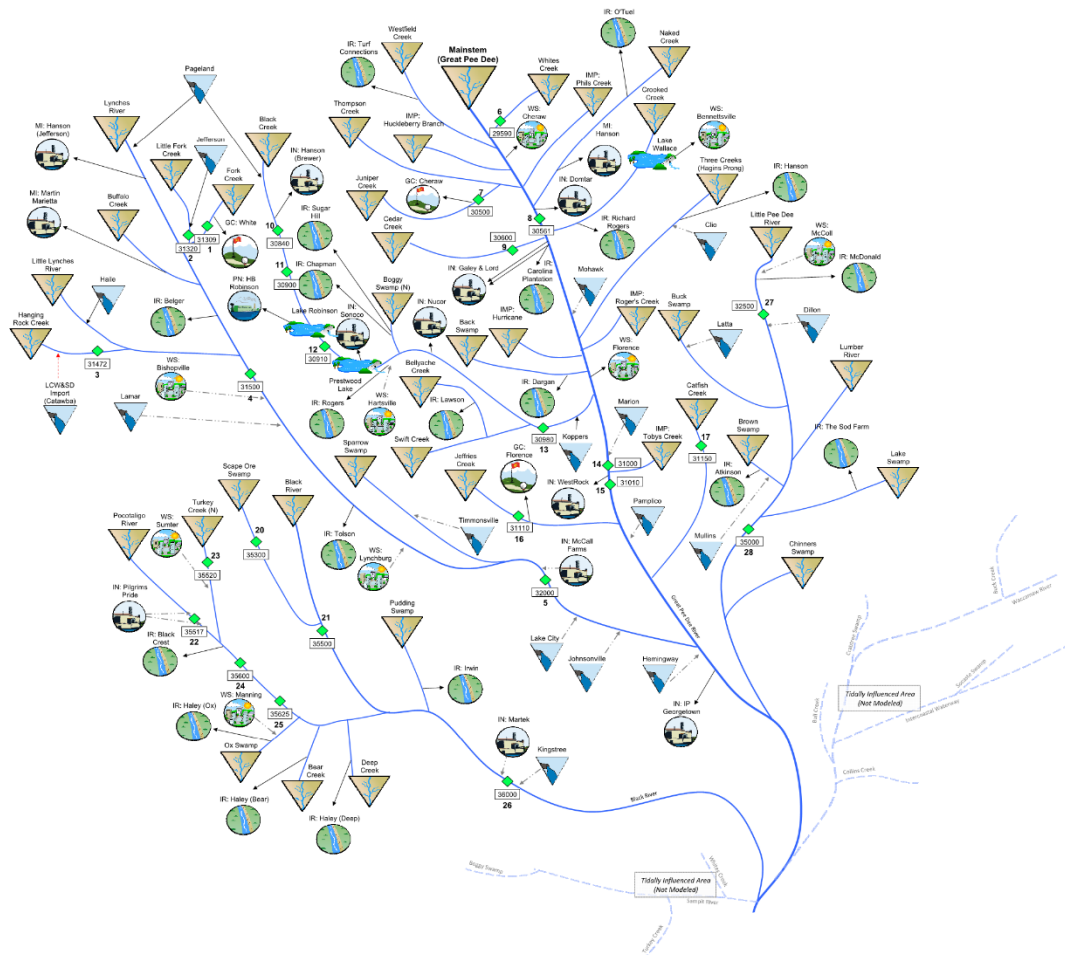


# South Carolina Surface Water Quantity Modeling Project

Pee Dee Basin Meeting No. 2 – Introduction to the Draft Model

Kirk Westphal, PE  
John Boyer, PE, BCEE  
Tim Cox, Ph.D., PE  
May 2, 2016



# Presentation Outline

- Project Background and Status
- Model Calibration/Verification
  - Calibration/Verification Philosophy and Approach
  - Calibration Results and Discussion
- Overview and Demonstration of Pee Dee Basin Model

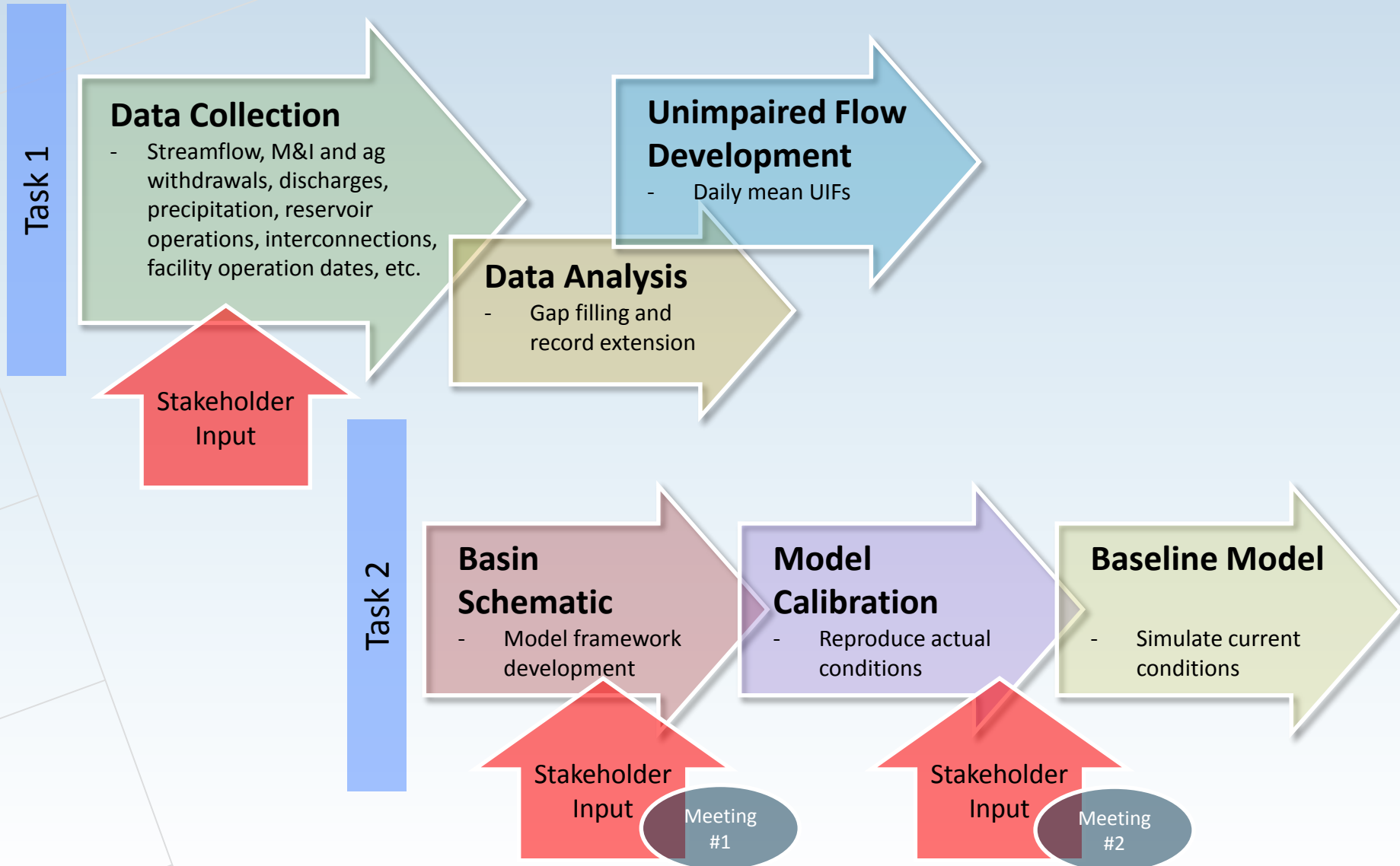
# Project Purpose

- 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 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)

# Project Status – Pee Dee Basin

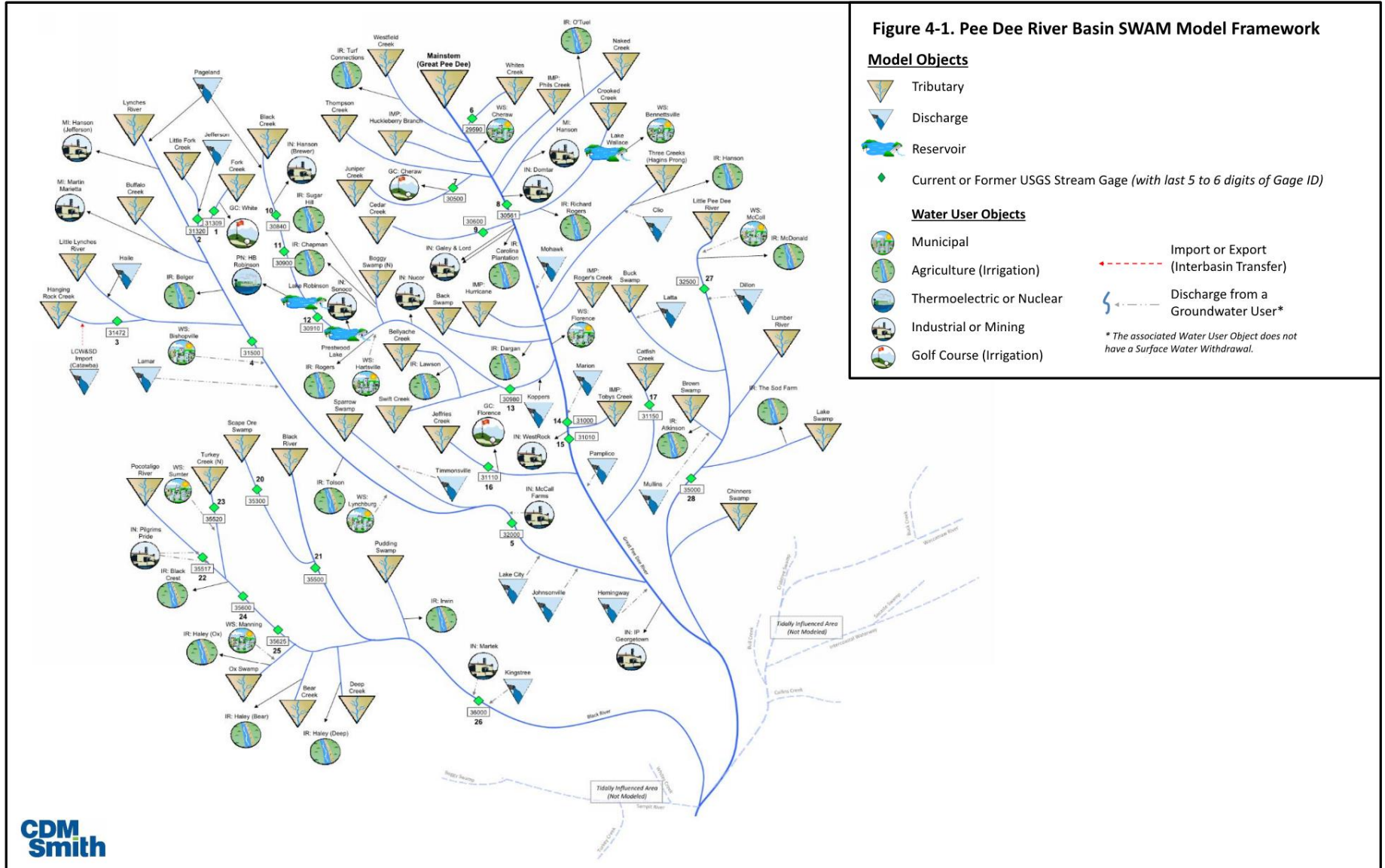




# Calibration vs. Baseline Model

- **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

# Pee Dee 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 topics: Boating, Education, Fishing, Hunting, Land, Maps, Regulations, Water, and Wildlife. The main content area is titled "Surface Water Modeling and Assessments" and contains the following text:

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, [@](#)) 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](#)

Social media icons for Facebook, RSS Feed, Twitter, and YouTube are located at the bottom of the page.

The cover of the report is titled "SOUTH CAROLINA SURFACE WATER QUANTITY MODELS PEE DEE RIVER BASIN MODEL". It features a large, colorful map of the Pee Dee River Basin, showing the river network and various sub-basins. The map is overlaid with a grid and various symbols representing different data points or model components. The report is submitted to the South Carolina Department of Natural Resources and the South Carolina Department of Health & Environmental Control. It is dated April 2016 and prepared by CDM Smith. The word "DRAFT" is prominently displayed in large, bold letters at the bottom left of the cover.

Pee Dee 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**

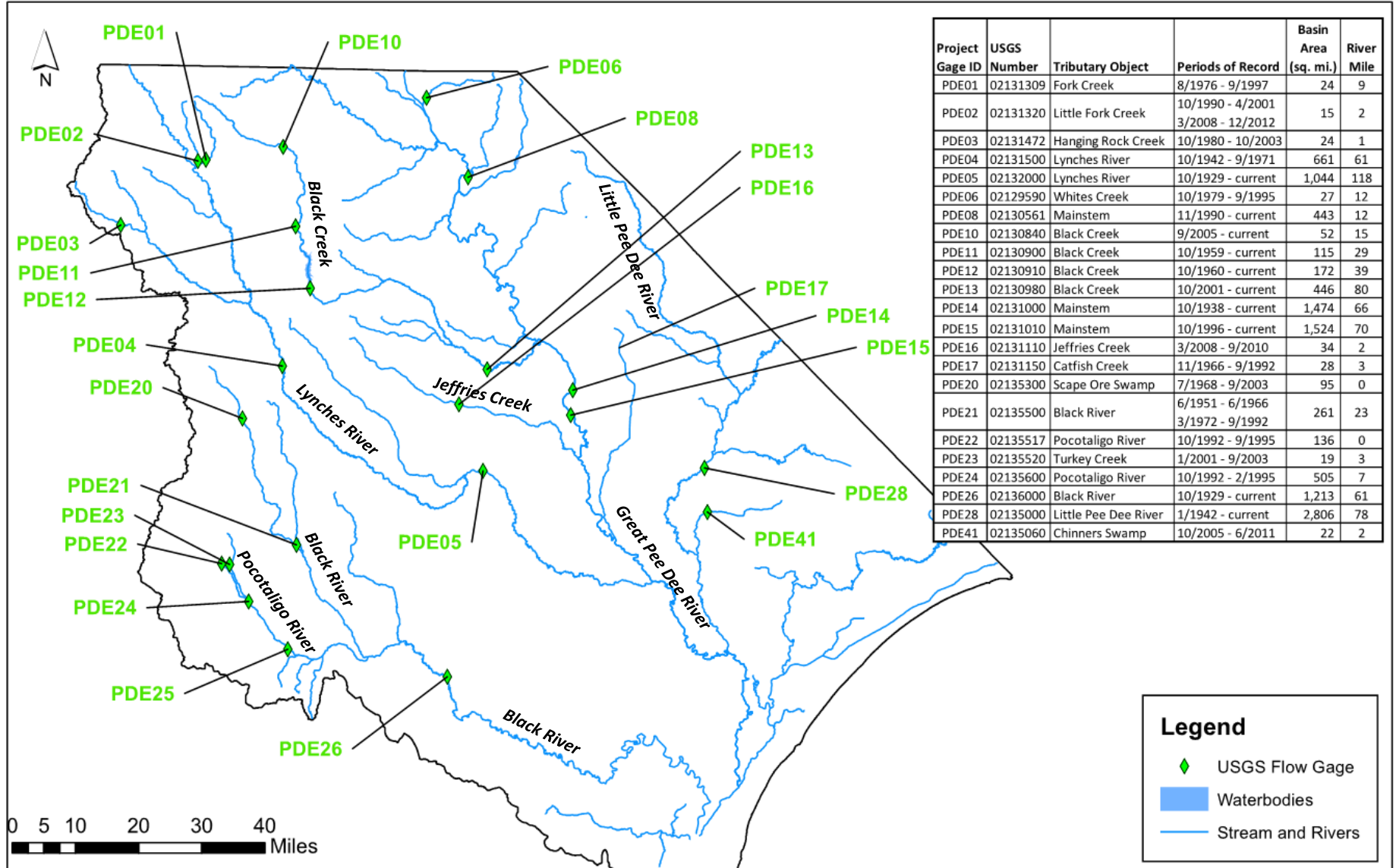
# Potential Sources of Model Error and Uncertainty

- 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 (where levels/storage are available)
- 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

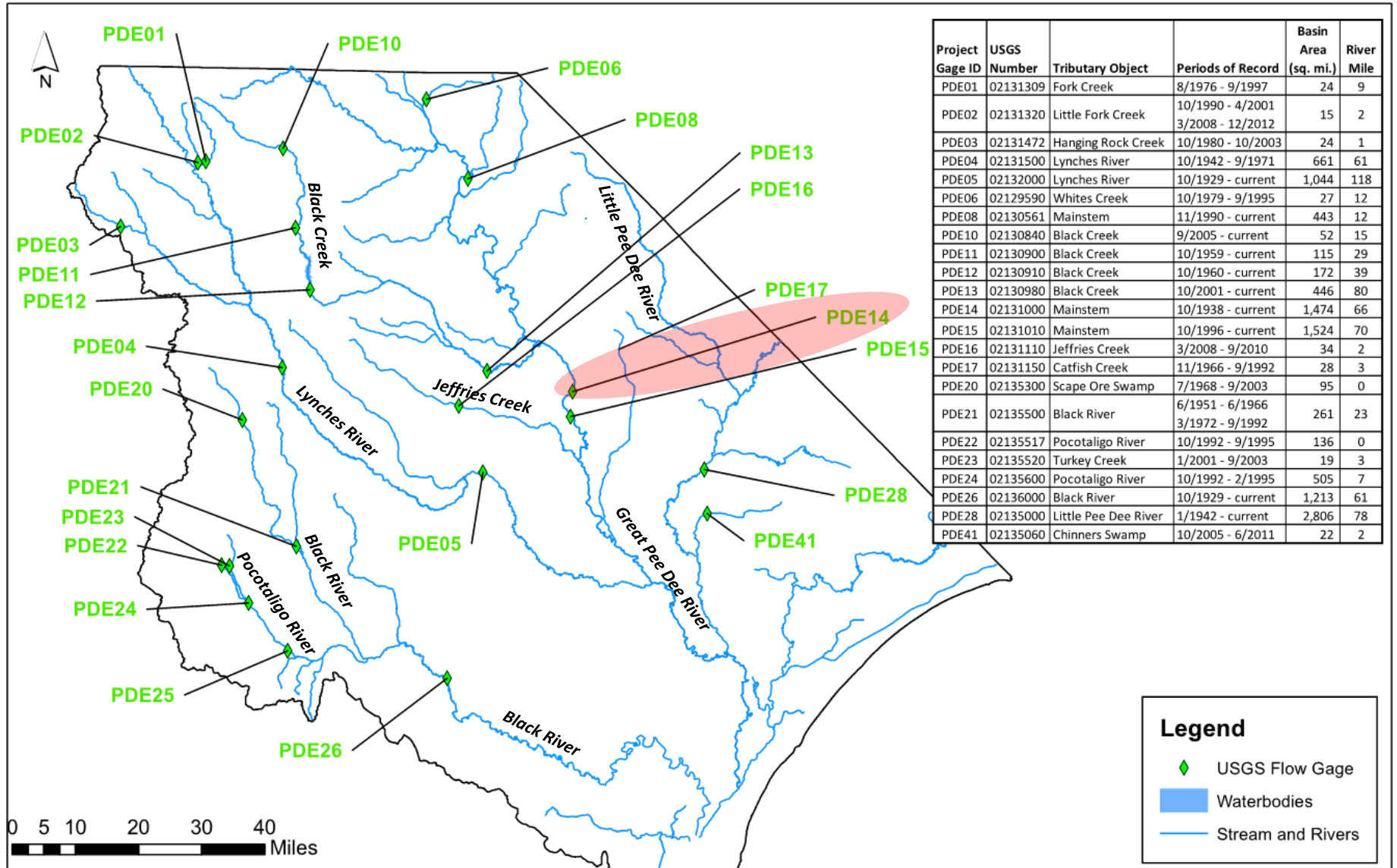


**Legend**

-  USGS Flow Gage
-  Waterbodies
-  Stream and Rivers

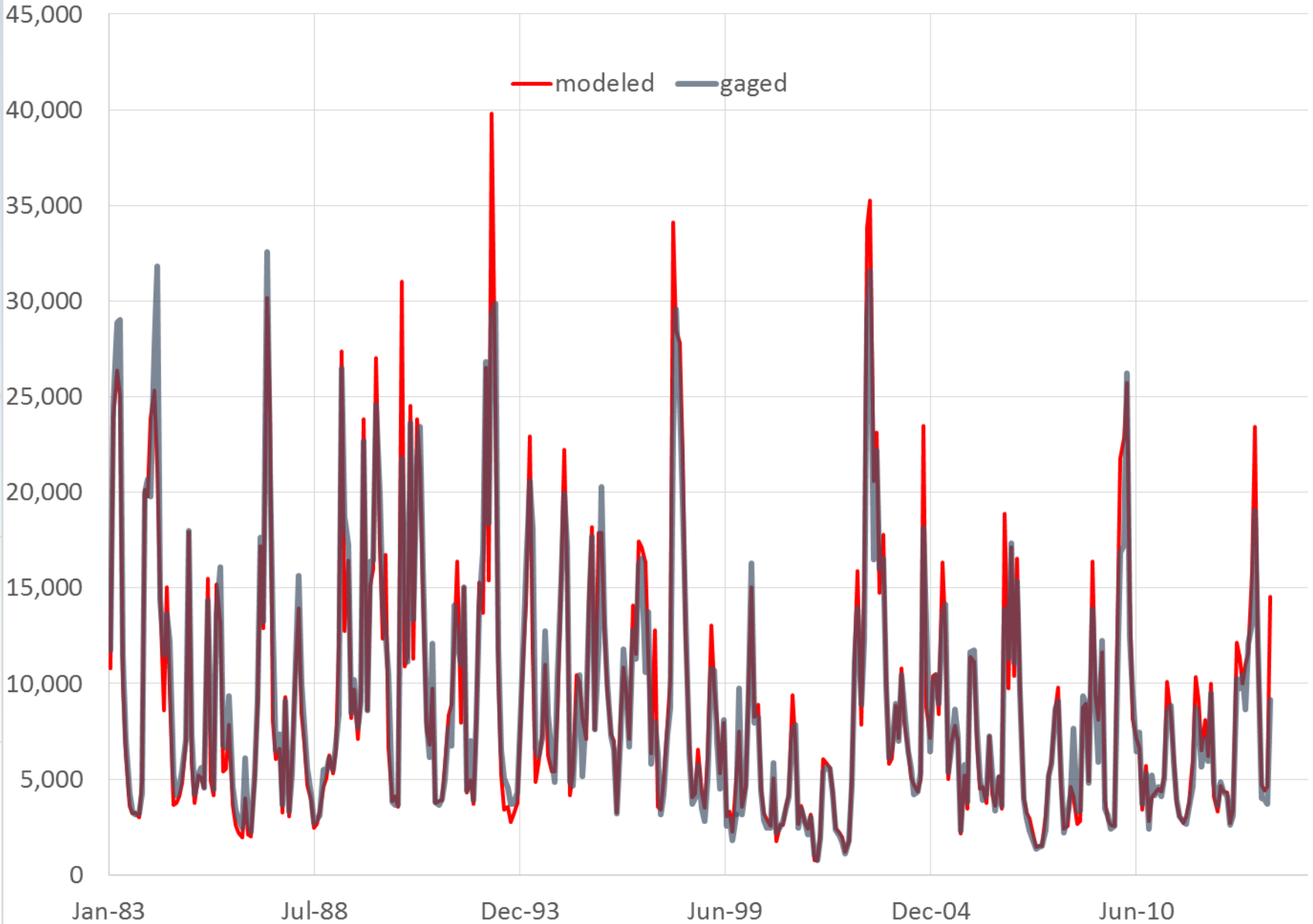
# Pee Dee River at Pee Dee

USGS Gage 02131000



# Monthly Flow Comparison

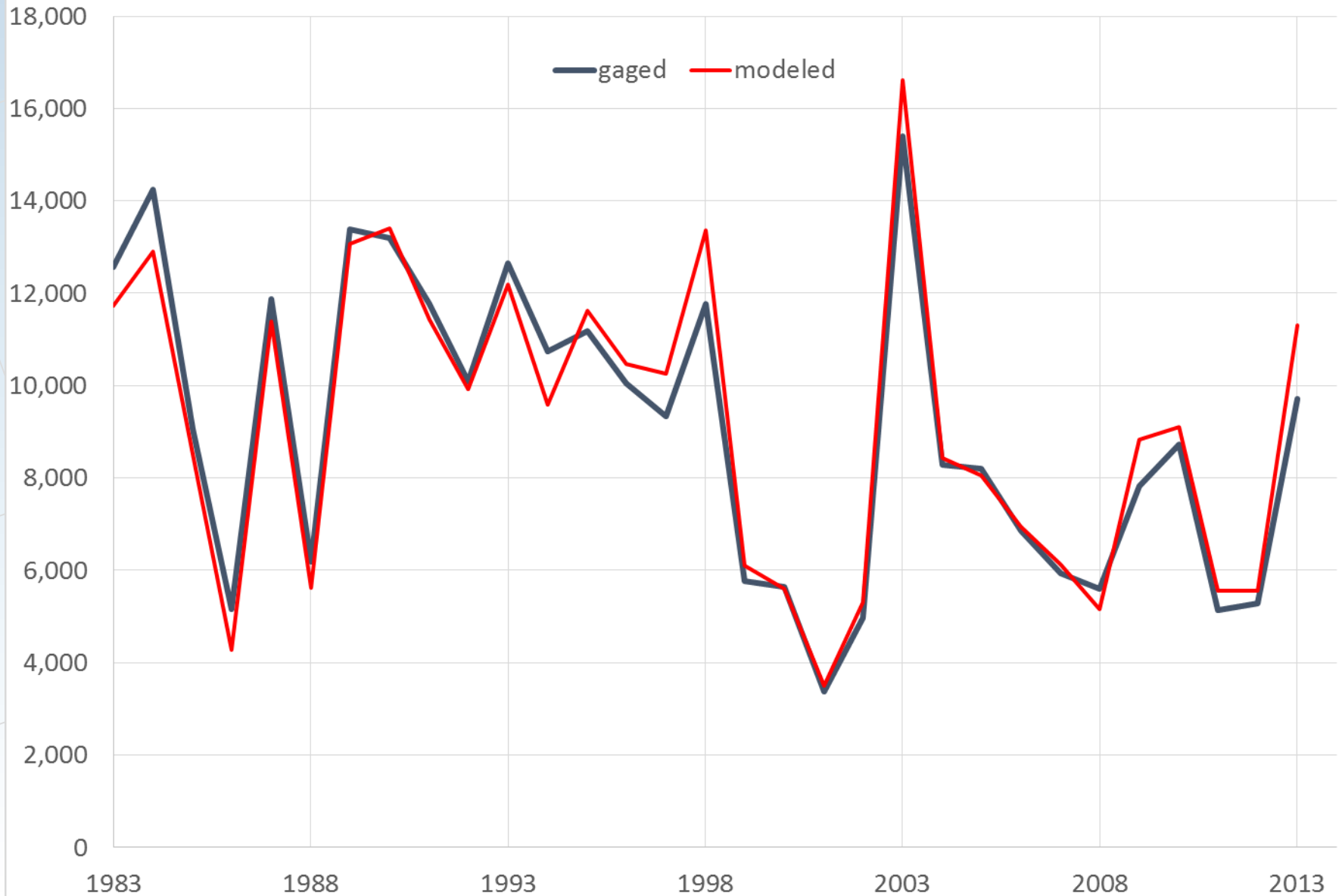
PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC (CFS)





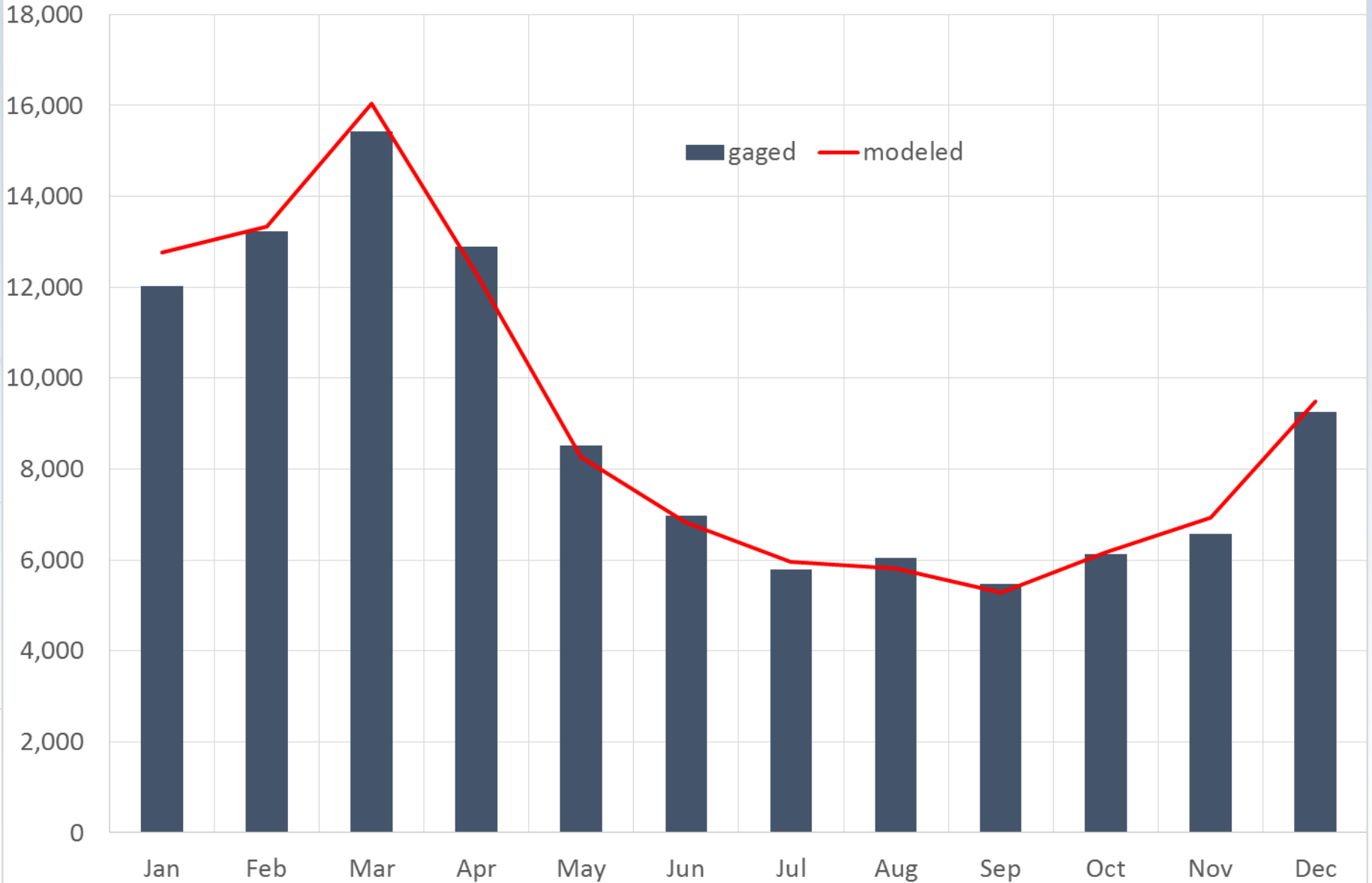
# Annual Average Flow Comparison

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC (CFS)  
Annual Average Flow



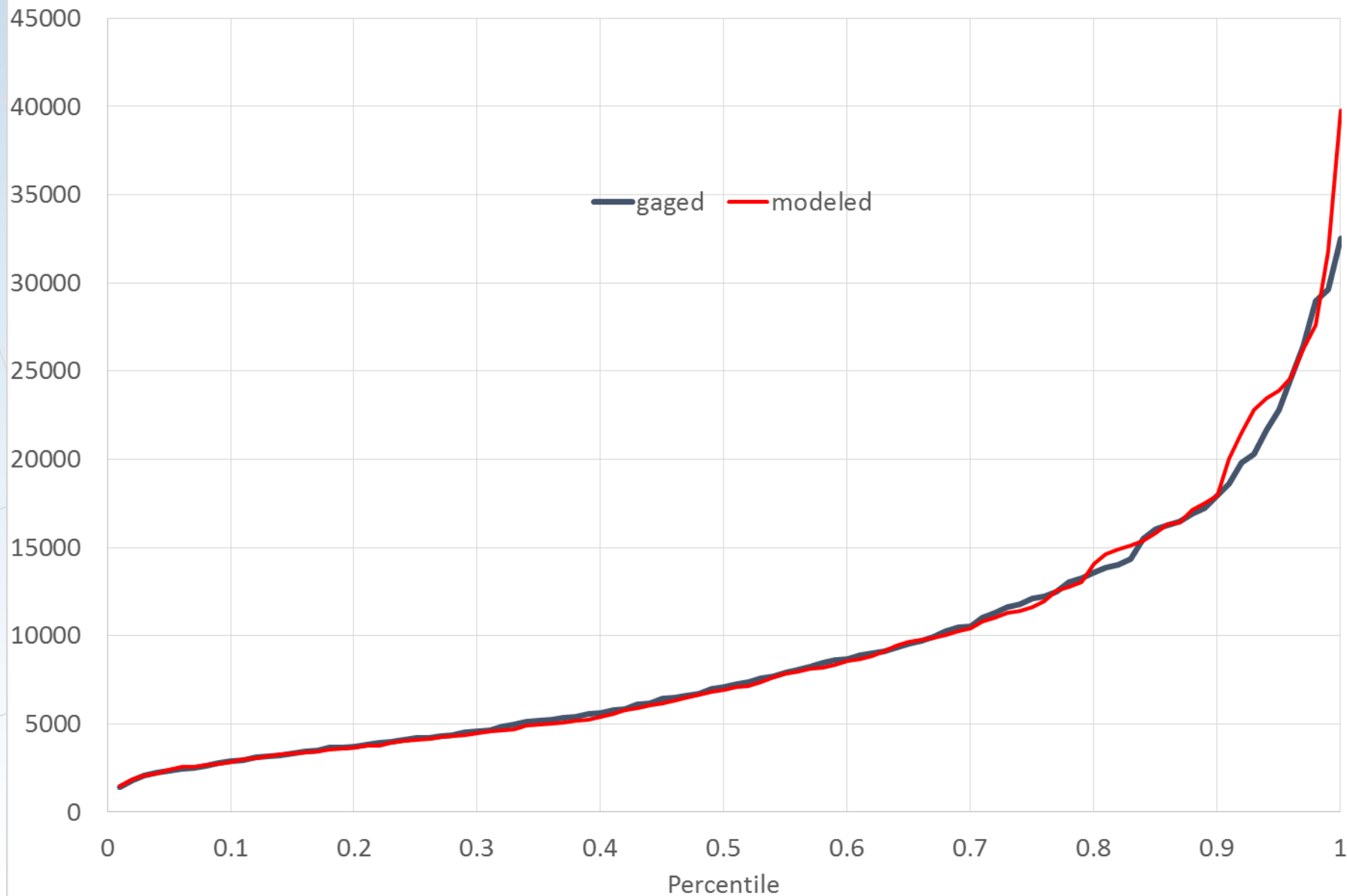
# Monthly Mean Flow Comparison

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC  
Monthly Mean Flow (CFS)



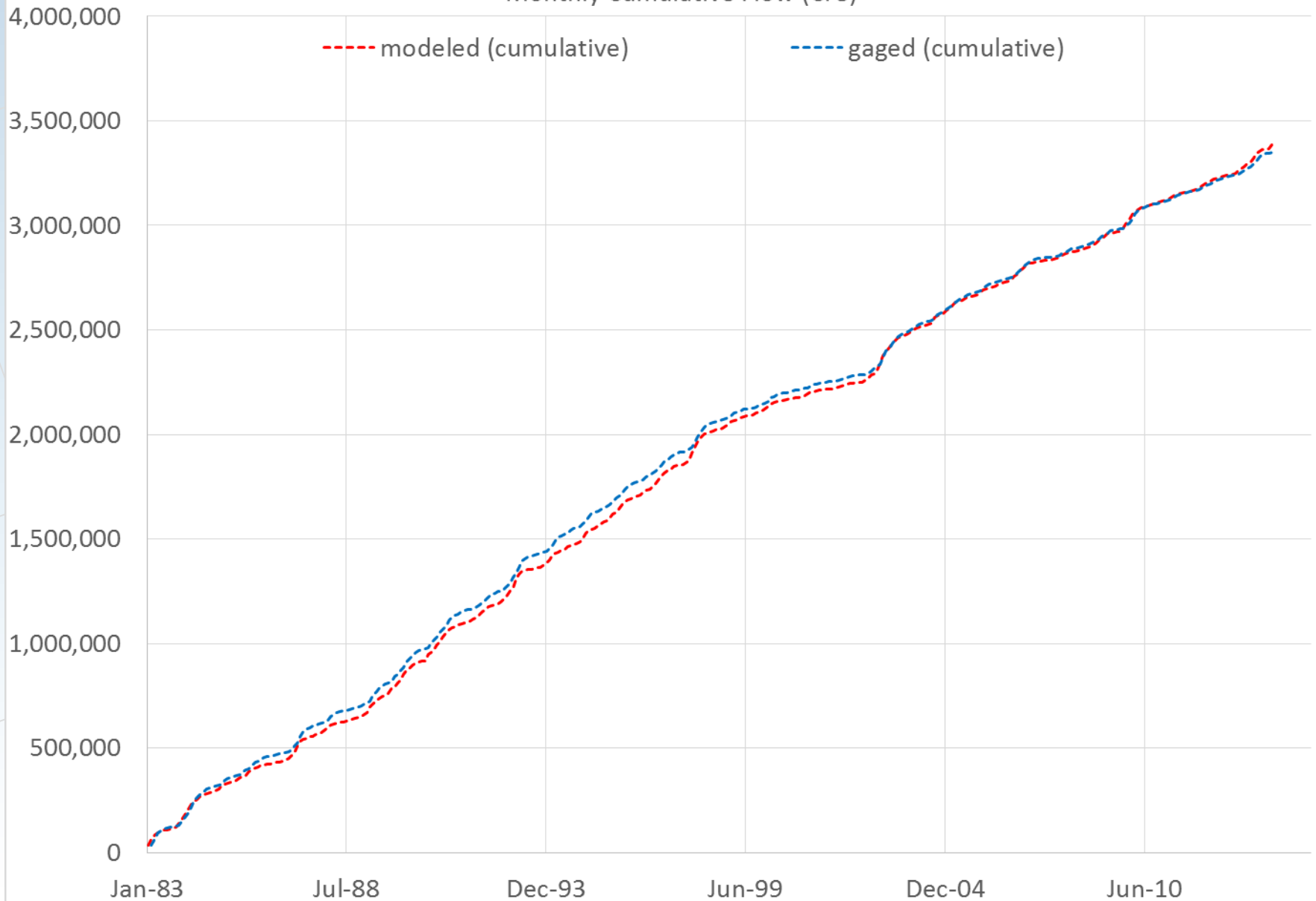
# Monthly Flow Percentiles Comparison

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC  
Monthly Flow Percentiles (CFS)



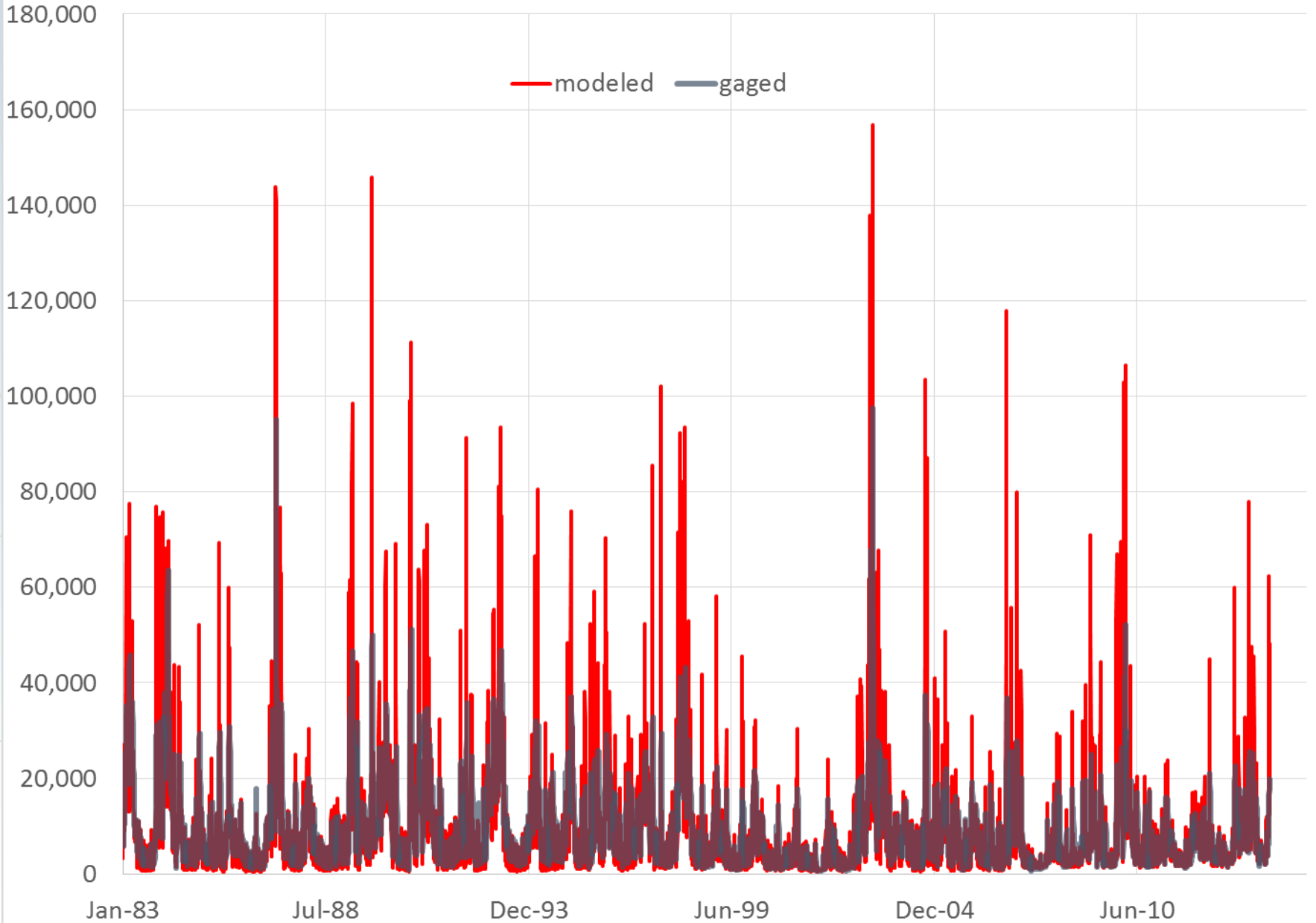
# Cumulative Flow Comparison

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC (CFS)  
Monthly Cumulative Flow (CFS)



# Daily Flow Comparison

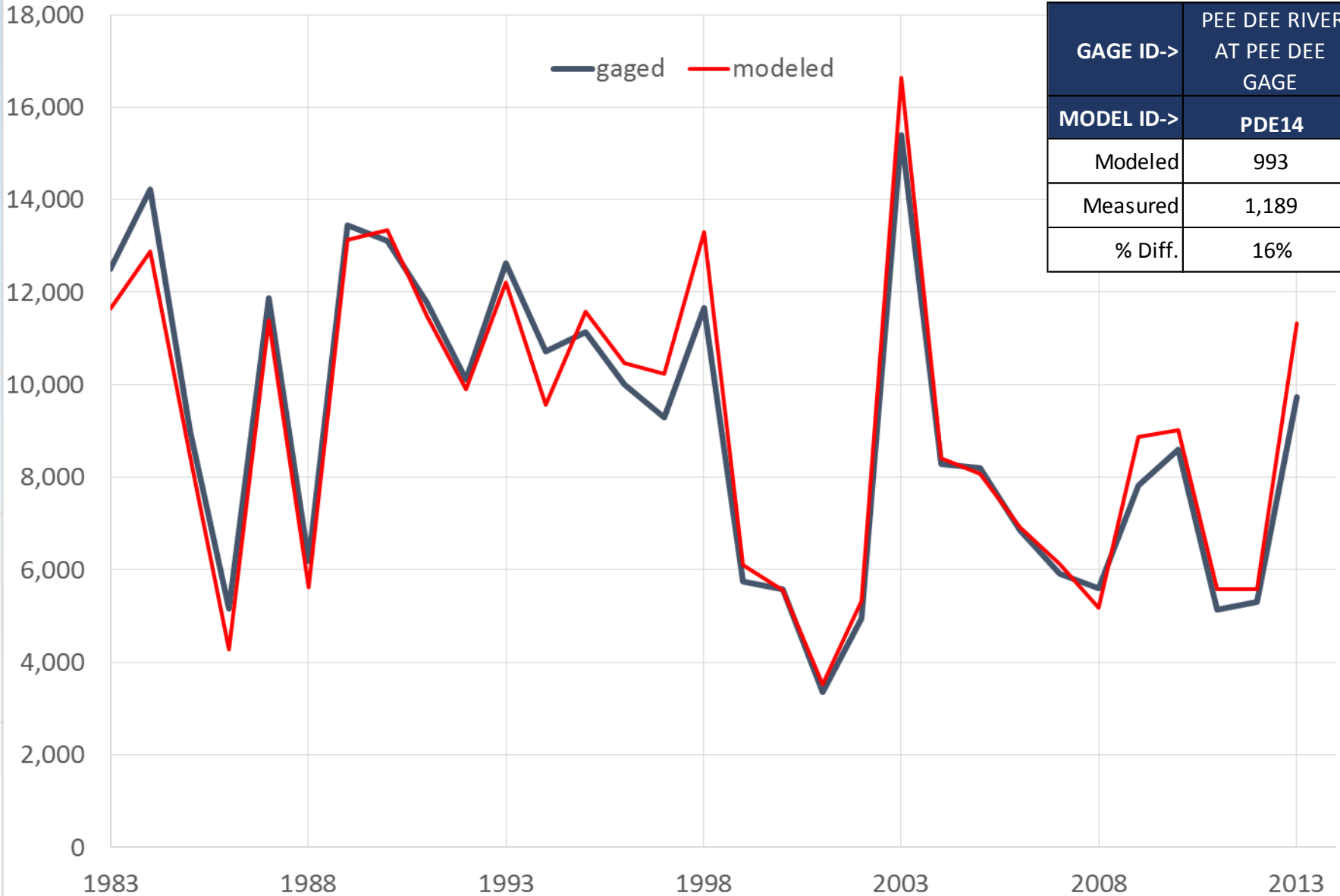
PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC (CFS)



# Annual 7 Day Low Flows

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC (CFS)  
Annual Average Flow

## 7Q10 Comparison



# SWAM Calibration/Validation Summary

- For most sites, modeled mean flow values, averaged over the full period of record, are within within 1% of measured mean flows

ID	Station	Modeled (cfs)	Measured (cfs)	% Difference	Years to compare
PDE41	CHINNERS SWAMP NEAR AYNOR	18	21	-15.0%	6
PDE10	BLACK CREEK BELOW CHESTERFIELD	40	43	-7.9%	9
PDE24.25	POCOTALIGO IVER NR SUMTER & MANNING	495	522	-5.4%	4
PDE21	BLACK RIVER NEAR GABLE	375	386	-3.2%	10
PDE05	LYNCHES RIVER AT EFFINGHAM	908	933	-2.8%	31
PDE28	LITTLE PEE DEE AT GALIVANTS FERRY	2,553	2,565	-0.5%	31
PDE04	LYNCHES RIVER NEAR BISHOPVILLE	481	482	-0.2%	12
PDE23	TURKEY CREEK (HWY 521) AT SUMTER	10	10	0.1%	3
PDE06	WHITES CREEK NEAR WALLACE	30	30	0.2%	13
PDE02	LITTLE FORK CREEK AT JEFFERSON	15	15	0.4%	16
PDE17	CATFISH CANAL AT SELLERS	21	21	0.4%	31
PDE13	BLACK CREEK NEAR QUINBY	353	351	0.5%	13
PDE26	BLACK RIVER AT KINGSTREE	909	903	0.6%	31
PDE11	BLACK CREEK NEAR MCBEE	127	126	0.7%	31
PDE20	SCAPE ORE SWAMP NEAR BISHOPVILLE	93	92	0.7%	21
PDE14	PEE DEE RIVER AT PEEDEE	9,097	9,031	0.7%	31
PDE03	HANGING ROCK CREEK NR KERSHAW	25	25	0.9%	21
PDE12	BLACK CREEK NEAR HARTSVILLE	182	180	1.0%	31
PDE16	JEFFRIES CREEK ABOVE FLORENCE	34	33	1.8%	4
PDE08	PEE DEE RIVER NR BENNETTSVILLE	7,416	7,251	2.2%	24
PDE15	PEE DEE RIVER BELOW PEE DEE	7,990	7,804	2.3%	18
PDE22	POCOTALIGO RIVER AT SUMTER	193	183	5.5%	4
PDE01	FORK CREEK AT JEFFERSON	29	26	9.4%	15

} >5% difference  
 } 5% or less diff.  
 } 1% or less difference  
 } 5% or less diff.  
 } >5% difference

# SWAM Calibration/Validation Summary

- 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:
  - 8% and 16% on the Great Pee Dee River;
  - 2% to 11% on Black Creek
  - 15% to 33% on the Lynches River
- The model adequately hindcasts delivered water supply for each water user in the model (no significant shortfalls).



Pee Dee River Basin

# BASELINE MODEL AND USES

# Baseline Model

- Will represent current demands and operations combined with an extended period of estimated hydrology
  - Most demands reflect 2004-2013 averages
  - Estimated hydrology from 1929 to 2013
  - Inactive users are not included
  - Users on tidally-influenced areas are not included
- The baseline model serves as the starting point for future predictive simulations

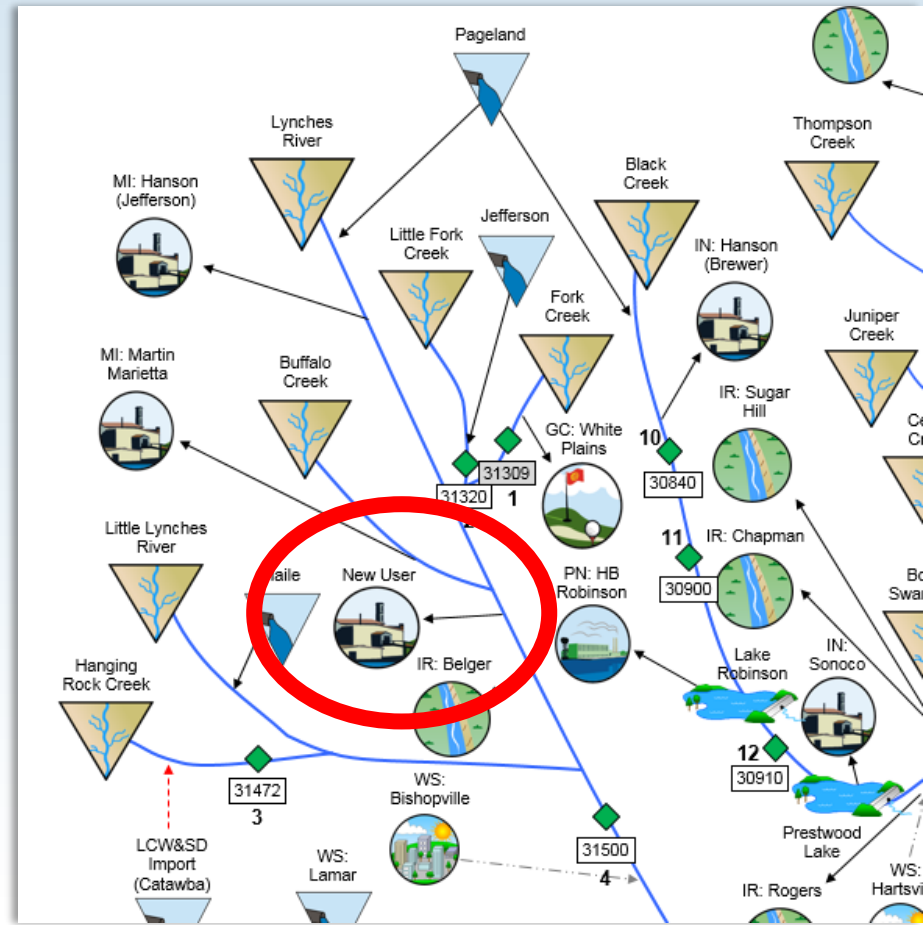
## The Models Can Be Used To...

- 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 on the Lynchses River
  - Demand = 20 mgd
  - Consumptive Use = 50% (return to Lynchses River)
- *Is there enough water to support the new user?*
- *Does the new withdrawal cause shortages for downstream users?*



# Add an Industrial Water User Object from the Palette

### Simplified Water Allocation Model (SWAM)

Simulation Period

Start Date (MM/DD/YYYY): 01/01/1983

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

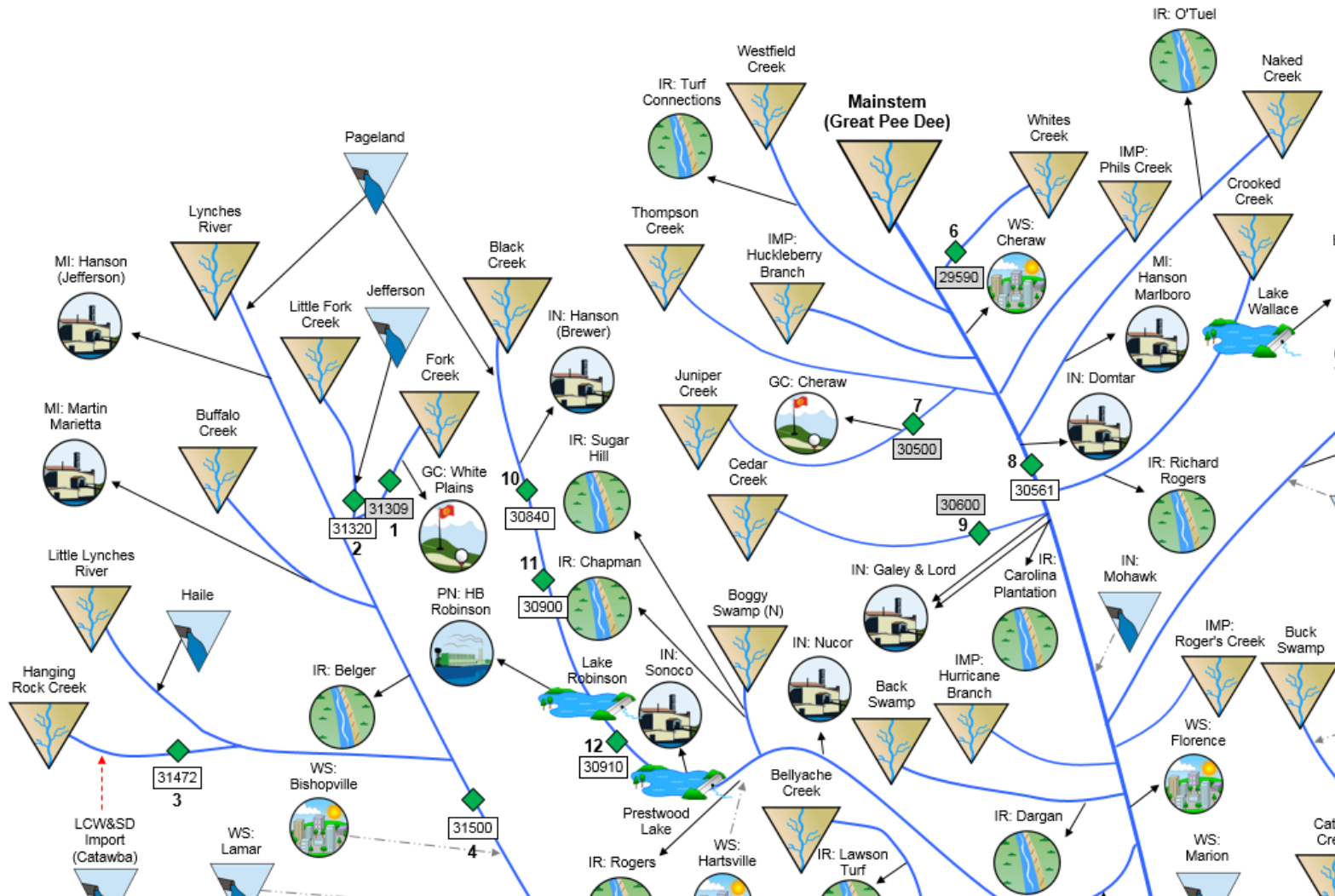
Node Priorities Node Locations Reservoir Accounts Output Specs

Input & Output

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

### Object Palette

The Object Palette contains icons for various water system components: a reservoir, a dam, a creek, an industrial facility (highlighted with a red circle), a power plant, a wind turbine, a solar panel, a water treatment plant, a pump, a storage tank, and a diamond-shaped node.



# Add an Industrial Water User Object from the Palette

Object Palette



## Simplified Water Allocation Model (SWAM)

Simulation Period

Start Date  
(MM/DD/YYYY)

01/01/1983

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)

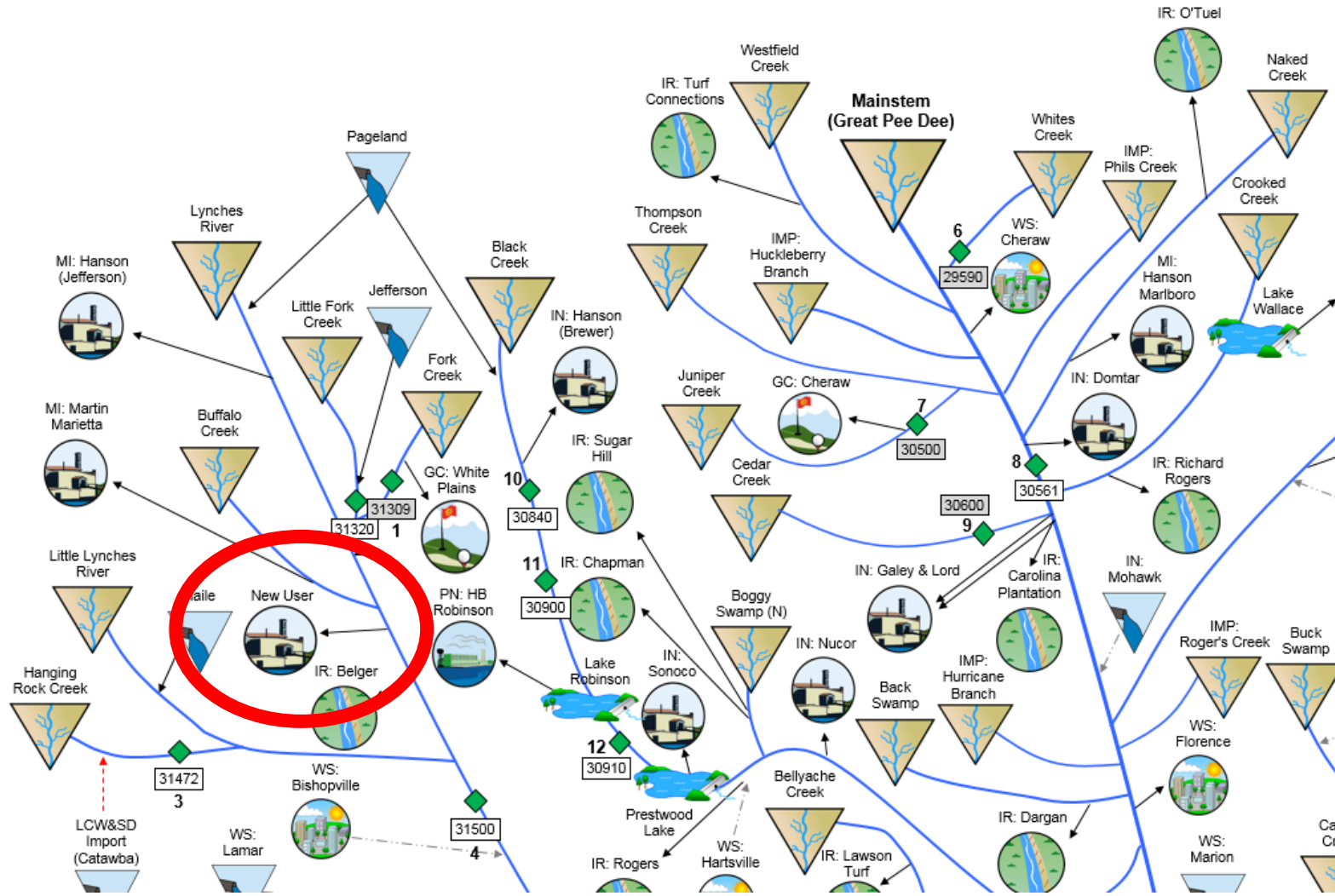
## Input Summaries and Outputting

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



Input & Output

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



# Add the New User in the Water User Dialogue

**Simplified Water Allocation Model (SWAM)**

Simulation Period

Start Date (MM/DD/YYYY): 01/01/1983

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

Water User

Main | Water Usage | Source Water | Return Flows

**Water User Name:** IN: New User **Delete Node**  Multiple Sources of Water?

Supplemental Supply/Demand Alternatives

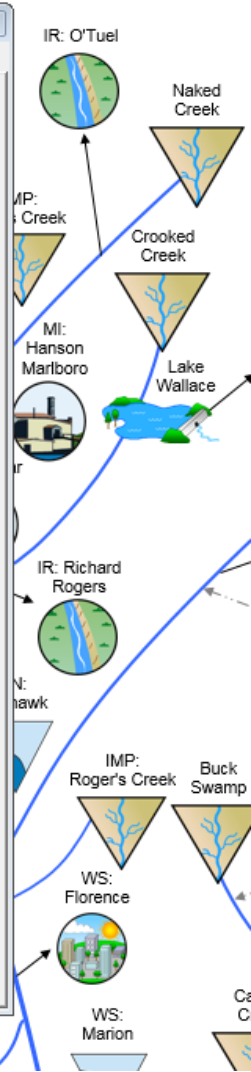
Conservation  Transbasin Import

Recapture Reuse  Water Exchange

Ag Transfer

Comments:

Save Close



Object Palette



# Specify Water Use

## Simplified Water Allocation Model (SWAM)

Simulation Period: Start Date (MM/DD/YYYY) 01/01/1980, End Date (MM/DD/YYYY) 12/31/2015

Simulation Type:  Monthly Planning,  Daily Planning,  Prior Appropriations,  Riparian Water Rights

Run (ctrl R)

## Input Summaries and Outputting

Node Priorities, Node Locations, Reservoir Accounts, Output Specs

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

Water User

Main | Water Usage | Source Water | Return Flows

Monthly User Distribution:  Manual,  M&I,  Agriculture

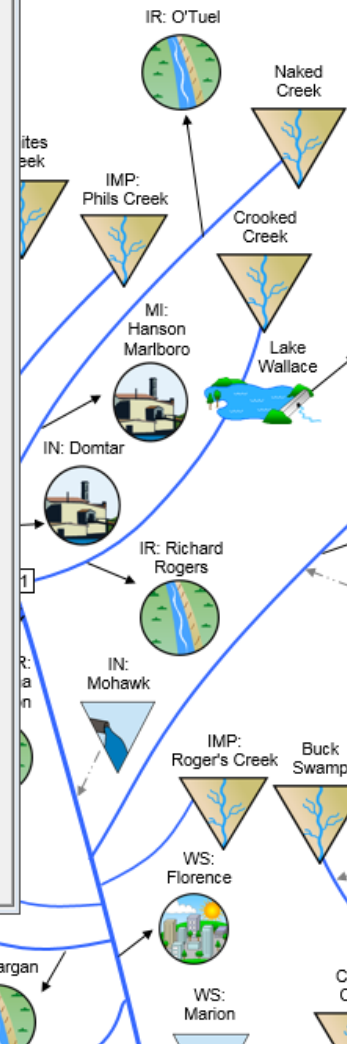
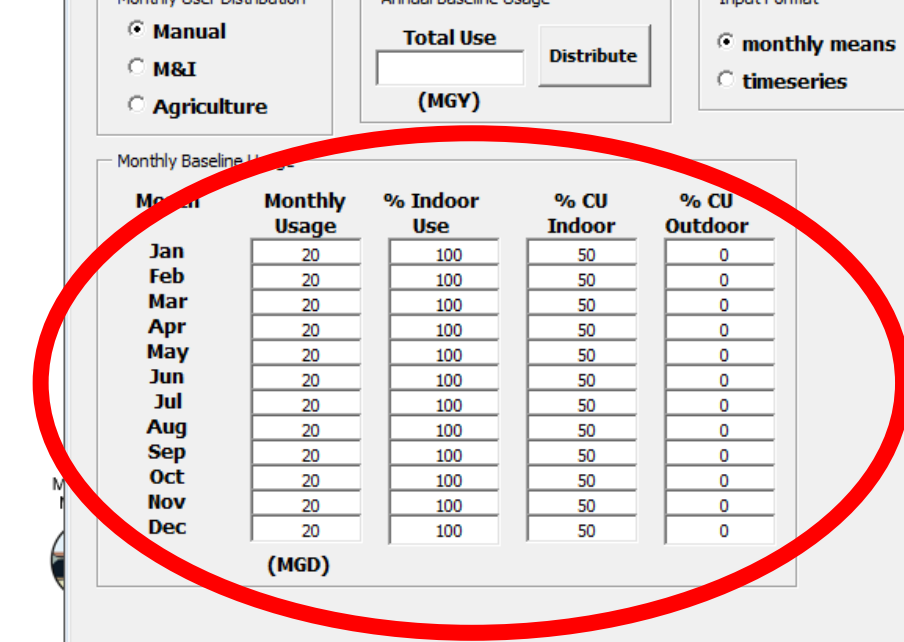
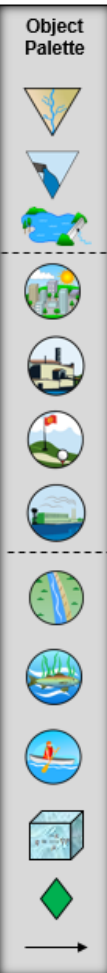
Annual Baseline Usage: Total Use (MGY) [ ] Distribute

Input Format:  monthly means,  timeseries

Month	Monthly Usage	% Indoor Use	% CU Indoor	% CU Outdoor
Jan	20	100	50	0
Feb	20	100	50	0
Mar	20	100	50	0
Apr	20	100	50	0
May	20	100	50	0
Jun	20	100	50	0
Jul	20	100	50	0
Aug	20	100	50	0
Sep	20	100	50	0
Oct	20	100	50	0
Nov	20	100	50	0
Dec	20	100	50	0

(MGD)

Save Close





# Specify Source and Withdrawal Location

### Simplified Water Allocation Model (SWAM)

Simulation Period: Start Date (MM/DD/YYYY) 01/01/1993, End Date (MM/DD/YYYY) 12/31/2013

Simulation Type:  Monthly Planning,  Daily Planning,  Prior Appropriations,  Riparian Water Rights

Run (ctrl R)

### Input Summaries and Outputting

Node Priorities, Node Locations, Reservoir Accounts, Output Specs

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

### Water User

Main | Water Usage | Source Water | Return Flows

**Source Stream:** Lynchas River

Source Water Type:  Direct River,  Reservoir,  Groundwater

**Diversion Location (mi):** 25

Priority Date: 2/19/1900

Diversion Capacity: 100000 (CFS)

Permit Limit: 100000 (MGM)

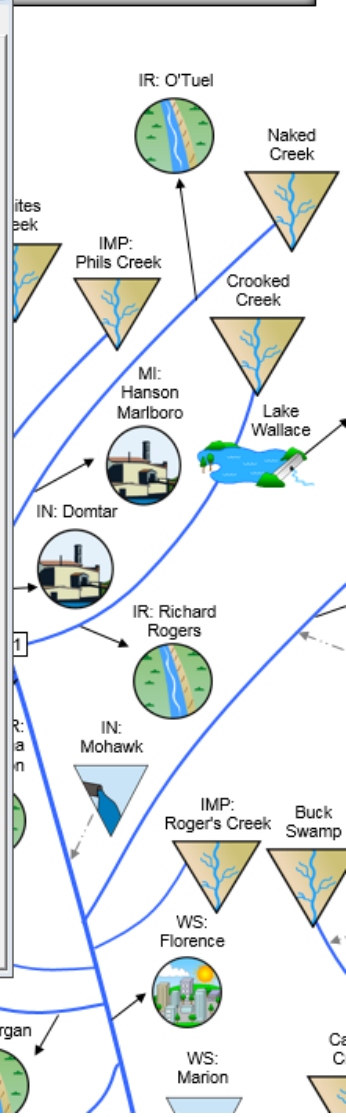
Seasonal Permit

Minimum Flow Requirements

Save

Close

Identifying Notes:



### Object Palette

- Water User (triangle)
- Water Usage (square)
- Source Water (circle)
- Return Flows (diamond)
- Reservoir (circle)
- Priority (circle)
- Location (circle)
- Account (circle)
- Spec (circle)
- Other icons for various water management elements.

# Specify Source the Return Location

The image displays the **Simplified Water Allocation Model (SWAM)** software interface. The main window is titled "Simplified Water Allocation Model (SWAM)" and contains several panels:

- Simulation Period:** Start Date (MM/DD/YYYY) and End Date (MM/DD/YYYY).
- Simulation Type:** Monthly Planning (selected), Daily Planning, Prior Appropriations, and Riparian Water Rights.
- Run (ctrl R):** A button to execute the simulation.
- Input Summaries and Outputting:** Buttons for Node Priorities, Node Locations, Reservoir Accounts, and Output Specs.
- Input & Output:** A section for specifying input and output parameters.

A **Water User** dialog box is open, showing the "Return Flows" tab. The "Return Flow Locations" section has two radio buttons: "single point" (selected) and "multiple points". The "Receiving Stream:" dropdown menu is highlighted with a red circle and contains the text "Lynches River". The "RF Location (mi)" field contains the value "26". The "RF Lag (months)" field is empty. There are "Save" and "Close" buttons on the right side of the dialog box.

The background shows a map of a water network with various nodes and connections. Nodes include:

- IR: O'Tuel
- Naked Creek
- IMP: Phils Creek
- Crooked Creek
- MI: Hanson Marlboro
- Lake Wallace
- IN: Domtar
- IR: Richard Rogers
- IN: Mohawk
- IMP: Roger's Creek
- Buck Swamp
- WS: Florence
- WS: Lamar
- IR: Rogers
- WS: Hartsville
- IR: Lawson Turf
- IR: Dargan
- WS: Marion
- LCW&SD Import (Catawba)
- 31472
- 3
- Bishopville
- 31500
- 4
- Prestwood Lake
- IR: Rogers
- WS: Hartsville
- IR: Lawson Turf
- IR: Dargan
- WS: Marion

# Run the Model Scenario

### Simplified Water Allocation Model (SWAM)

Simulation Period

Start Date (MM/DD/YYYY): 01/01/1983 | End Date (MM/DD/YYYY): 12/31/2013

Simulation Type

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

**Run (ctrl R)**

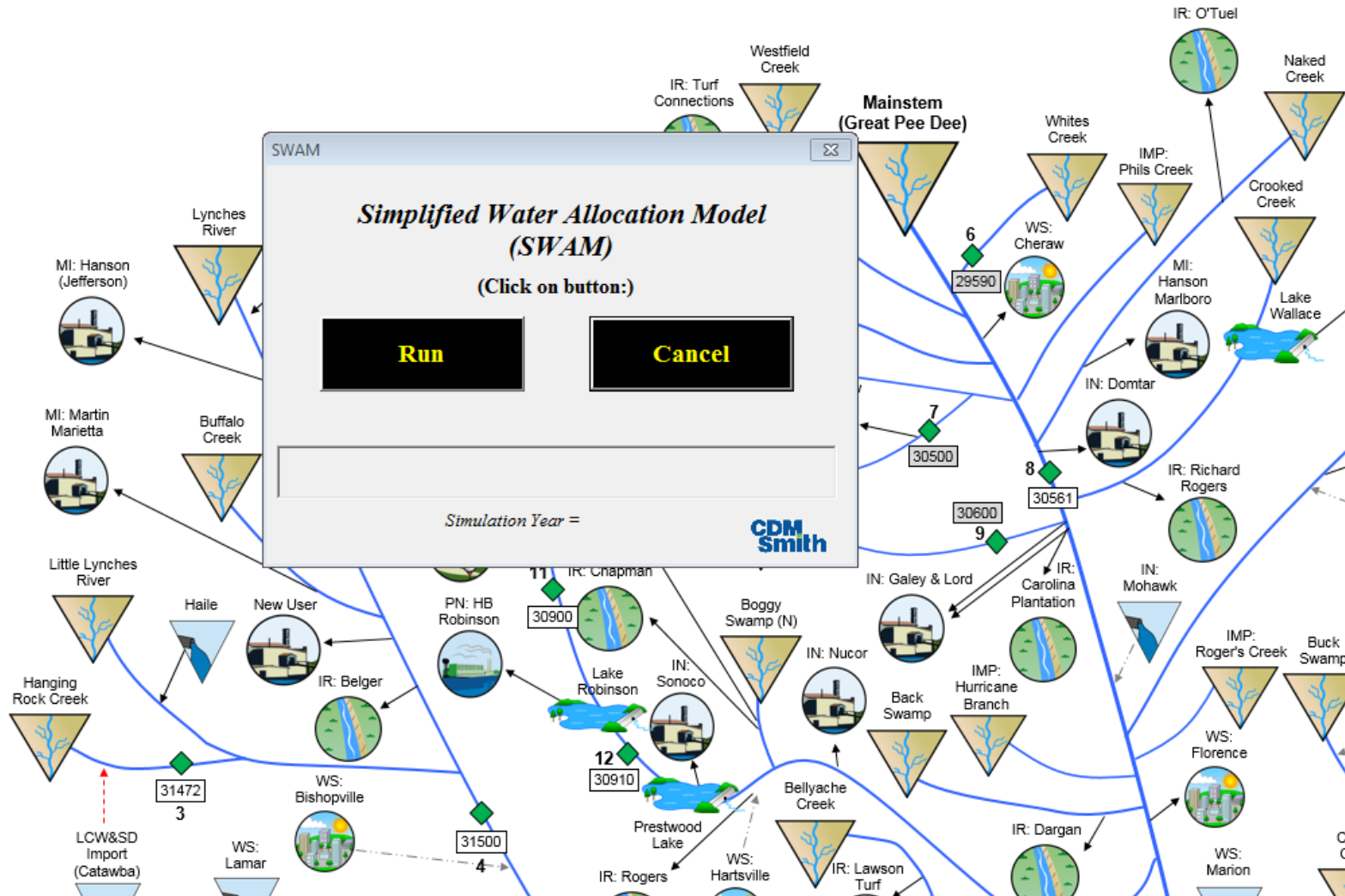
### Input Summaries and Outputting

Node Priorities | Node Locations | Reservoir Accounts | Output Specs

Input & Output

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

### Object Palette



# Build a Shortage Plot for the New User

**Simplified Water Allocation Model (SWAM)**

Simulation Period

Start Date (MM/DD/YYYY): 01/01/1983

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 Output**

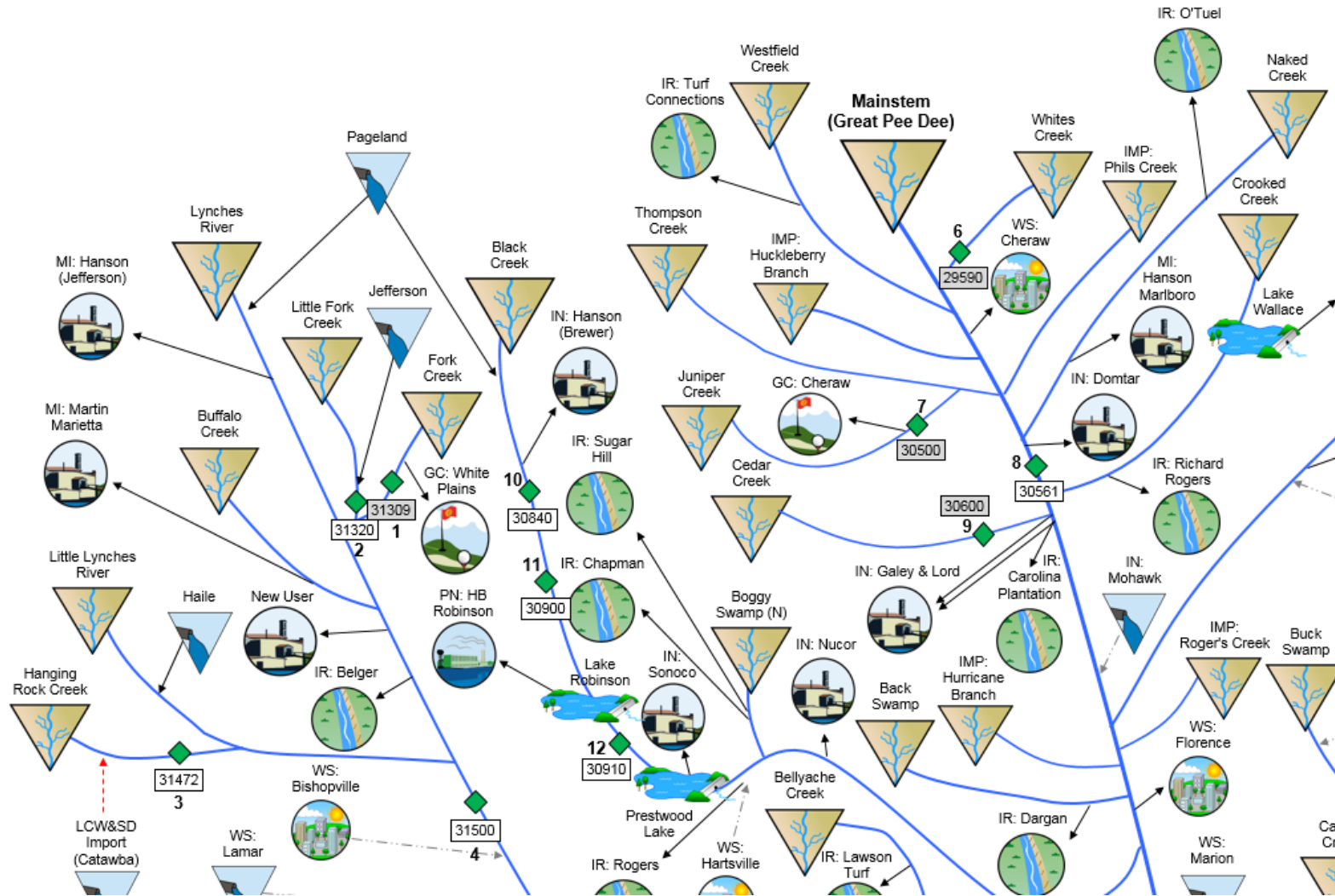
Node Priorities Node Locations Reservoir Accounts Output Specs

Input & Output

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



Object Palette

A vertical column of icons representing various water management objects: a reservoir, a dam, a river, a lake, a city, a factory, a power plant, a wind turbine, a solar panel, a boat, a dam, a reservoir, and a diamond shape.



# Build a Shortage Plot for the New User

## Simplified Water Allocation Model (SWAM)

Simulation Period

Start Date  
(MM/DD/YYYY)  
01/01/1983

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)

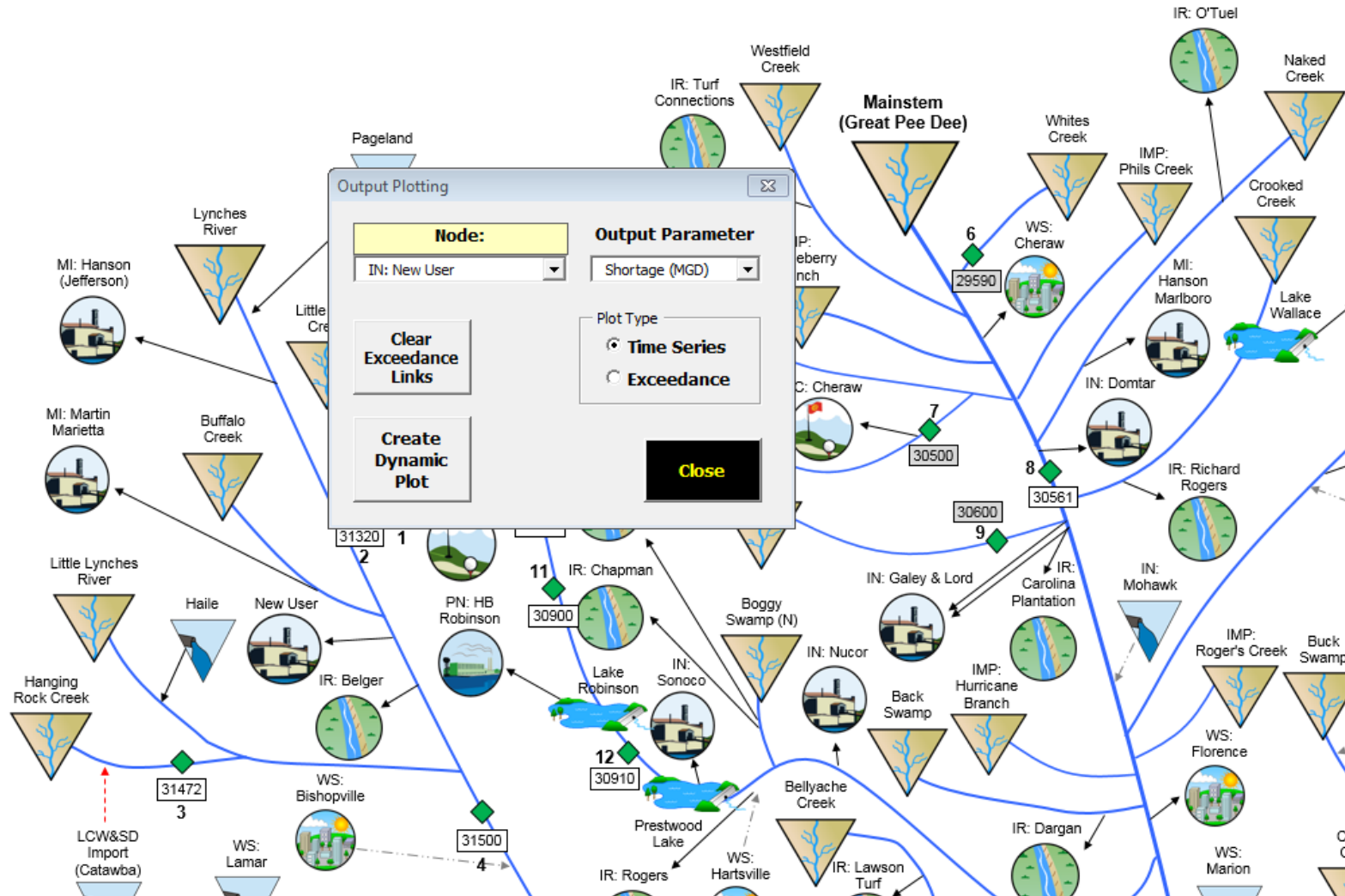
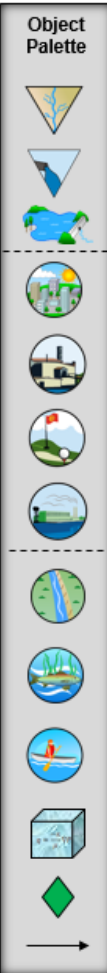
## Input Summaries and Outputting

Node Priorities Node Locations Reservoir Accounts Output Specs



Input & Output

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



**Output Plotting**

Node: IN: New User

Output Parameter: Shortage (MGD)

Plot Type:  
 Time Series  
 Exceedance

Buttons: Clear Exceedance Links, Create Dynamic Plot, Close

# Build a Shortage Plot for the New User

## Simplified Water Allocation Model (SWAM)

**Simulation Period**

Start Date (MM/DD/YYYY): 01/01/1983

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

**Simulation Type**

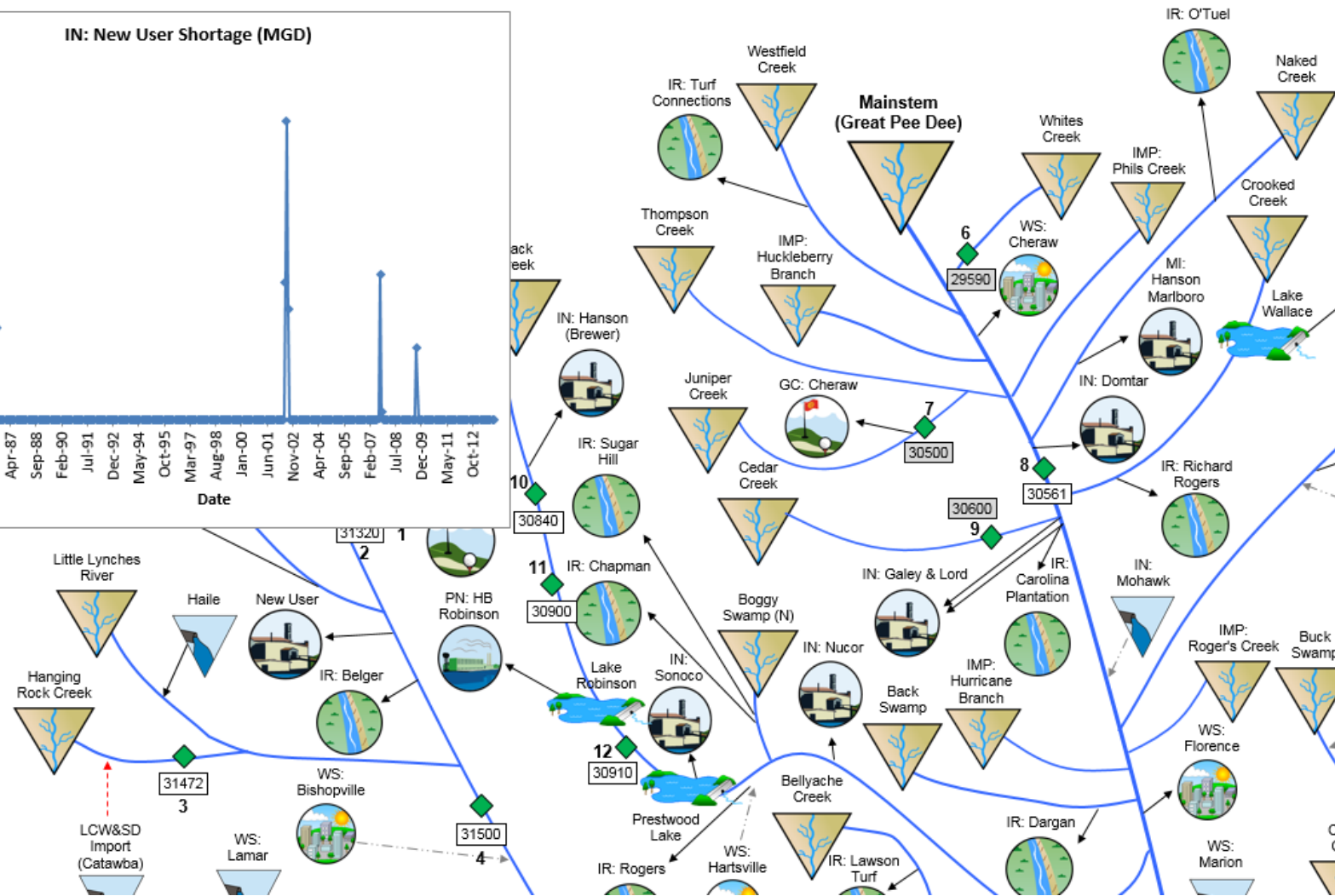
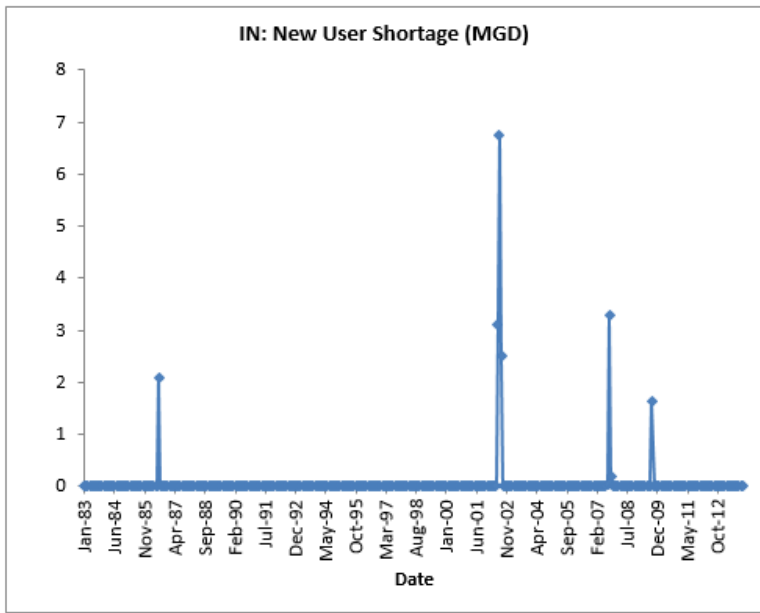
Monthly Planning      Prior Appropriations  
 Daily Planning      Riparian Water Rights  
 Short Term Forecasting  
 Firm Yield Calculator

**Run (ctrl R)**

## Input Summaries and Outputting

**Input & Output**

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



# Shortages are Also Listed in the Node Output Table

	A	B	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV
1	Output			<u>Priority Rank</u>	<u>Reach</u>	<u>Location</u>	<u>Permit Limit (MGM)</u>	<u>Diversion Capacity (CFS)</u>	<u>Storage Capacity (MG)</u>	<u>Reservoir Withdrawal Permit (MGM)</u>			<u>Priority Rank</u>	<u>Reach</u>	<u>Location</u>	<u>Permit Limit (MGM)</u>
2		<i>IN: New User</i>	52	<i>ynches Rive</i>	25	100000	100000	0				<i>IR: Belger</i>	55	<i>ynches Rive</i>	31	10000
3	Date	Physically Avail. (MGD)	Legally Avail. (MGD)	Demand (MGD)	River Withdrawal (MGD)	Storage (MG)	Groundwater Withdrawal (MGD)	Shortage (MGD)	Return Flow (MGD)			Physically Avail. (MGD)	Legally Avail. (MGD)	Demand (MGD)	River Withdrawal (MGD)	Storage (MG)
4	Min	13	13	20	13	0	0	0	7			9	9	0	0	0
5	Max	967	967	20	20	0	0	7	10			1097	357	0	0	0
6	Avg	177	177	20	20	0	0	0	10			192	158	0	0	0
229	7/31/01	45	45	20	20	0	0	0	10			43	43	0	0	0
230	8/31/01	26	26	20	20	0	0	0	10			21	21	0	0	0
231	9/30/01	22	22	20	20	0	0	0	10			16	16	0	0	0
232	10/31/01	22	22	20	20	0	0	0	10			16	16	0	0	0
233	11/30/01	25	25	20	20	0	0	0	10			19	19	0	0	0
234	12/31/01	32	32	20	20	0	0	0	10			27	27	0	0	0
235	1/31/02	74	74	20	20	0	0	0	10			75	75	0	0	0
236	2/28/02	87	87	20	20	0	0	0	10			90	90	0	0	0
237	3/31/02	81	81	20	20	0	0	0	10			84	84	0	0	0
238	4/30/02	86	86	20	20	0	0	0	10			89	89	0	0	0
239	5/31/02	37	37	20	20	0	0	0	10			32	32	0	0	0
240	6/30/02	17	17	20	17	0	0	3	8			11	11	0	0	0
241	7/31/02	13	13	20	13	0	0	7	7			9	9	0	0	0
242	8/31/02	17	17	20	17	0	0	3	9			11	11	0	0	0
243	9/30/02	54	54	20	20	0	0	0	10			53	53	0	0	0
244	10/31/02	61	61	20	20	0	0	0	10			62	62	0	0	0
245	11/30/02	121	121	20	20	0	0	0	10			131	131	0	0	0
246	12/31/02	171	171	20	20	0	0	0	10			185	185	0	0	0
247	1/31/03	139	139	20	20	0	0	0	10			150	150	0	0	0
248	2/28/03	295	295	20	20	0	0	0	10			324	324	0	0	0
249	3/31/03	729	729	20	20	0	0	0	10			820	323	0	0	0
250	4/30/03	530	530	20	20	0	0	0	10			595	333	0	0	0
251	5/31/03	199	199	20	20	0	0	0	10			215	215	0	0	0
252	6/30/03	208	208	20	20	0	0	0	10			229	229	0	0	0
253	7/31/03	259	259	20	20	0	0	0	10			285	285	0	0	0
254	8/31/03	229	229	20	20	0	0	0	10			252	252	0	0	0
255	9/30/03	70	70	20	20	0	0	0	10			70	70	0	0	0
256	10/31/03	67	67	20	20	0	0	0	10			66	66	0	0	0
257	11/30/03	84	84	20	20	0	0	0	10			87	87	0	0	0
258	12/31/03	103	103	20	20	0	0	0	10			108	108	0	0	0
259	1/31/04	80	80	20	20	0	0	0	10			82	82	0	0	0
260	2/28/04	207	207	20	20	0	0	0	10			228	228	0	0	0
261	3/31/04	167	167	20	20	0	0	0	10			183	183	0	0	0
262	4/30/04	71	71	20	20	0	0	0	10			72	72	0	0	0
263	5/31/04	52	52	20	20	0	0	0	10			49	49	0	0	0
264	6/30/04	30	30	20	20	0	0	0	10			24	24	0	0	0
265	7/31/04	43	43	20	20	0	0	0	10			39	39	0	0	0
266	8/31/04	76	76	20	20	0	0	0	10			77	77	0	0	0

# Reduce the New Users Total Water User to 10 mgd

## Simplified Water Allocation Model (SWAM)

Simulation Period: Start Date (MM/DD/YYYY) 01/01/1983, End Date (MM/DD/YYYY) 12/31/2013

Simulation Type:  Monthly Planning,  Daily Planning,  Prior Appropriations,  Riparian Water Rights

Run (ctrl R)

## Input Summaries and Outputting

Node Priorities, Node Locations, Reservoir Accounts, Output Specs

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

Water User

Main | Water Usage | Source Water | Return Flows

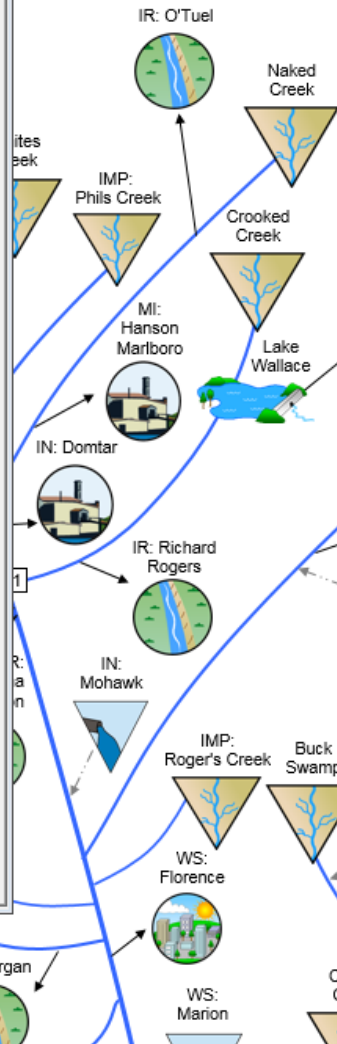
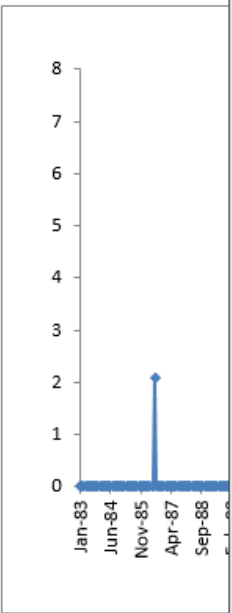
Monthly User Distribution:  Manual,  M&I,  Agriculture

Annual Baseline Usage: Total Use (MGY) [ ] Distribute

Input Format:  monthly means,  timeseries

Month	Monthly Usage (MGD)	% Indoor Use	% CU Indoor	% CU Outdoor
Jan	10	100	50	0
Feb	10	100	50	0
Mar	10	100	50	0
Apr	10	100	50	0
May	10	100	50	0
Jun	10	100	50	0
Jul	10	100	50	0
Aug	10	100	50	0
Sep	10	100	50	0
Oct	10	100	50	0
Nov	10	100	50	0
Dec	10	100	50	0

Save Close



Object Palette

- Water body icons
- Reservoir icon
- Water user icons (factory, house, etc.)
- Flow control icons (valve, dam)



# Rerun the Model Scenario

### Simplified Water Allocation Model (SWAM)

Simulation Period

Start Date (MM/DD/YYYY): 01/01/1983

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

Simulation Type

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

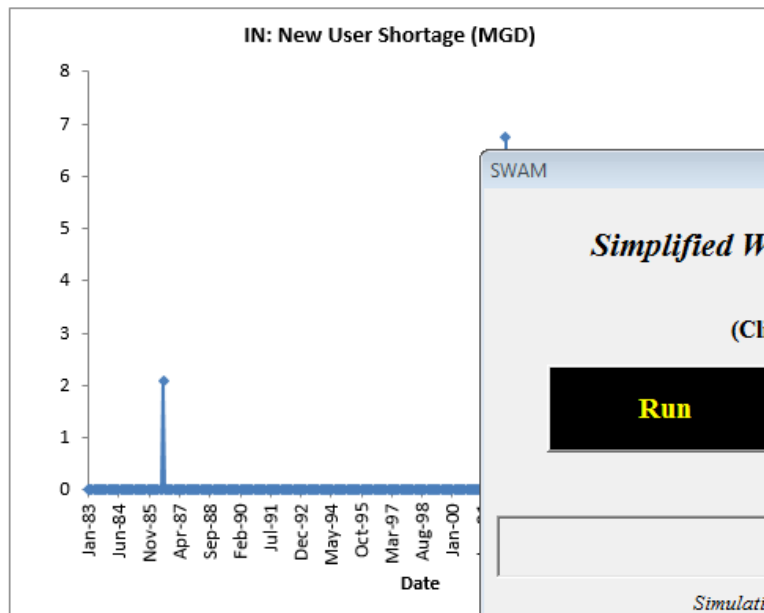
**Run (ctrl R)**

### 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



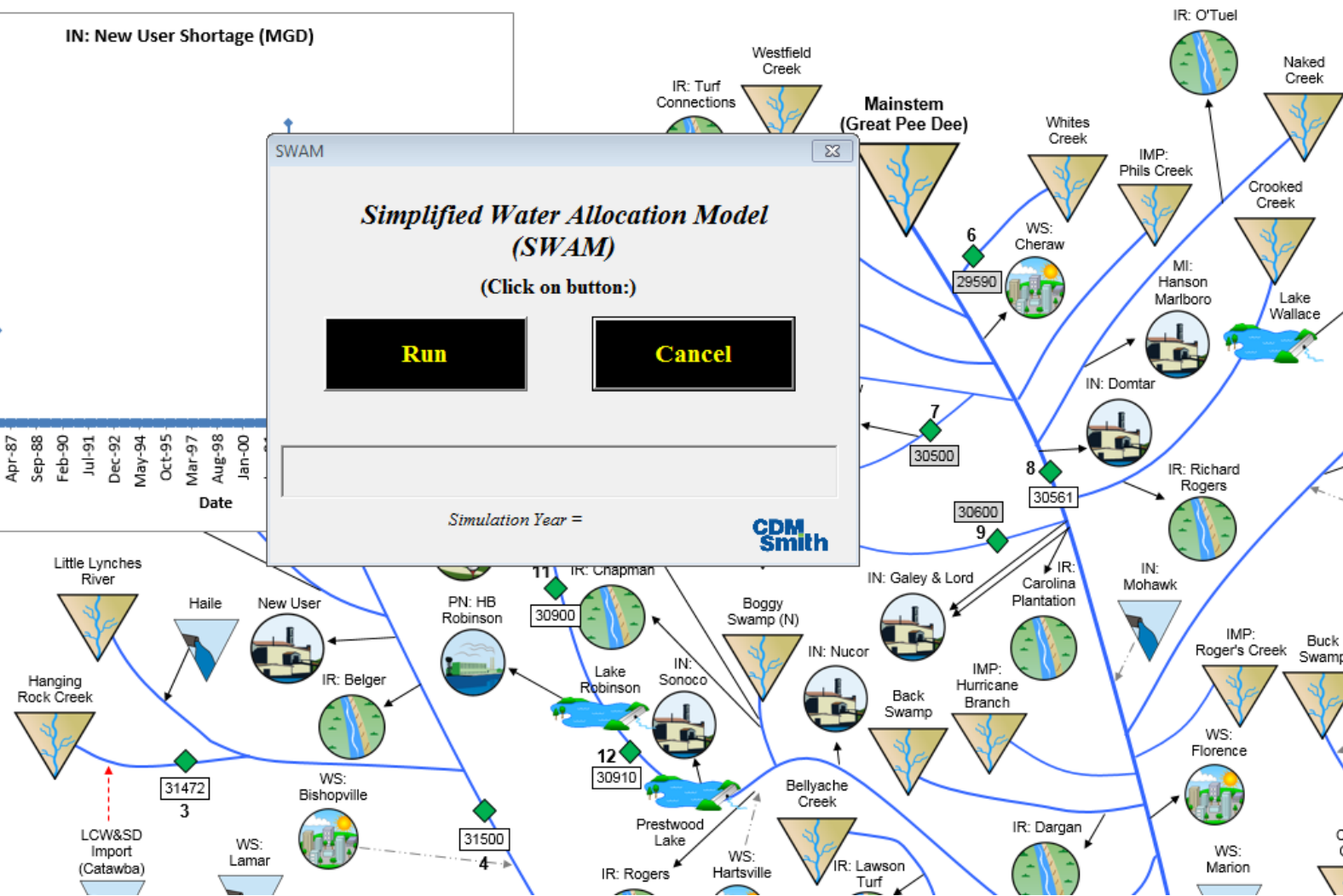
### Simplified Water Allocation Model (SWAM)

(Click on button:)

**Run** **Cancel**

Simulation Year =

CDM Smith



### Object Palette

- Water body icons
- Reservoir icons
- Industrial facility icons
- City icons
- Swamp icons
- Flow direction arrows

# Dynamic Shortage Plots Update Automatically

### Simplified Water Allocation Model (SWAM)

**Simulation Period**

Start Date (MM/DD/YYYY):

End Date (MM/DD/YYYY):

**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

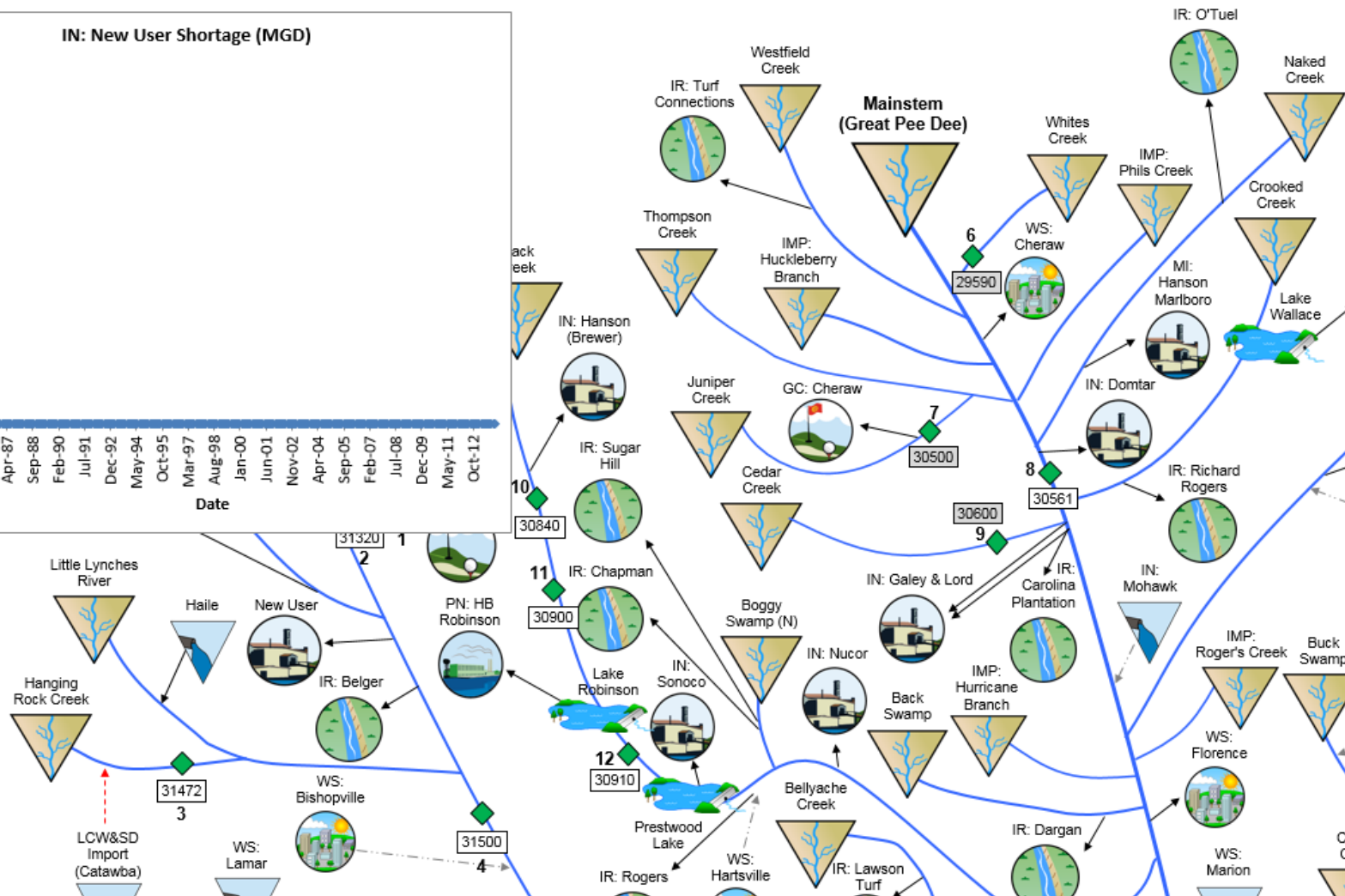
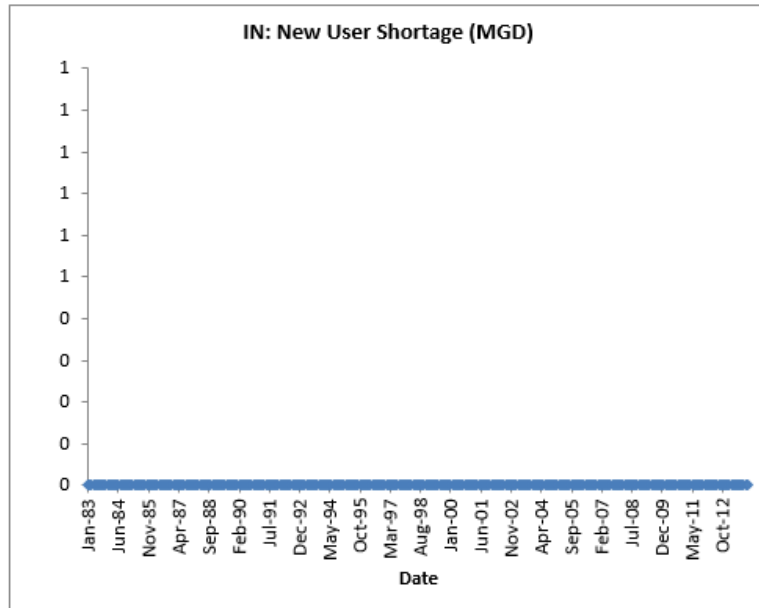
Node Locations

Reservoir Accounts

Output Specs

**Input & Output**

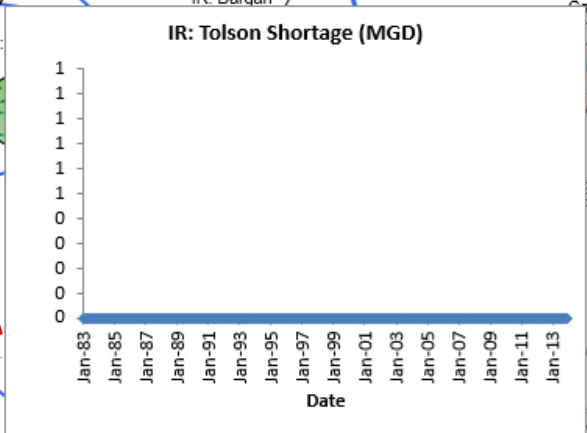
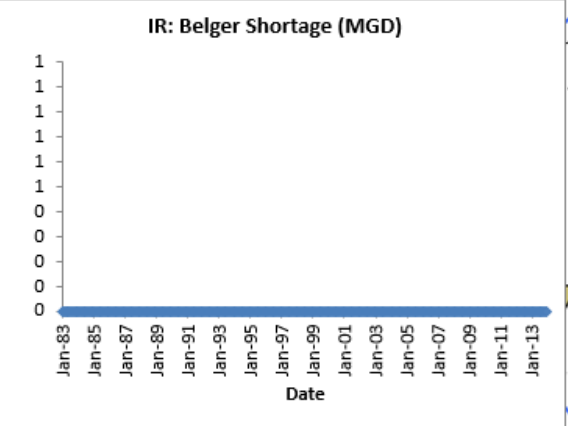
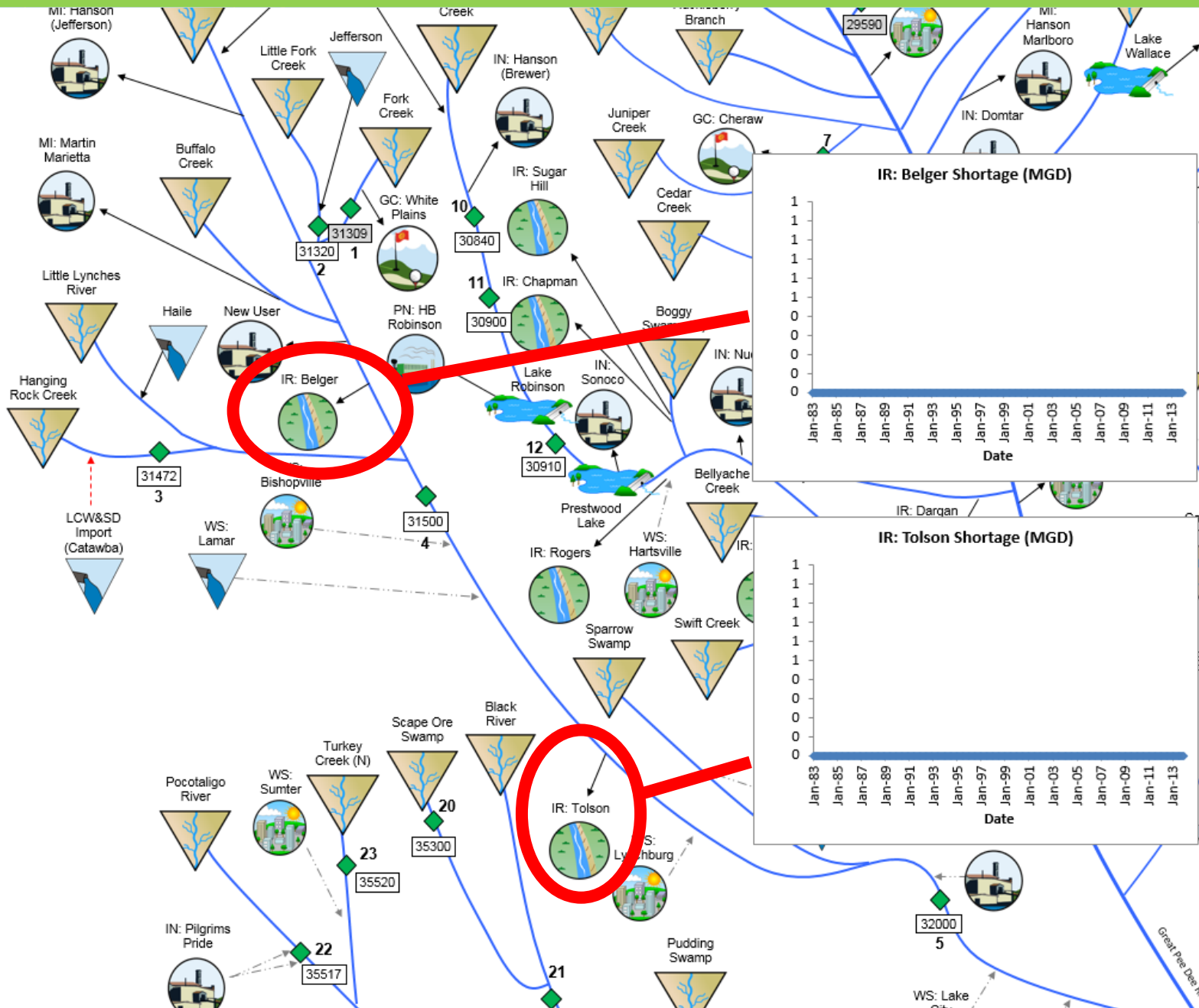
AF, AFM, AFD     MG, MGD, CFS     m3, m3/d, m3/s



#### Object Palette

- 
- 
- 
- 
- 
- 
- 
- 
- 
-

# Check for Shortages for Downstream Users



# Demonstrations and Q&A

- Station 1 (Tim)

Evaluate an increase in Ag User demands

- Station 2 (John)

Evaluate a proposed new municipal water supply withdrawal

- Station 3 (Kirk)

Evaluate new industrial user and compare against instream flow requirements

Pee Dee River Basin

THANK YOU