MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
Operations RCG Meeting

September 17, 2014

Final KDM 10-30-14

ATTENDEES:

Dick Christie (SCDNR)
Scott Harder (SCDNR)
Steve Summer (SCANA)
Henry Mealing (Kleinschmidt)
Bret Hoffman (Kleinschmidt)
Randy Mahan (SCANA)
Bill Argentieri (SCE&G)
Ray Ammarell (SCE&G)
Kelly Miller (Kleinschmidt)
Byron Hamstead (USFWS)
Bruce Halverson (Kleinschmidt)
Amy Bresnahan (SCE&G)

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Henry gave a brief overview on the purpose of the meeting and then turned the floor over to Bret. Bret gave a PowerPoint presentation on the Operations Model, including the three different components; the river routing model (HEC-RAS); the reservoir routing model (HEC-ResSim); and the model database (HEC-DSS). The presentation is attached to the end of these notes.

Byron asked if the HEC-DSS was used to manipulate variables of the HEC-RAS and HEC-ResSim. Bret said that changes are made in the rules of these two programs, but the HEC-DSS allows the user to see how those changes affected the model output. Datasets, such as the input and results datasets, are easily stored in HEC-DSS versus Excel spreadsheets.

Bret then discussed the HEC-RAS model and the SCDNR terrain data that was used. Bret explained that the LiDAR data doesn’t show what is going on beneath the water, so Bruce developed an approximate equivalent trapezoid underneath the water level that is large enough to pass the flows for that particular day. The IFIM study will give better definition of the bathymetry at specific transects along the Broad River.

Scott asked how the HEC-RAS applies to the IFIM study. Bret said that the IFIM is targeting habitat qualities and the amount of water and flow needed to support a particular species. Henry explained that low flows are examined in the IFIM study to determine how minimum flows affect the quality and amount of fish habitat available at adjustment range of flows.

Scott asked if there was a point identified downstream that could cause a problem during high flows. Ray said that there is an area of private property downstream that could be inundated during high flows. Ray also mentioned that the current license does not allow the Project to add to a flood event.

Scott asked if the HEC-RAS model was a tool that SCE&G wanted to use, or was it requested by the agencies. Ray explained that it is important for studying wave attenuation, navigation, etc downstream of Parr Shoals Dam. Also, stakeholders expressed interest in determining how fluctuations might be affecting the downstream reach, including striped bass spawning in the river.

Bruce then began the demonstration of the HEC-ResSim model. Scott asked if the model was set up to use the maximum amount of fluctuation. Ray said that the model currently represents the full capability of the Project, even if it isn't used to the maximum every day. Ray said that in the future the Project will be used to its full capacity more often. The group disagreed as to whether the "baseline" model should be set up to demonstrate how the Project is currently being utilized or to demonstrate the full capabilities of the Project. Ray said that every day the Project is operated differently based on conditions, so the "baseline" model should demonstrate full operational abilities. Dick said that baseline seems to him to be current or daily operating conditions, which typically does not include full fluctuation potential. A scenario can then be created to demonstrate the full capabilities of the Project.

Bruce said that a scenario can be created to show what has happened in the past, but the model must be developed first to include the full operating range of the Project. Once the full range has been accounted for, the model operator can hone in on specific daily variations.

Scott said that while it is impossible to recreate the past in the model, there needs to be a check completed to demonstrate that the model is accurate. Ray said that there is a lot more that goes into operating the Project on a daily basis than just the if/then constraints that Bruce used to create the model. If the generation (MWH) for a particular day is entered into the model, it should yield reservoir levels and flows that were recorded for that day by the USGS. The group then discussed running a load curve. Ray said that if the group decides on a representative load curve for the Project, the MWH demands can be entered into the model. Flows that the model produces can be compared to the inflow and downstream flow recorded by USGS for that time period. This is one way to check the accuracy of the model.

Ray noted that it is important to ensure the Project works in the future with the addition of the new nuclear units. This is why it is important to make sure the model will mimic a load curve. Bruce and Ray will identify a two week period when all data needed to perform a load curve check is available. This information will be included in an appendix to the Operations Model Report.

Scott asked how the nuclear units will affect the operation of the Project and downstream flows, and if this is accounted for in the model. Scott said it was the DNR's understanding that when there is less water in the system, due to low inflow, withdrawals from the new nuclear units would be removed from the 29,000 acre-feet of usable storage and Monticello would reach the low pool limit quicker.

Currently the existing nuclear unit evaporation is deducted from inflows for minimum flow release requirements. Bruce created a flow diversion in the model that accounts for this. However, the two new nuclear units are permitted withdrawals and not deducted from inflows for minimum flow requirements. The current model does not include future diversions. Bruce will update the model with a placeholder for future diversions.

The group agreed that the model needs to include license constraints. The group also agreed that it would be helpful if the RCG members would create a list of issues that will be examined during relicensing, such as spring spawning flows, reservoir constrictions, recreation flows, and continuous minimum flows. These would be provided to Bruce so that he can develop an Output Format that will interpret model outputs into to more easily understandable results.

During the discussion of the HEC-ResSim model, Scott asked that a glossary be added to the Operations Model Report for datasets of primary interest. Bruce then demonstrated the HEC-RAS model to the group.

Following the meeting, Scott submitted a list of comments regarding the Operations Modeling System and the Operations Model Report. These comments are appended to the end of these notes.

ACTION ITEMS:

- Bruce will refine the HEC-ResSim model to remove diversions for withdrawals associated with the new nuclear units.
- Bruce will add a glossary to Operations Model Report for datasets of primary interest.
- RCG members will provide a list of possible scenarios to be run in the future. These scenarios should cover a range of issues that the RCG anticipate could arise.
    - Examples:
        - continuous min-flow of XXX,
        - spawning flow of XXX cfs during (Feb – April),
        - recreation flow on the weekends of XXX for 6 hours (10am-4pm) during June – Oct

Scott Harder

Hydrologist, SCDNR

9/18/14

Re: Comments on the Parr-Fairfield Operations Modeling System report and the 9/17/14 Model demonstration meeting.

1. A "baseline scenario" should be developed that uses a monthly or seasonal load shape curve that approximates historic or current generation patterns. The baseline scenario would also not include the two new nuclear units at VC Summer.

2. A methodology for model verification needs to be developed to show that the model is approximating reality or current operations (for baseline scenario). One approach is to look for time periods (weeks to months) where there were few to no complicating operational considerations and compare model outflows with data from the Alston gage. Another approach is to perform some tests on mass conservation over longer periods of times (years) to ensure that the model is not losing or gaining (unlikely) water over time and serve as a check on evaporation estimates. I would recommend attempting both approaches but certainly welcome other suggestions as well. A section should be added to the "Parr-Fairfield Operations Modeling System" report on model verification.

3. From previous discussions associated with the nuclear licensing of the two new units at VC Summer, my understanding was that the evaporative losses from these units would not be subtracted from the inflow to determine outflow during low flow conditions. Instead, the volume of water pumped between Monticello and Parr would be reduced during these low flow periods. In other words, the operation of the new units would have little to no impact on downstream flows during low flow periods. The version of the model introduced at the meeting on 9/17/14 should be modified to reflect this rule. Future scenarios should generally reflect this rule unless a scenario(s) is proposed that specifically addresses the rule.

Parr-Fairfield Operations Modeling System

Bret Hoffman, PE

Bruce Halverson, PE

SCE&G®
A SCANA COMPANY

Kleinschmidt

Introduction

- FERC Licensing of Parr Hydroelectric Project
- Operations Resource Conservation Group
- Study Plan – Methodology and Objectives

Study Objectives

- Historic Inflow Hydrograph Development
- Hydraulic Modeling
- Operations Model
- Next steps: Scenario Modeling

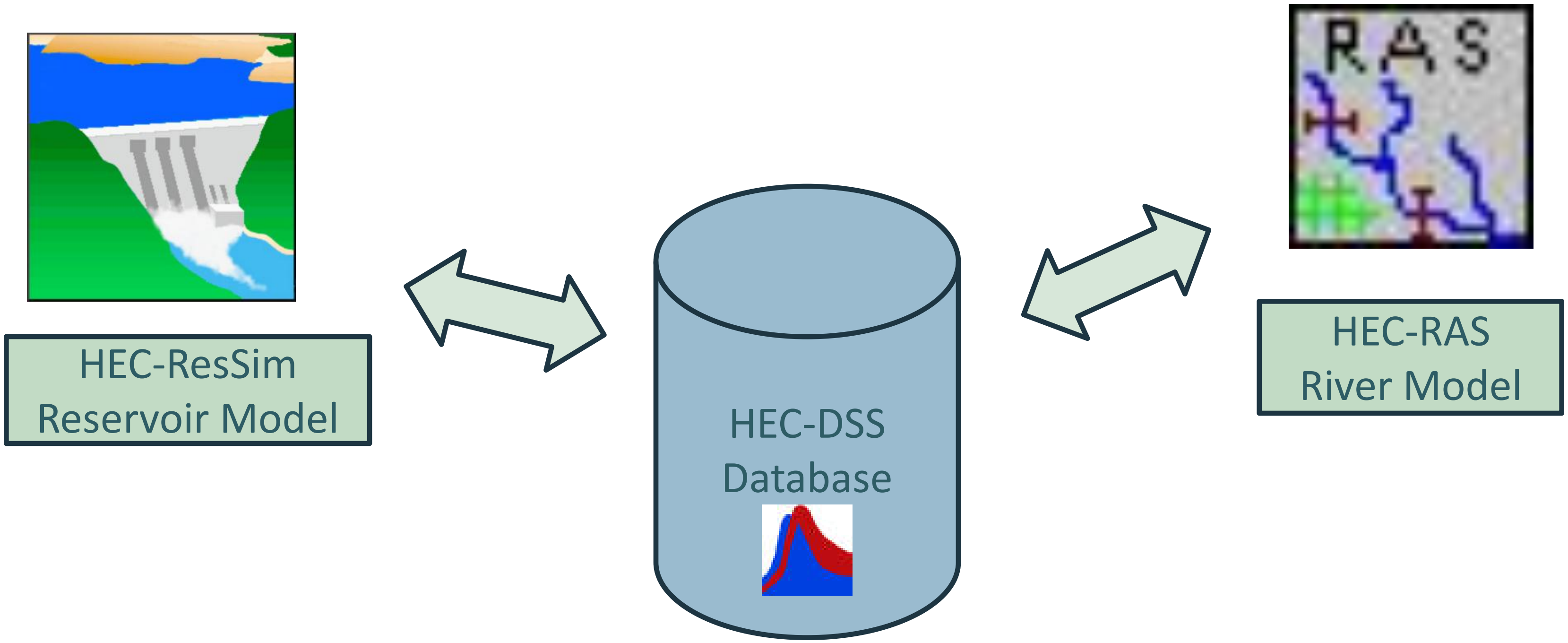
PROJECT SCOPE

- Develop an Operations Model
  - Identify pre-defined constraints
  - Simulate baseline conditions
  - Capable of evaluating stake-holder requested changes to existing operating parameters
- Develop Draft Operations Model Report
- Provide Model Demonstration
- Finalize Baseline Operations Model Report

Modeling System Components

- River Routing Model (HEC-RAS)
- Reservoir Routing Model (HEC-ResSim)
- Model Database (HEC-DSS)

Modeling System Schematic



SCE&G® A SCANA COMPANY

Kleinschmidt

Modeling Database Files

- HEC-DSS files
- Direct access database file structure
- Primarily for time series and paired-data, such as rating tables
- No manual handling of data required

SCE&G® A SCANA COMPANY

Kleinschmidt

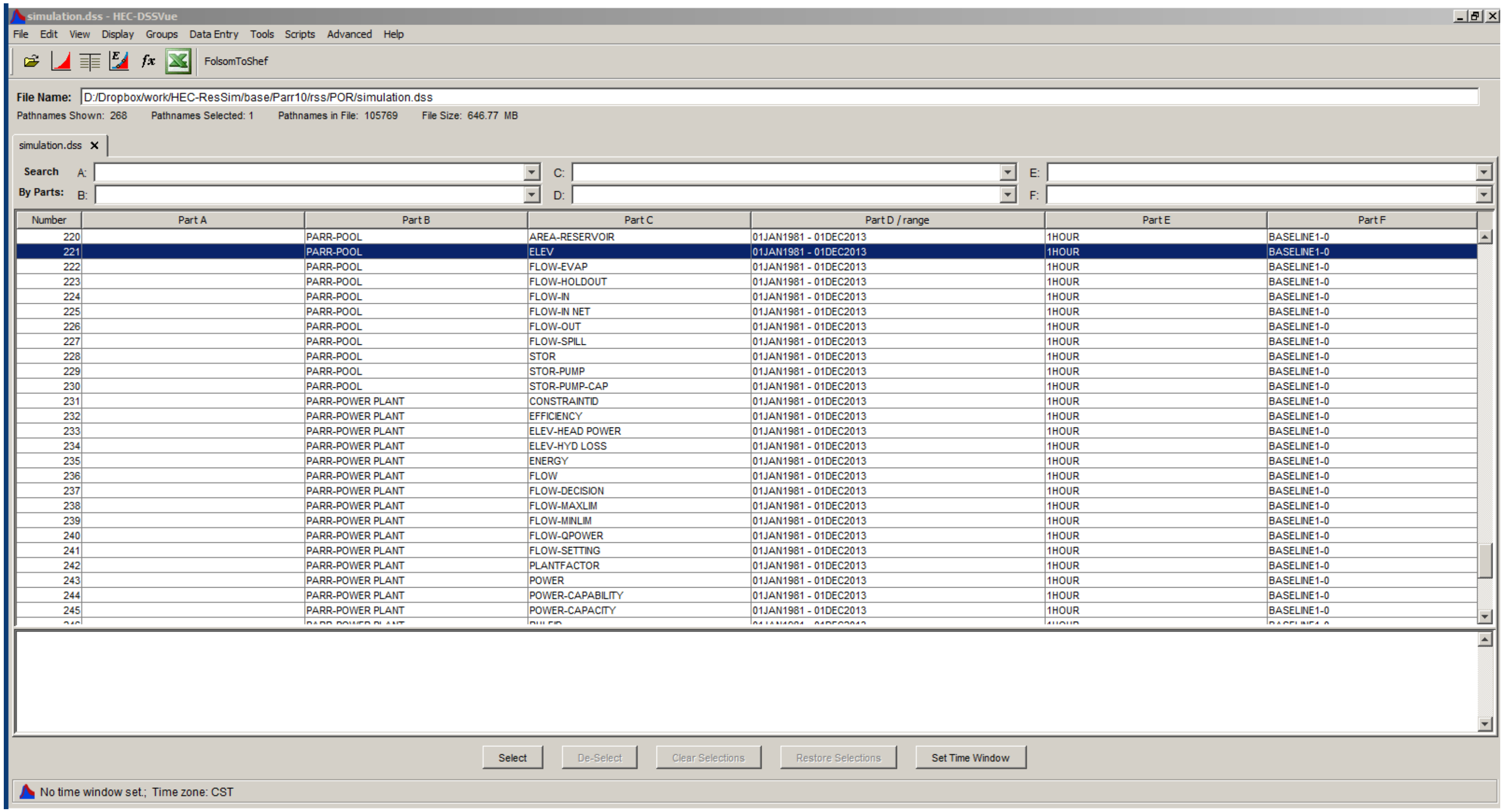
Modeling Database Files

- File #1 > Input data for HEC-ResSim (inflow)
- File #2 > Output data from HEC-ResSim, used as input to HEC-RAS
- File #3 > Output data from HEC-RAS

SCE&G®
A SCANA COMPANY

Kleinschmidt

HEC-DSSVue - Point/click GUI

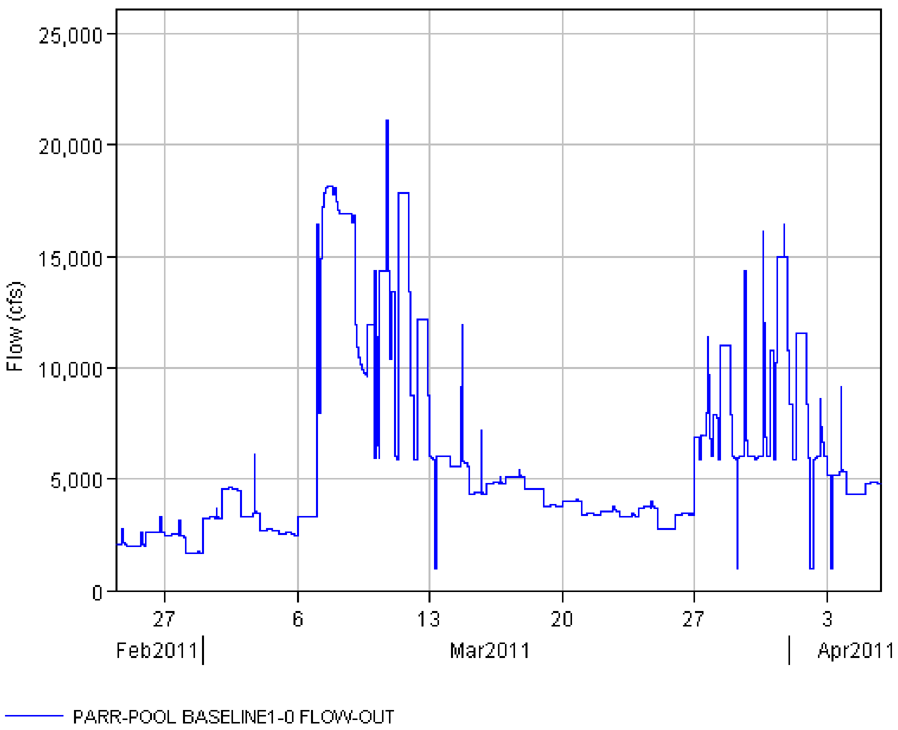


SCE&G® A SCANA COMPANY

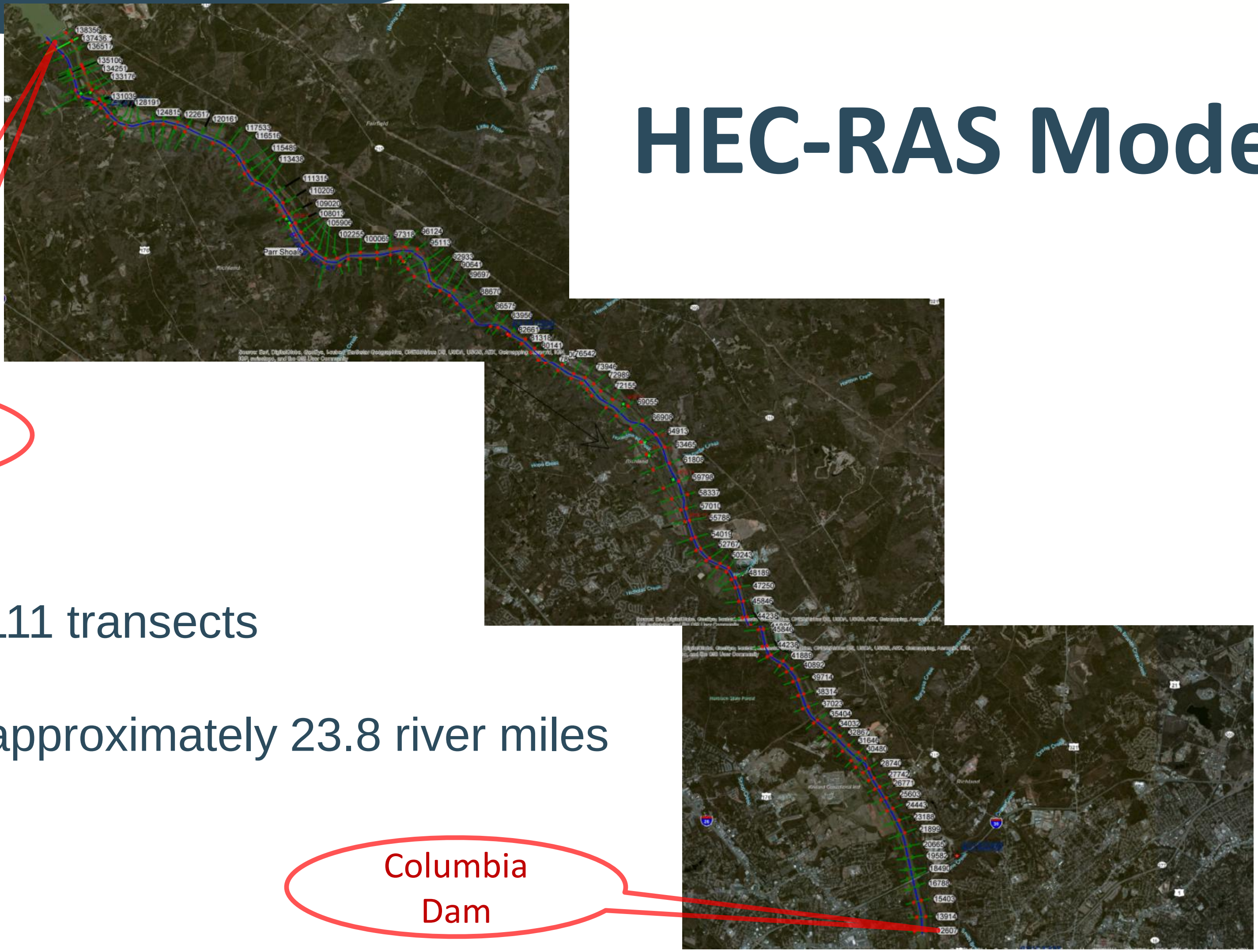
Kleinschmidt

HEC-DSSVue - Point/click GUI

- View
- Print
- Export to Excel
- Several others



HEC-RAS Model



- Total of 111 transects
- Covers approximately 23.8 river miles

SCE&G® A SCANA COMPANY

Kleinschmidt

Data Requirements

- Physical Geometric / Terrain data
- Satellite Imagery (visual aid)
- Boundary conditions & calibration data
- Inflow data

SCE&G
A SCANA COMPANY

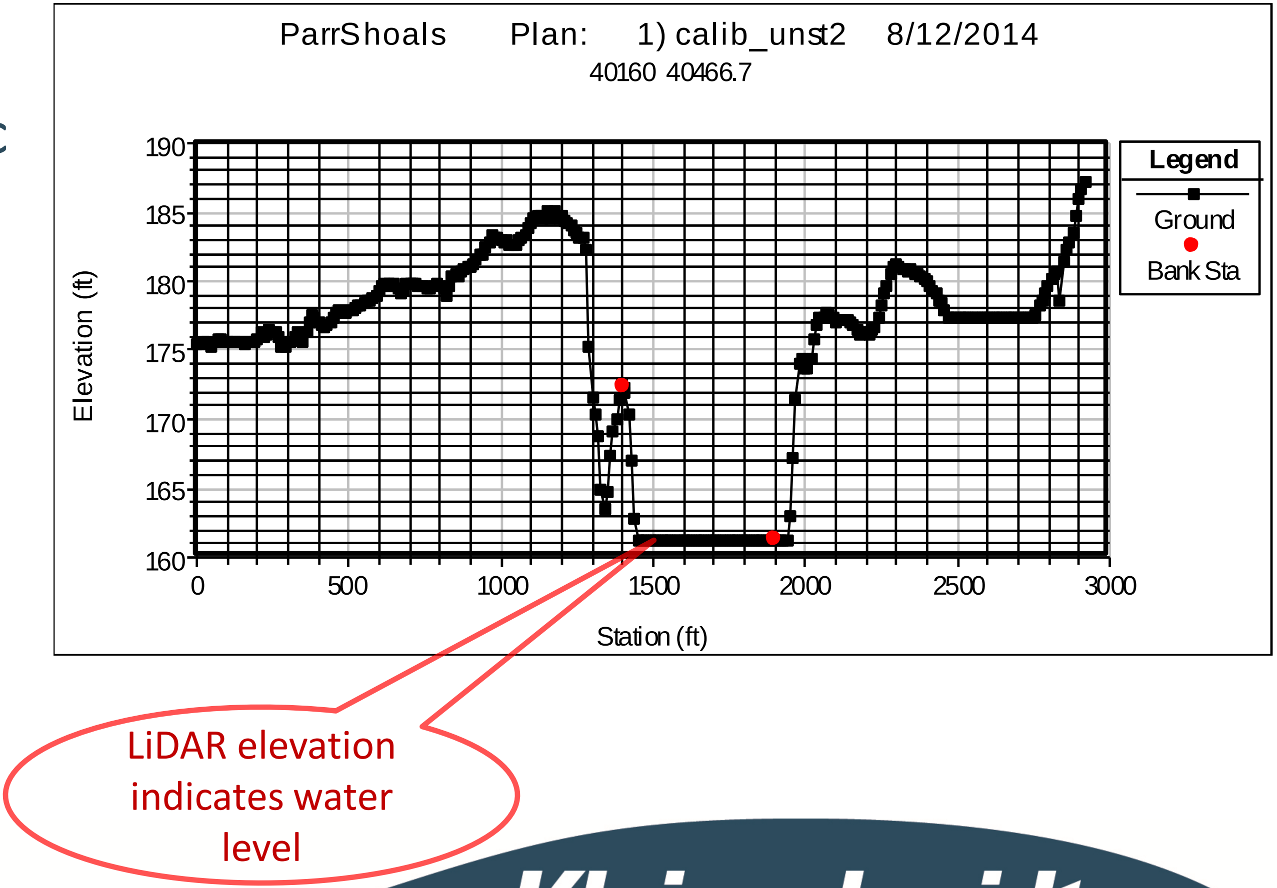
Kleinschmidt

Terrain Data

- Downloaded from SCDNR web server
- LiDAR data – 10’ (approx.) grid
- Vertical datum = NAVD88
- Note > HEC-RAS is NAVD88

Cross-section – Unedited LiDAR

- Lacking bathymetric definition
- Requires manual editing



Imagery Data

- Primarily ESRI non-proprietary aerial images
- Georeferenced
- Not used by the model – used by the model**er**
- Used to determine landforms and channel characteristics

Imagery example

Boundary Conditions & Calibration Data

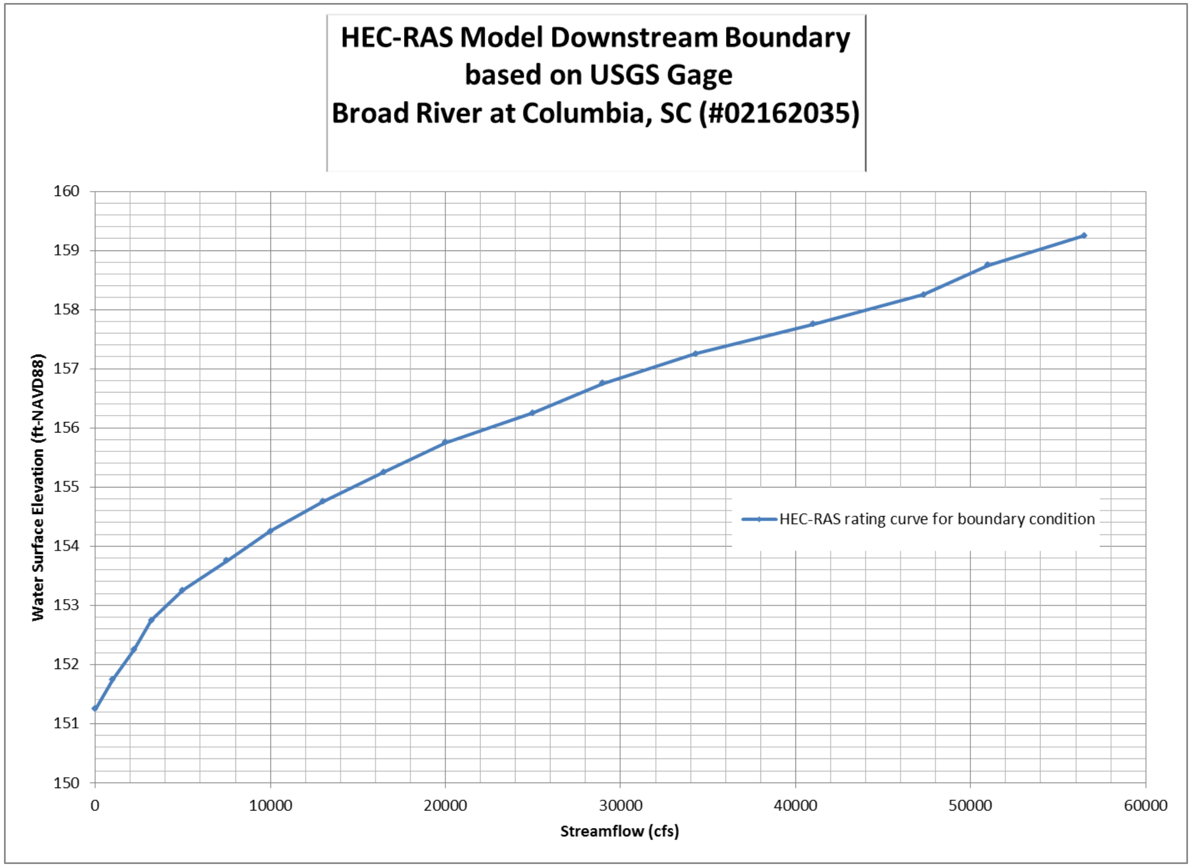
- USGS flow and stage data
- USGS gage rating tables
- Downstream boundary – Columbia Dam
- Monitoring data - 2014

SCE&G® A SCANA COMPANY

Kleinschmidt

Downstream Boundary Condition

- Includes observed data for normal flows
- High flows – computed
- Affects downstream-most 5 miles

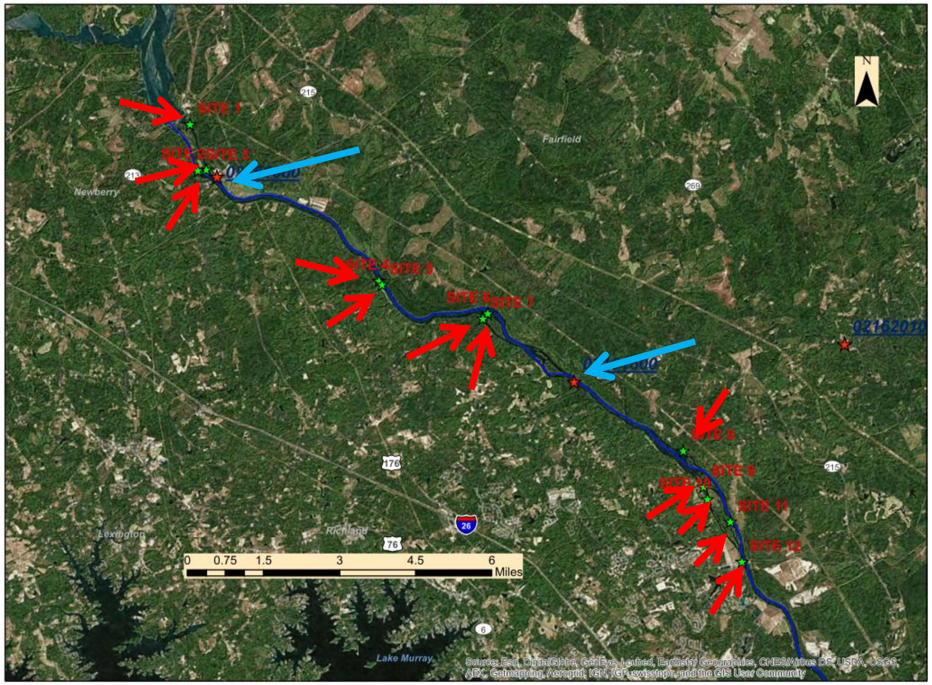


Model Calibration

- Iterative process to adjust cross-section data and channel roughness

- **USGS gage sites (2)**
- **Monitoring sites (12)**

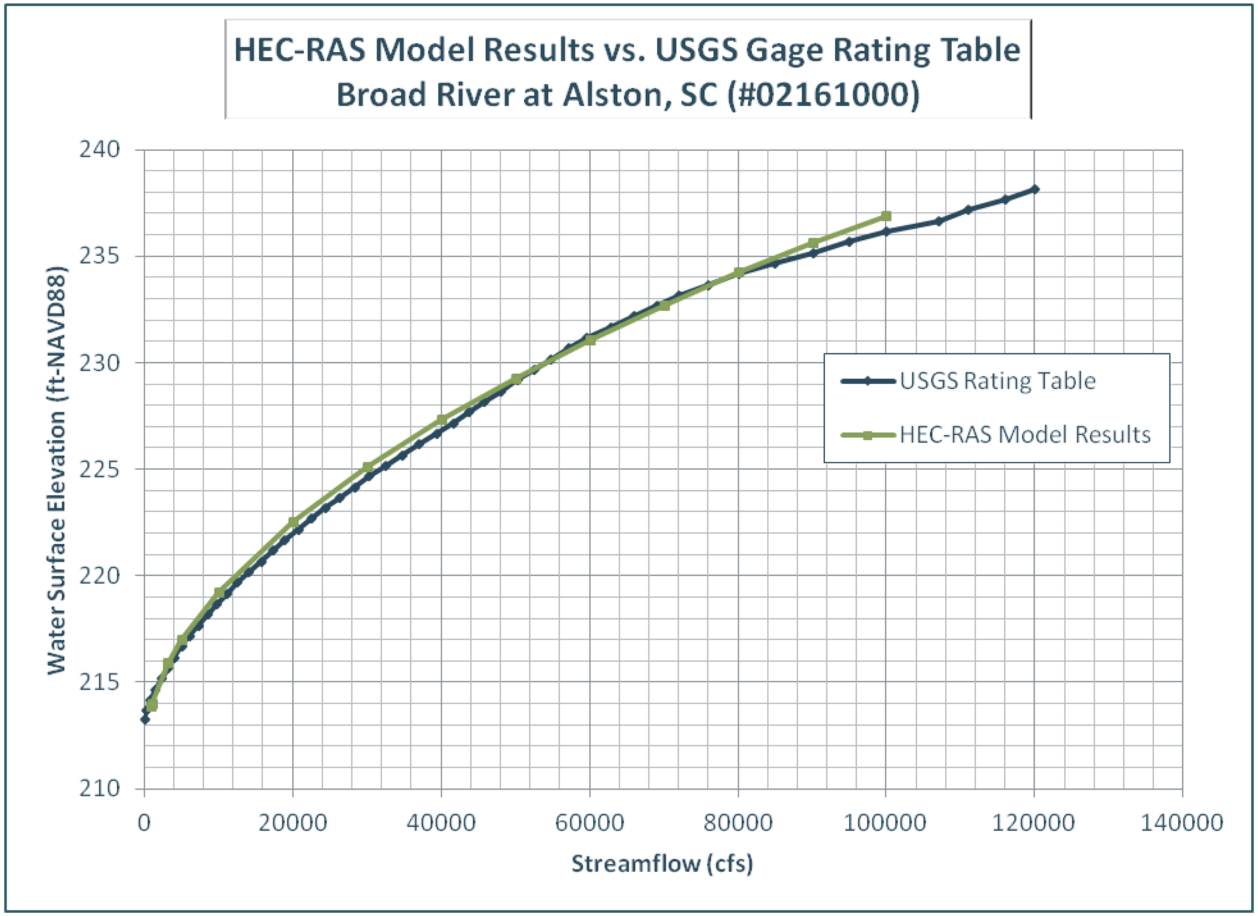
Broad River - Datalogger Sites / USGS Gage Sites



SCE&G A SCANA COMPANY

Kleinschmidt

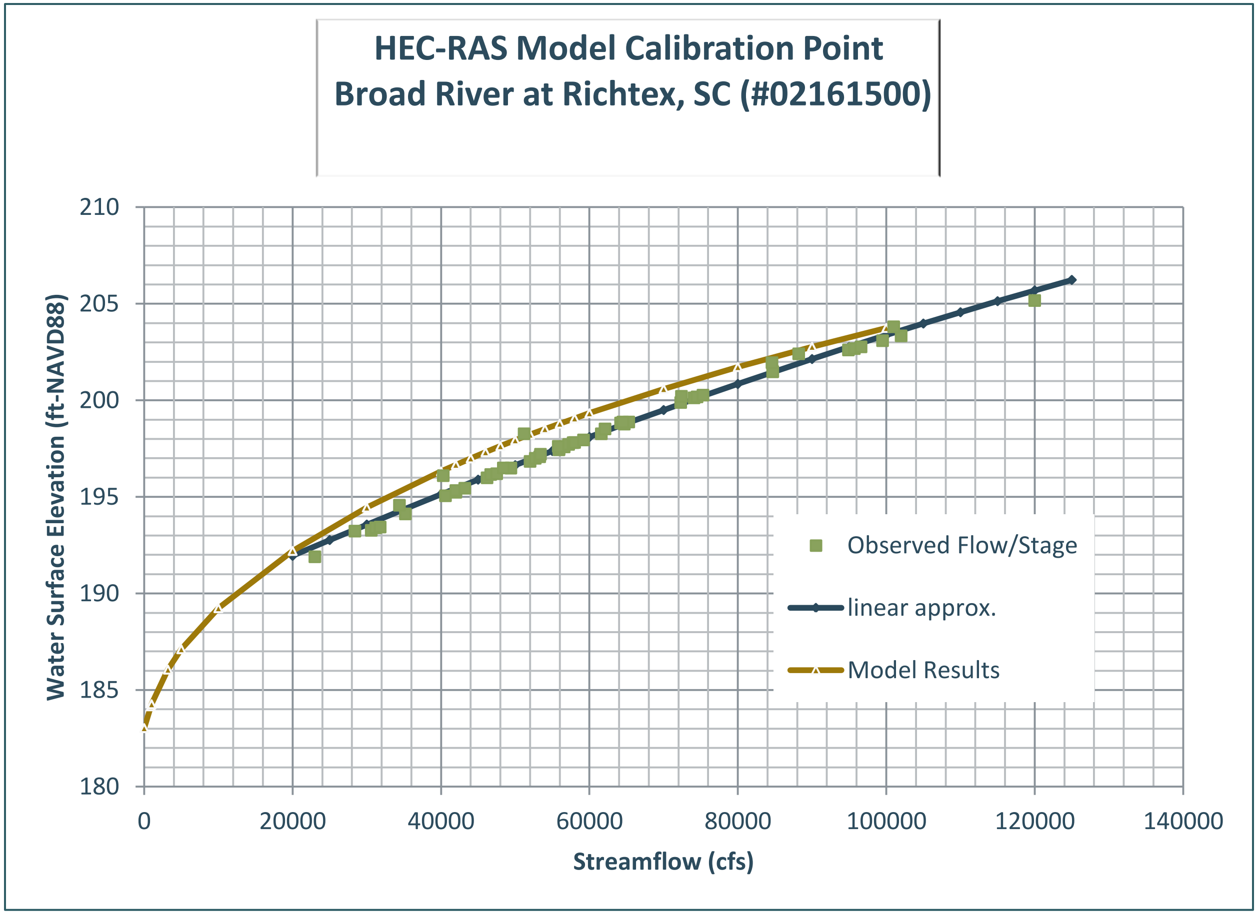
Calibration example: Alston gage



SCE&G® A SCANA COMPANY

Kleinschmidt

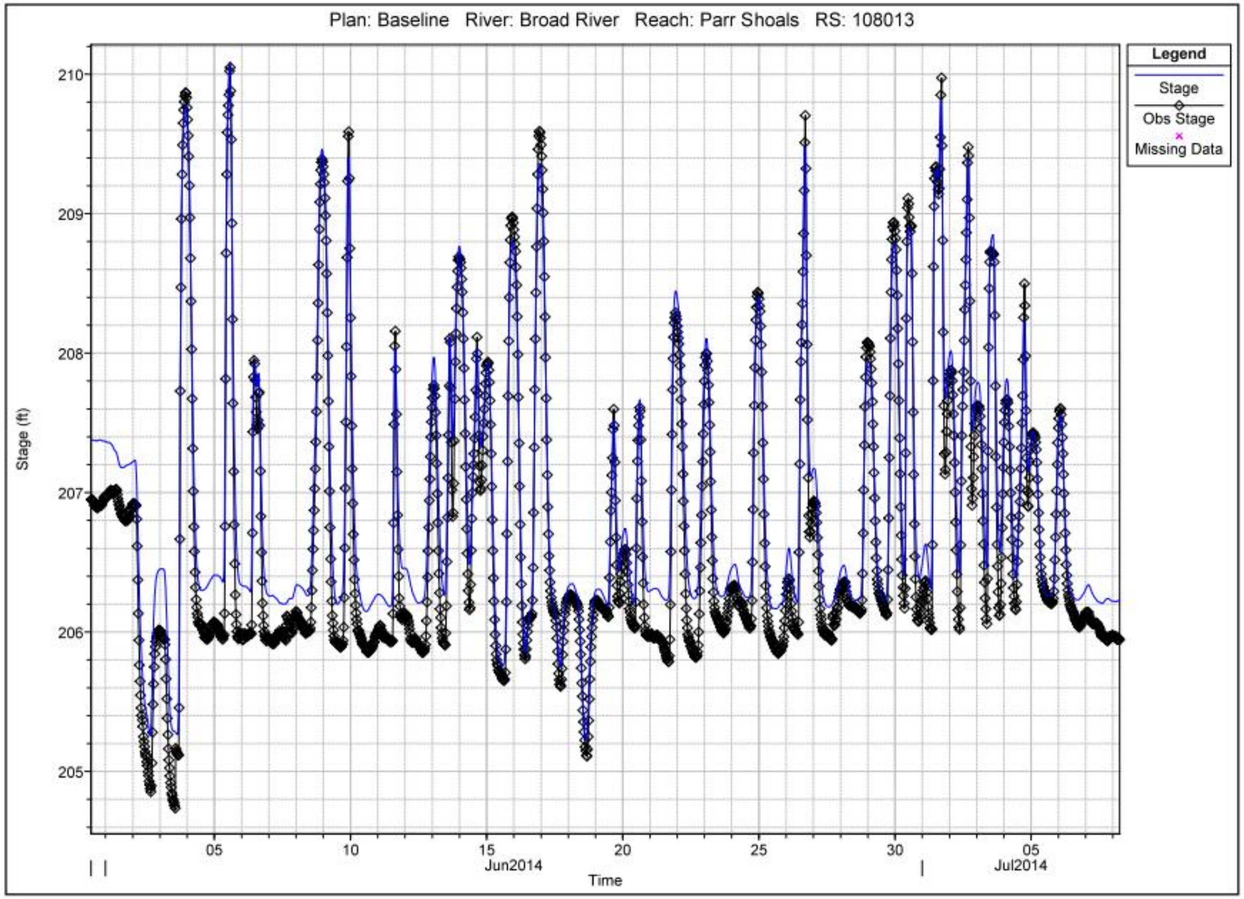
Calibration example: Richtex gage site



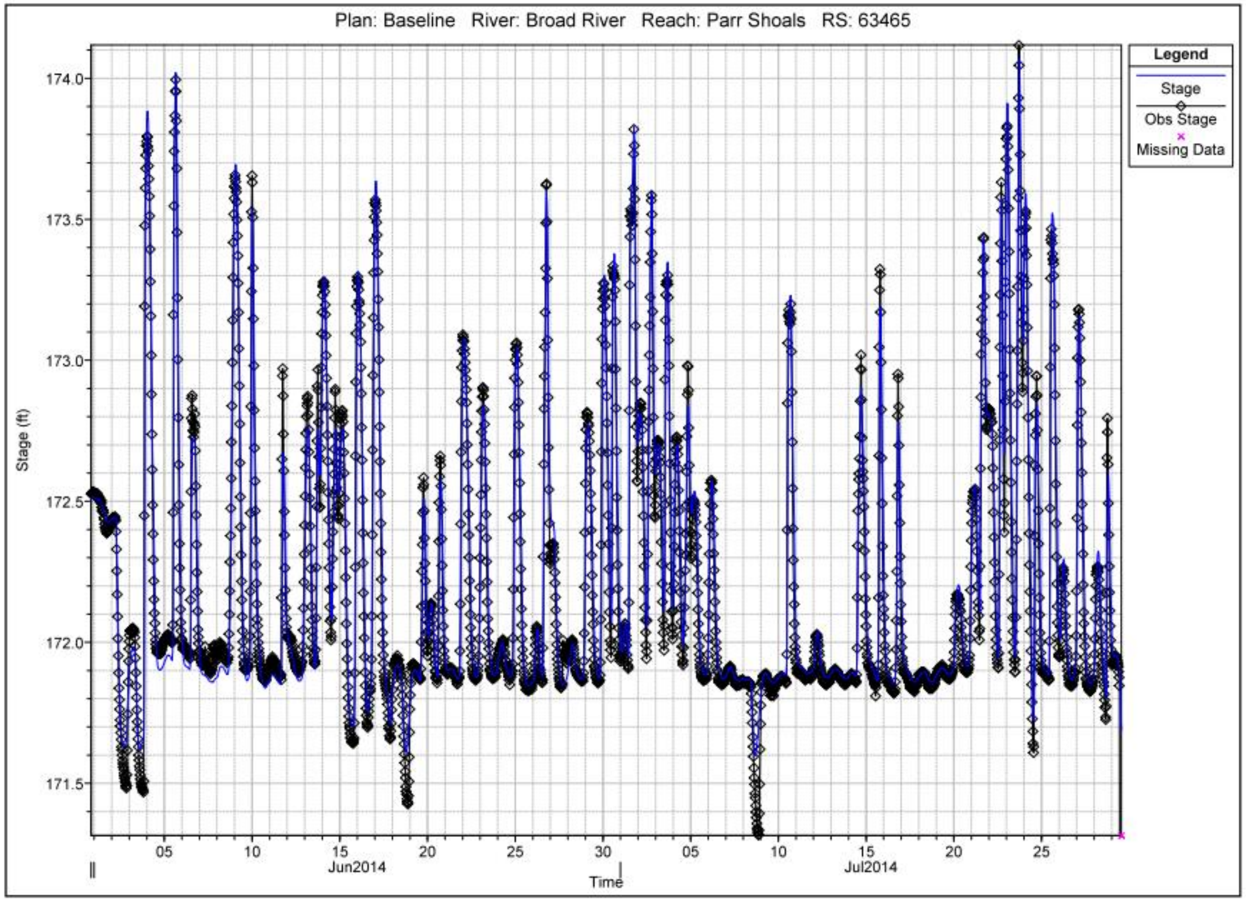
SCE&G® A SCANA COMPANY

Kleinschmidt

Calibration example: Site 5



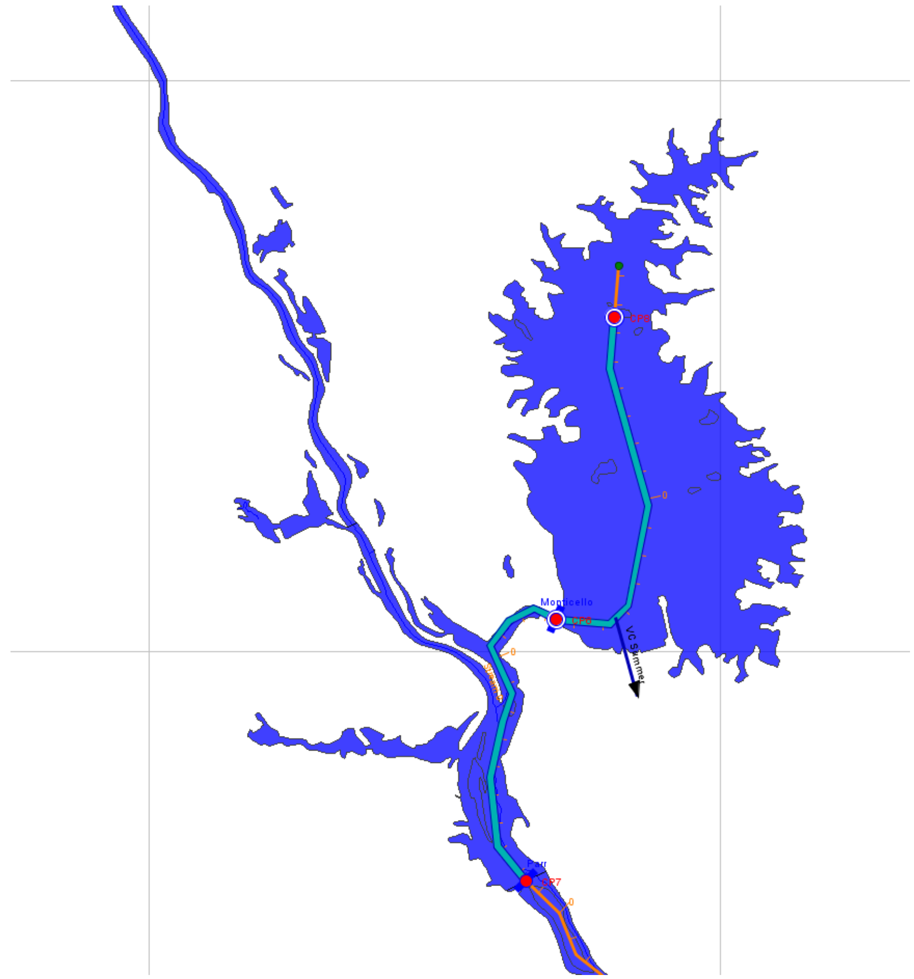
Calibration example: Site 10



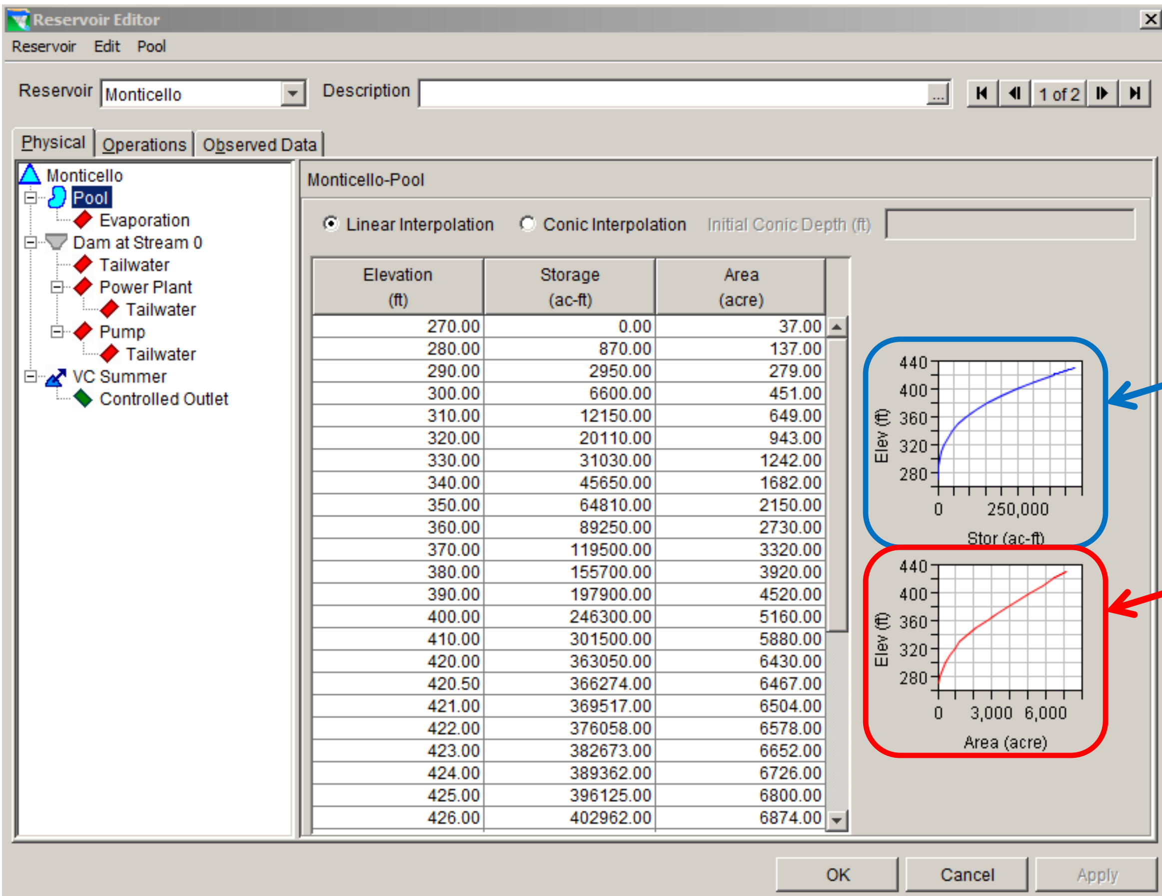
HEC-ResSim Model

<u>Data Requirements</u>:

- Static model inputs
- Temporal / time series data
- Operational Rules



Static Model Inputs



Elevation (ft)	Storage (ac-ft)	Area (acre)
270.00	0.00	37.00
280.00	870.00	137.00
290.00	2950.00	279.00
300.00	6600.00	451.00
310.00	12150.00	649.00
320.00	20110.00	943.00
330.00	31030.00	1242.00
340.00	45650.00	1682.00
350.00	64810.00	2150.00
360.00	89250.00	2730.00
370.00	119500.00	3320.00
380.00	155700.00	3920.00
390.00	197900.00	4520.00
400.00	246300.00	5160.00
410.00	301500.00	5880.00
420.00	363050.00	6430.00
420.50	366274.00	6467.00
421.00	369517.00	6504.00
422.00	376058.00	6578.00
423.00	382673.00	6652.00
424.00	389362.00	6726.00
425.00	396125.00	6800.00
426.00	402962.00	6874.00

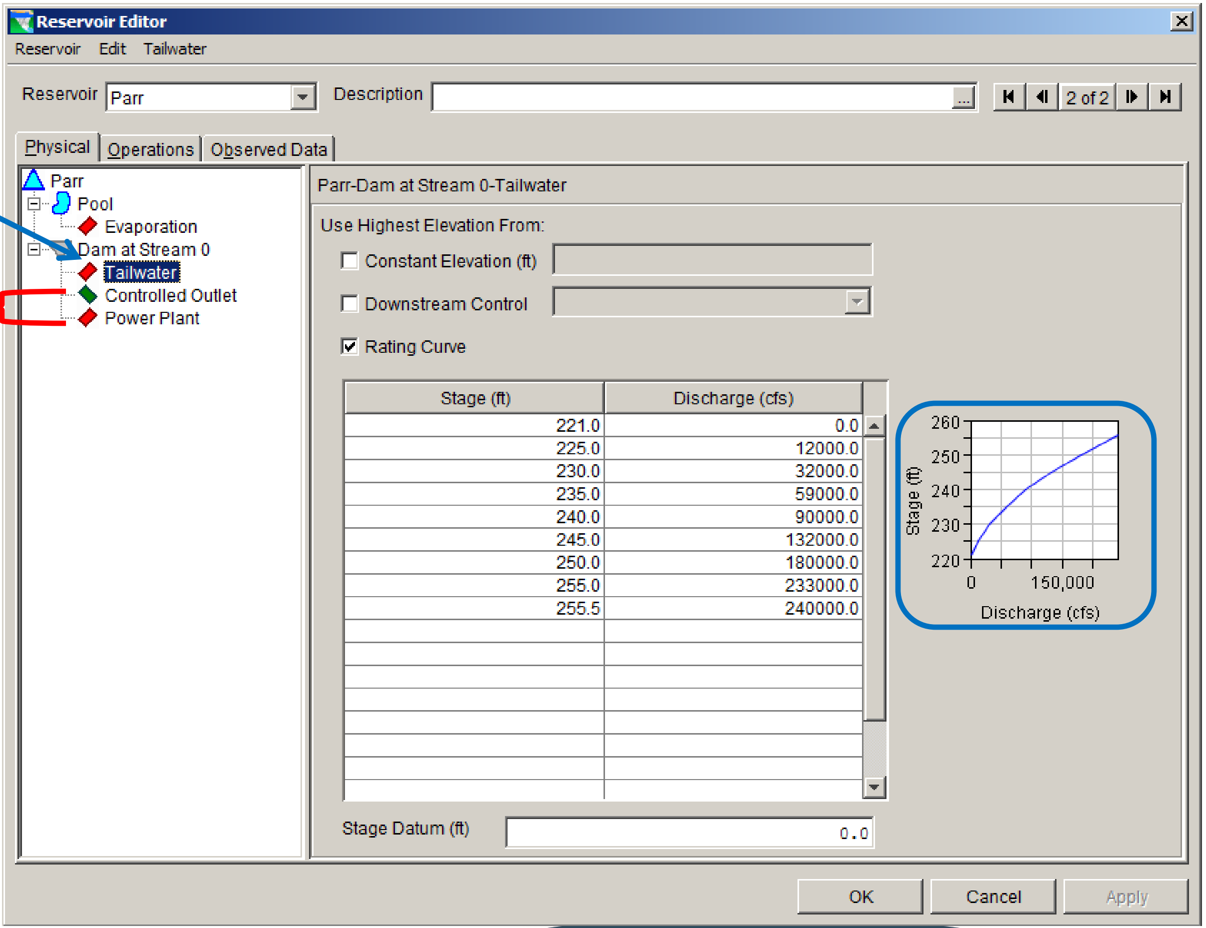
Stage vs Volume

Stage vs Area

Static Model Inputs

Tailwater rating curves

Outflow rating curves



SCE&G® A SCANA COMPANY

Kleinschmidt

Temporal Model Inputs

- Inflow Dataset
- Evaporation rates
  - losses computed as function of pan evaporation

Operational Rules

- Minimum flow
- Drought constraints
- Min / max pool levels
- Pumping Rules
- Generation constraints

Operational Rules

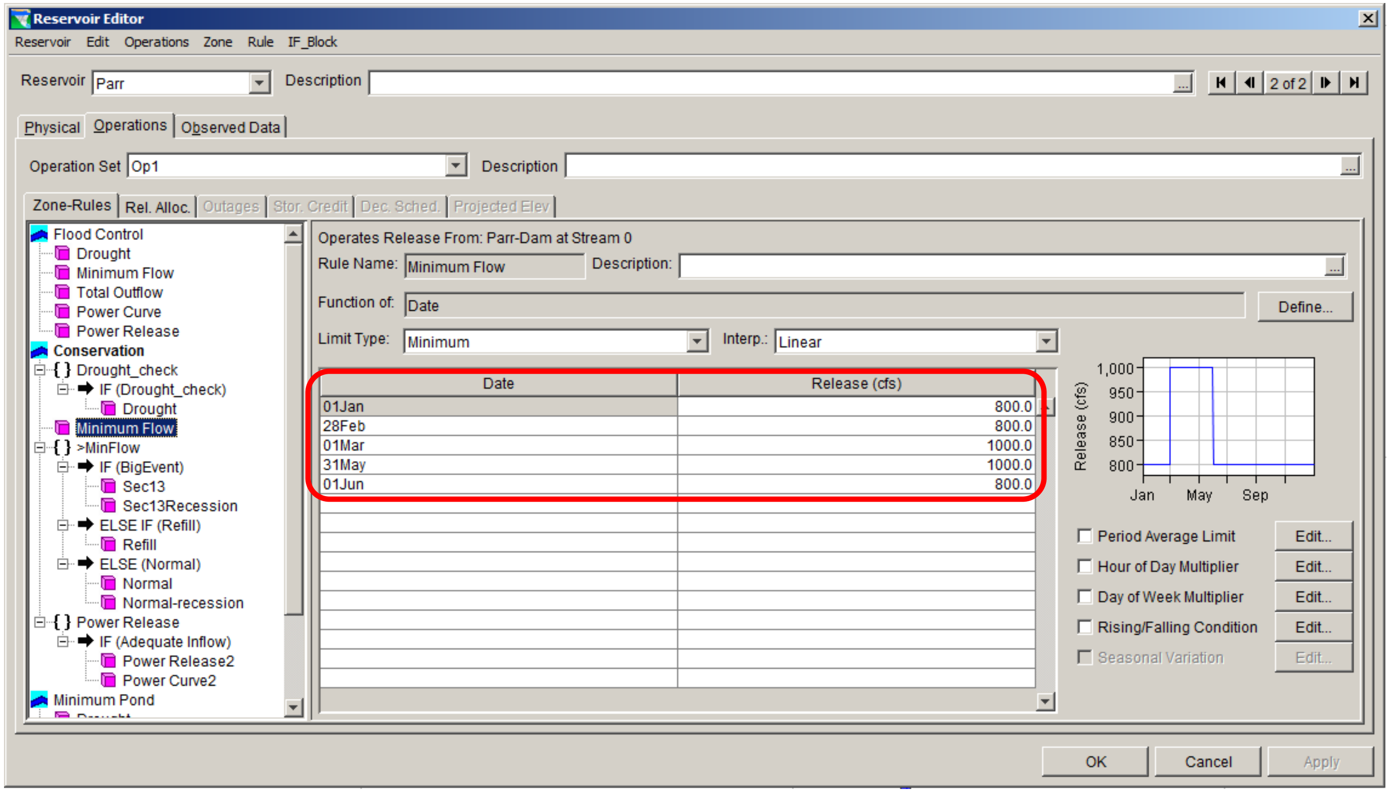
- Coded in model using if-then logic
- Constrained by variety of factors
  a. Date
  b. Inflow
  c. Reservoir level

Baseline vs. Scenario Rules

- Baseline operational rules are superseded in scenario simulations
- Prioritizations and thresholds can be adjusted

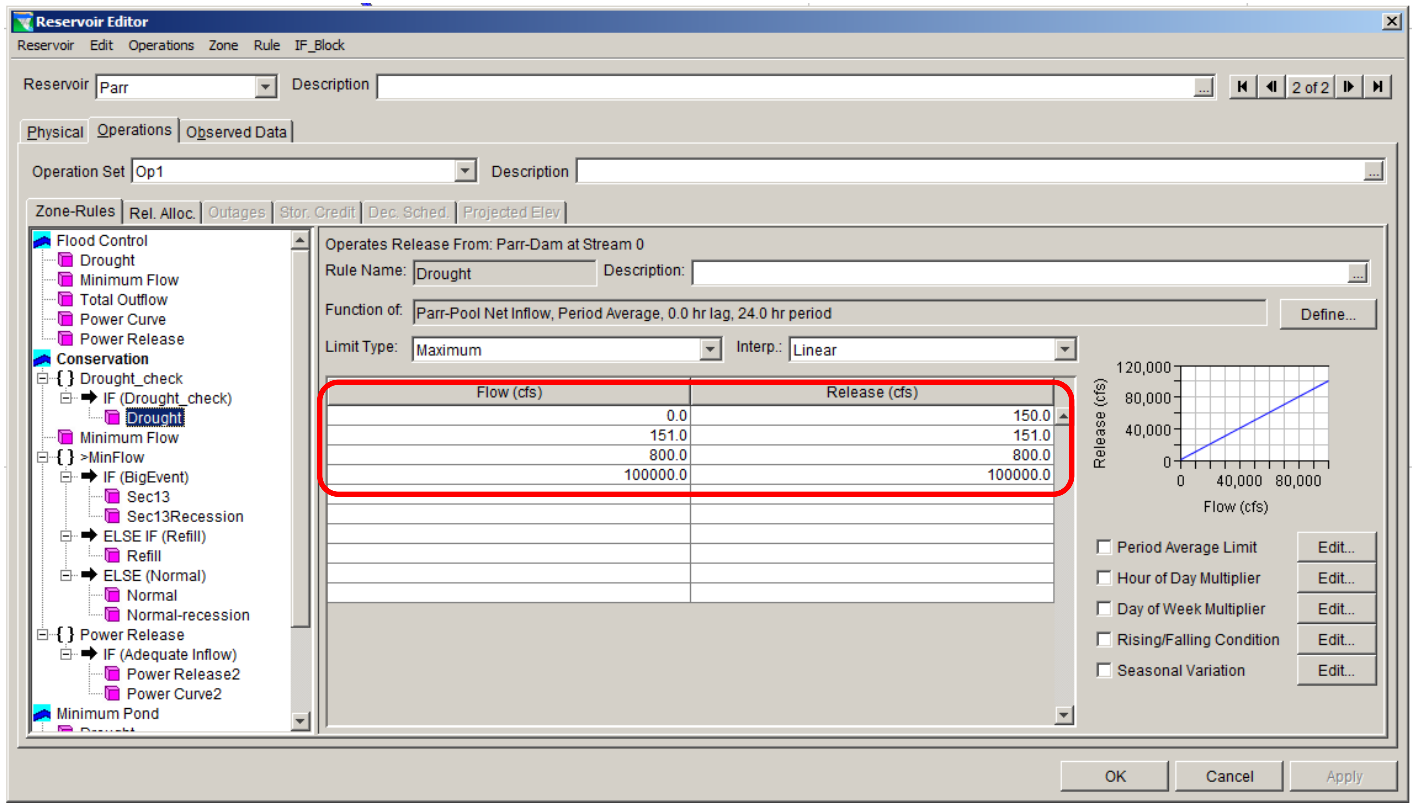
Operational Rules – Minimum Flow

Coded as function of date



Operational Rules – Drought

Coded as function of net inflow (Upstream flow minus evaporative losses)



SCE&G® A SCANA COMPANY

Kleinschmidt

Other Operational Rules

- Curtail generation at Fairfield to avoid contributing to high flow releases (> 40k cfs)
- Decrease max pond level at Parr during high inflows to prevent upstream flooding
- Pumping to Monticello during evening, Fairfield generation during day

SCE&G® A SCANA COMPANY

Kleinschmidt

Next Steps

- Finalize Baseline Model & Report (Current Project, 2014)
- Define Metrics to be Evaluated (2015)
- Develop Output Summary Format (2015)
- Final Report of Model Simulations (2016)

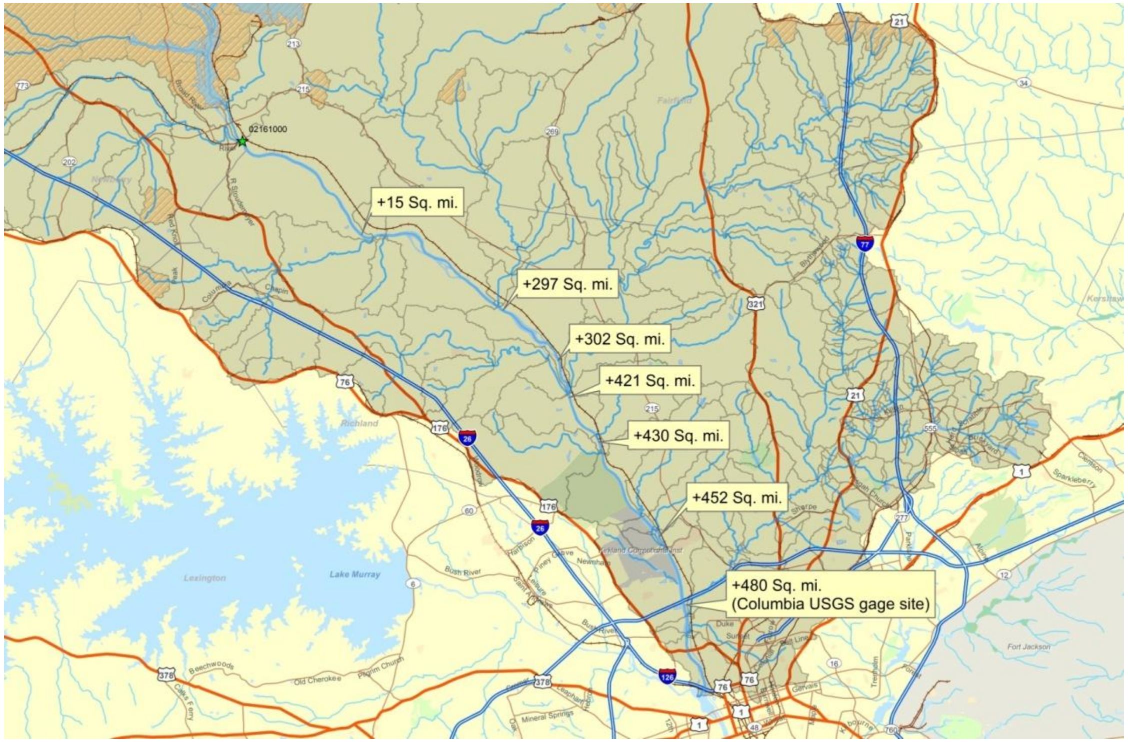
QUESTIONS?

Bruce Halverson, PE

Bruce.Halverson@KleinschmidtGroup.com

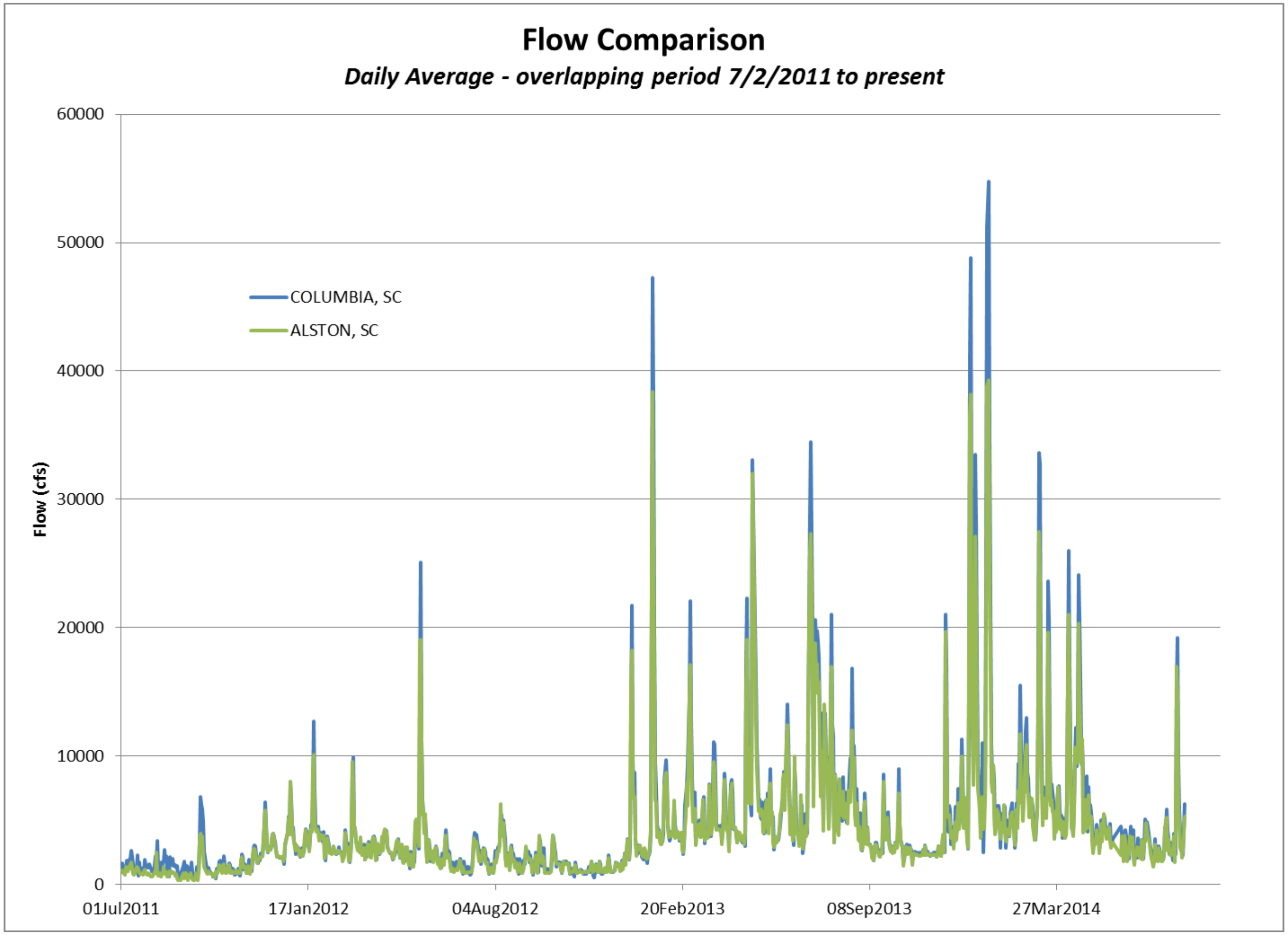
Thank you

Broad River Hydrology – Parr to Columbia



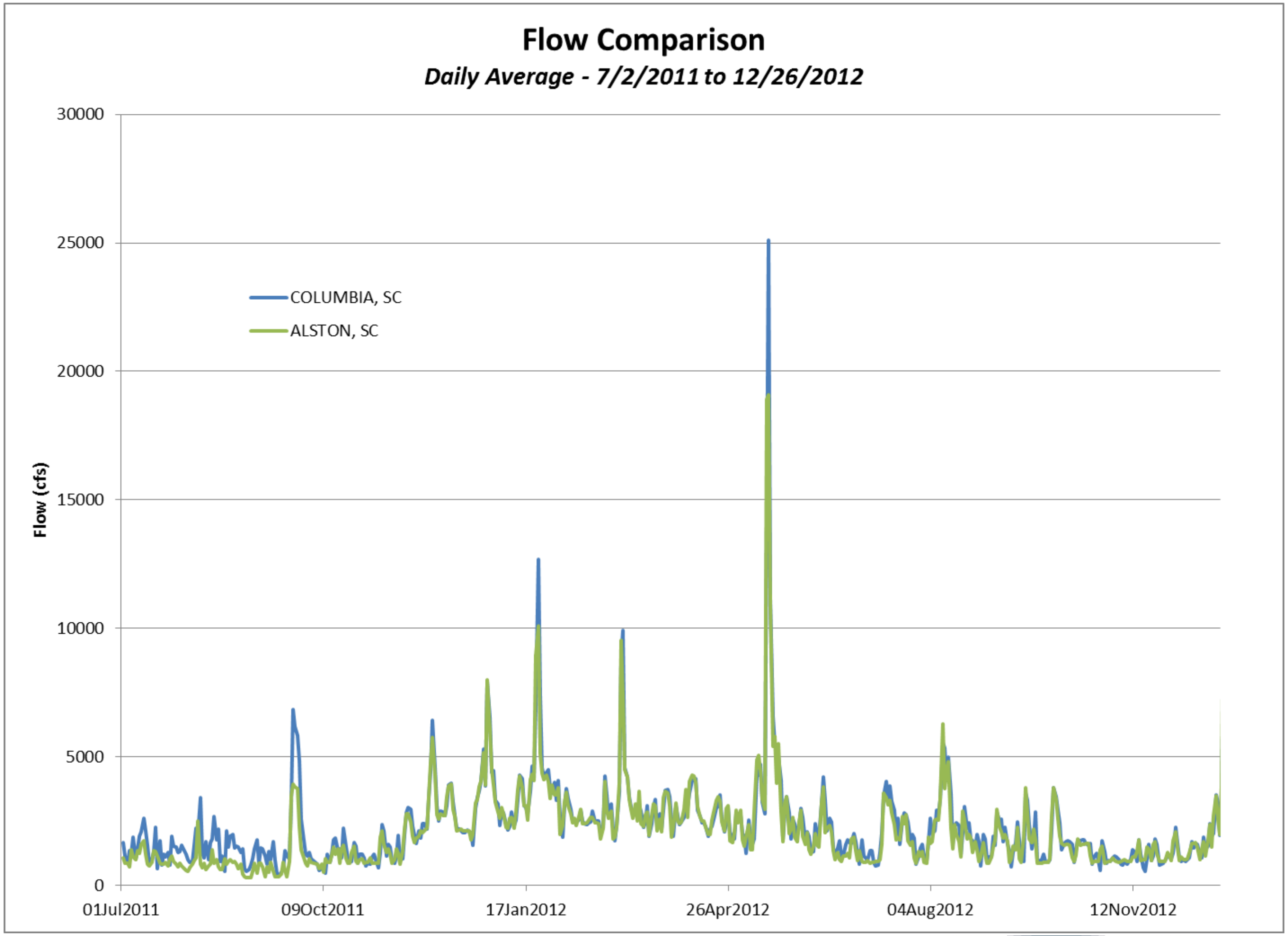
Drainage Area Comparison:

- at Parr – 4,750 sq. mi.
- at Columbia gage – 5,230 sq. mi.



SCE&G A SCANA COMPANY

Kleinschmidt



SCE&G®
A SCANA COMPANY

Kleinschmidt

Average Daily Flow Comparison*

Period	7/2/2011 to present	7/2/2011 to 12/26/2012
Alston	4,150	2,097
Columbia	4,633	2,282
Difference	483	185
% of Columbia	10.4%	8.1%
# of values	1,122	540

*Includes only days with data values from both gages

SCE&G® A SCANA COMPANY

Kleinschmidt