



Update on Safe Yield of Major Reservoirs

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Agenda Item 4b

Concepts and Purpose

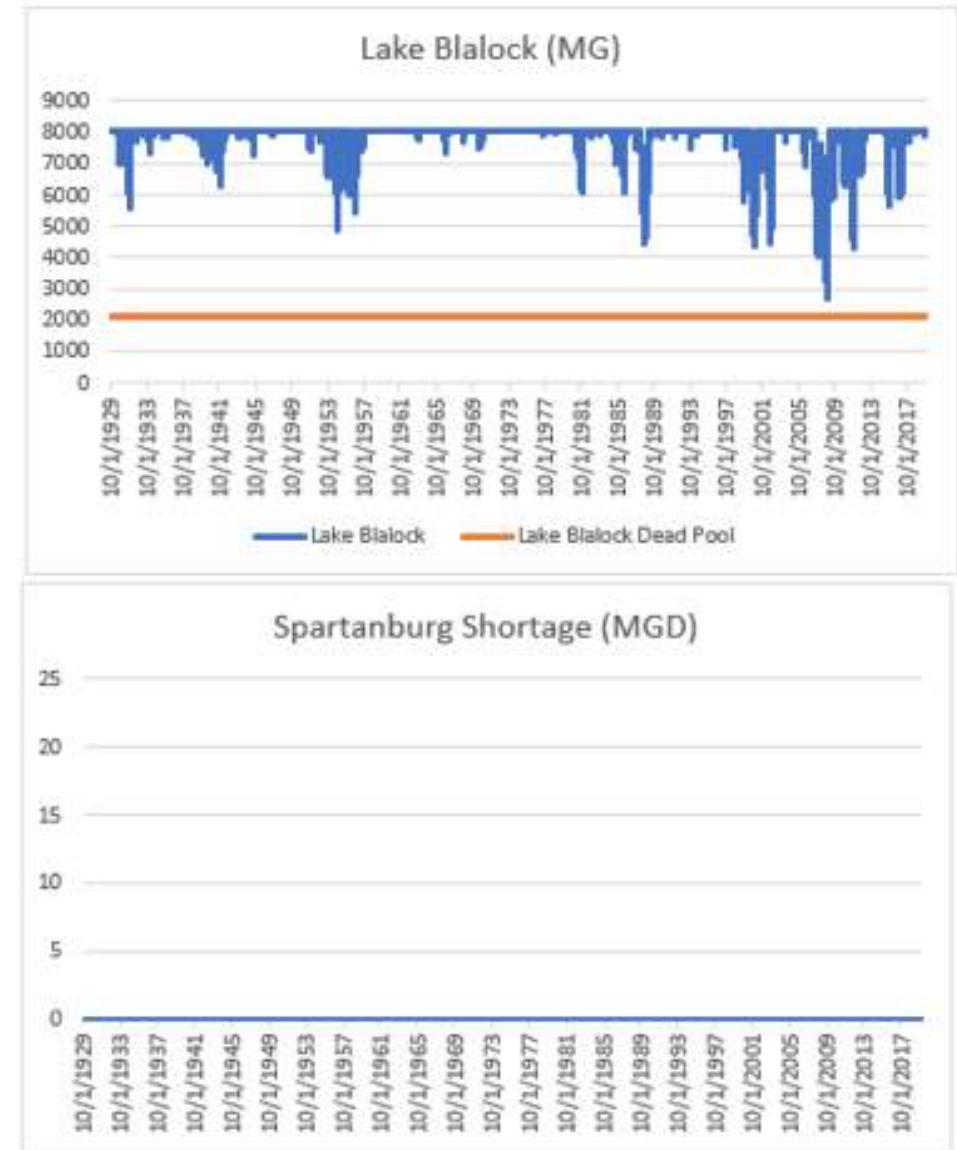
- **Safe Yield** = Maximum annual average demand that can be sustained through the period of record without depleting available storage (based on shallowest intake)
- **Reservoir Balancing:** In some cases, we can adjust rules so that reservoirs in a system draw down together at the same relative rate to avoid water in one but not others (for example)
- **Demand Assumptions:** Current / Permitted and Registered / **2070 High Demand**
- **Purpose:** Determine the amount of water that is physically/hydrologically available at a reservoir
- **Note:** Reservoir Safe Yield is DIFFERENT than basin safe yield used by SCDHEC for withdrawal permitting
 - **Reservoir Safe Yield:** Hypothetical maximum withdrawal volume used for planning
 - **Basin Safe Yield:** Statistical availability of free-flowing water in a river, used for permit evaluation

Method

- Remove permit / intake / treatment constraints at the reservoir
- Suspend target elevation rules
- Maintain downstream release rules
- Apply appropriate demand scenarios upstream
- Consolidate withdrawals from the reservoir to a single hypothetical user at the reservoir
- Gradually increase continuous annual withdrawal (with seasonality) until:
 - lowest storage over period of record = dead pool / lowest allowable level
 - No Shortages

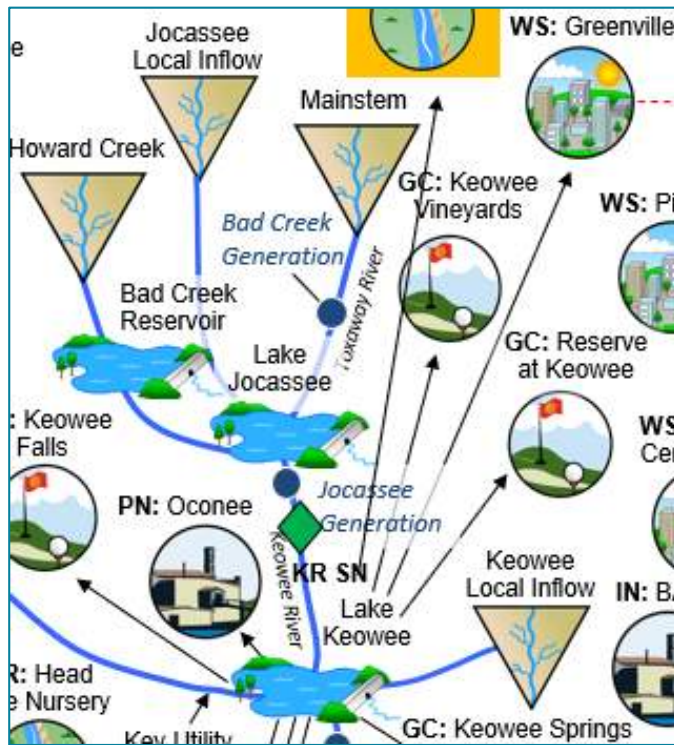
Graphs on the following slides now show lake elevations on the x-axis (not storage)

Example from Broad River Basin

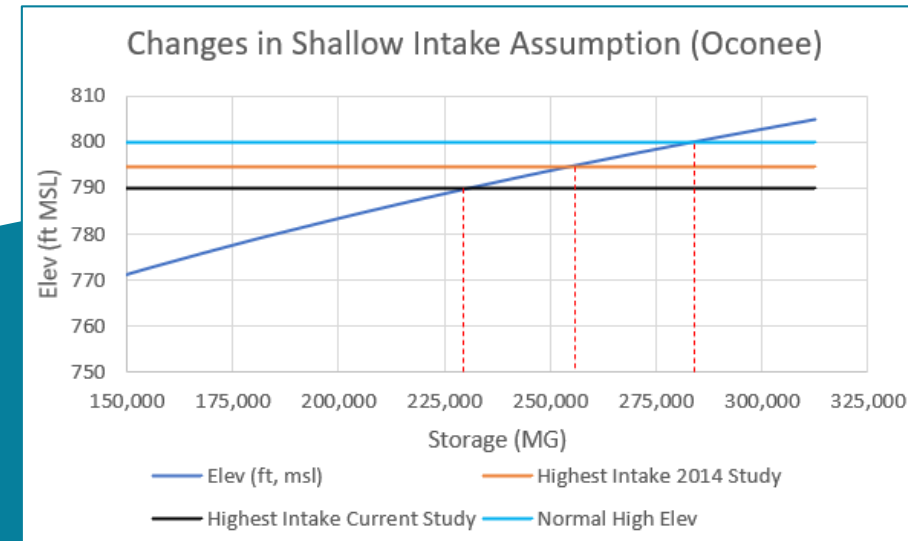


Upper Reservoirs

Bad Creek Reservoir, Lake Jocassee, Lake Keowee



- Evaluated as a system of reservoirs in series
- Yield evaluated and reported at Keowee
- Deadpool based on Oconee Power Station intake at 790 ft
- All withdrawals consolidated to Greenville to maintain seasonality
- Greenville return flow re-routed downstream of Keowee
- All other users turned off



From 2014 Study: Safe Yield <69 MGD

Intake Elevations and Prior Results

Keowee-Toxaway Water Supply Study 2014, App H.

KEOWEE DAM						
Full Pond Elevation			Full Pond	800.00	Y	Keowee elevation 790 ft AMSL is based on the lowest boat ramp elevation of 787 ft AMSL plus 3 ft for boat access (provided by Duke Energy).
Critical Boat Access Levels			Public Access	790.00	Y	
Critical Swimming Access Levels			Public Access	N/A	Y	
Greenville Water System	Witty Atkins WTP	Lake	Intake	770.00	Y	
City of Seneca	Seneca City WTP	Lake	Intake	775.00	Y	
Duke Energy Corporation	Oconee Nuclear Station	Lake	Intake	794.60	Y	
Hydro Operations			Hydro	775.00	Y	

Keowee-Toxaway Water Supply Study 2014, App H.

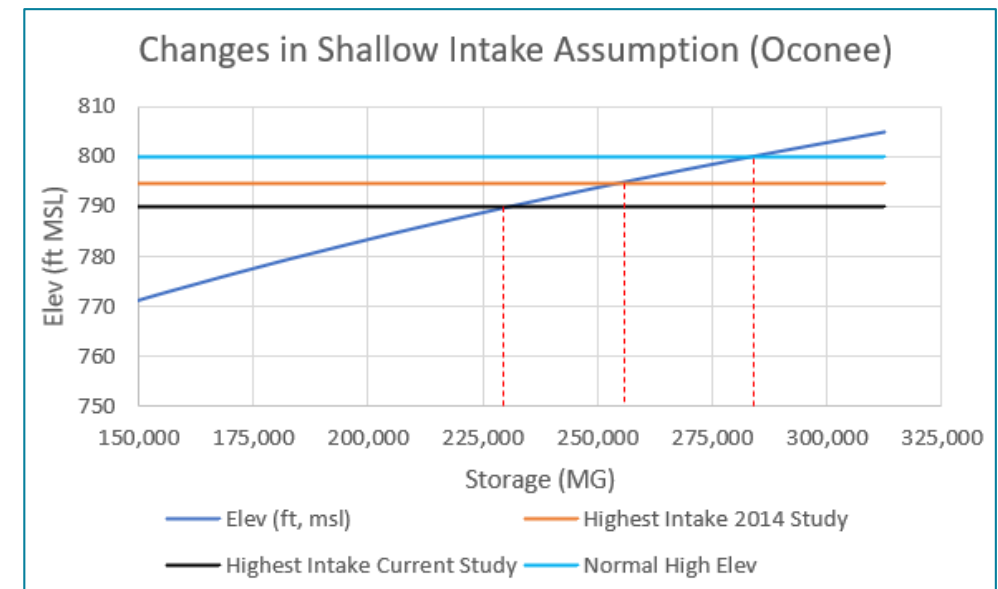
Table ES.2 Water Yield Evaluation – Critical Intake Constraint Summary

Reservoir	Projected Range of Water Yield Values (mgd) [Corresponding Water Use Projection Decade]	
	Baseline	Blend2Dbv2 Operating Scenario
Licensee Reservoirs ¹	<69 [<Base Year]	>160 [>2066]
Hartwell	24-38 [Base Year-2016]	<24 [<Base Year]
Russell	>10 [>2066]	>10 [>2066]
Thurmond	>53 [>2066]	>53 [>2066]

Notes:

¹ Combined Bad Creek, Jocassee, and Keowee Reservoirs, includes only a small net withdrawal from Bad Creek and Jocassee subbasins for agriculture/irrigation use projections.

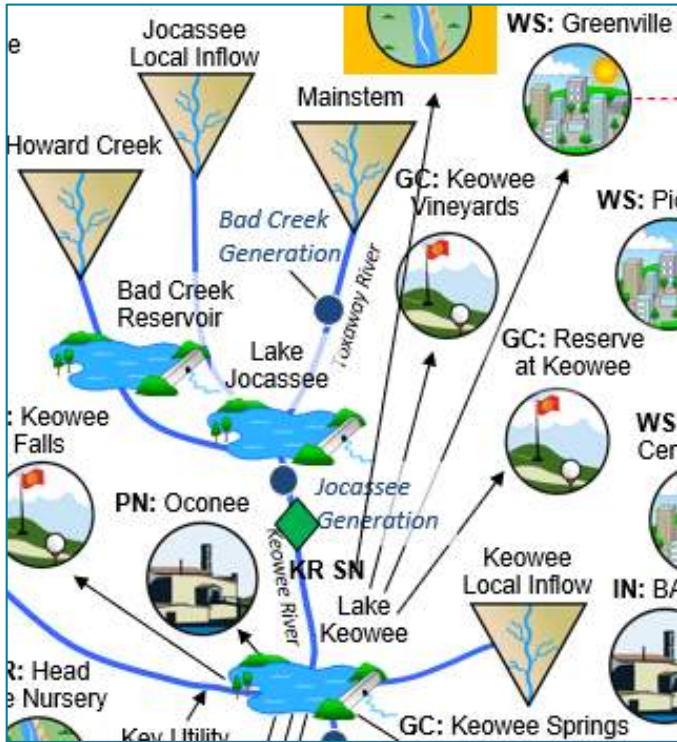
Oconee intake elevation has changed from 794.6 ft to 790 ft since this study



From 2014 Study: Safe Yield 69 - >160 MGD

Lake Keowee – Baseline

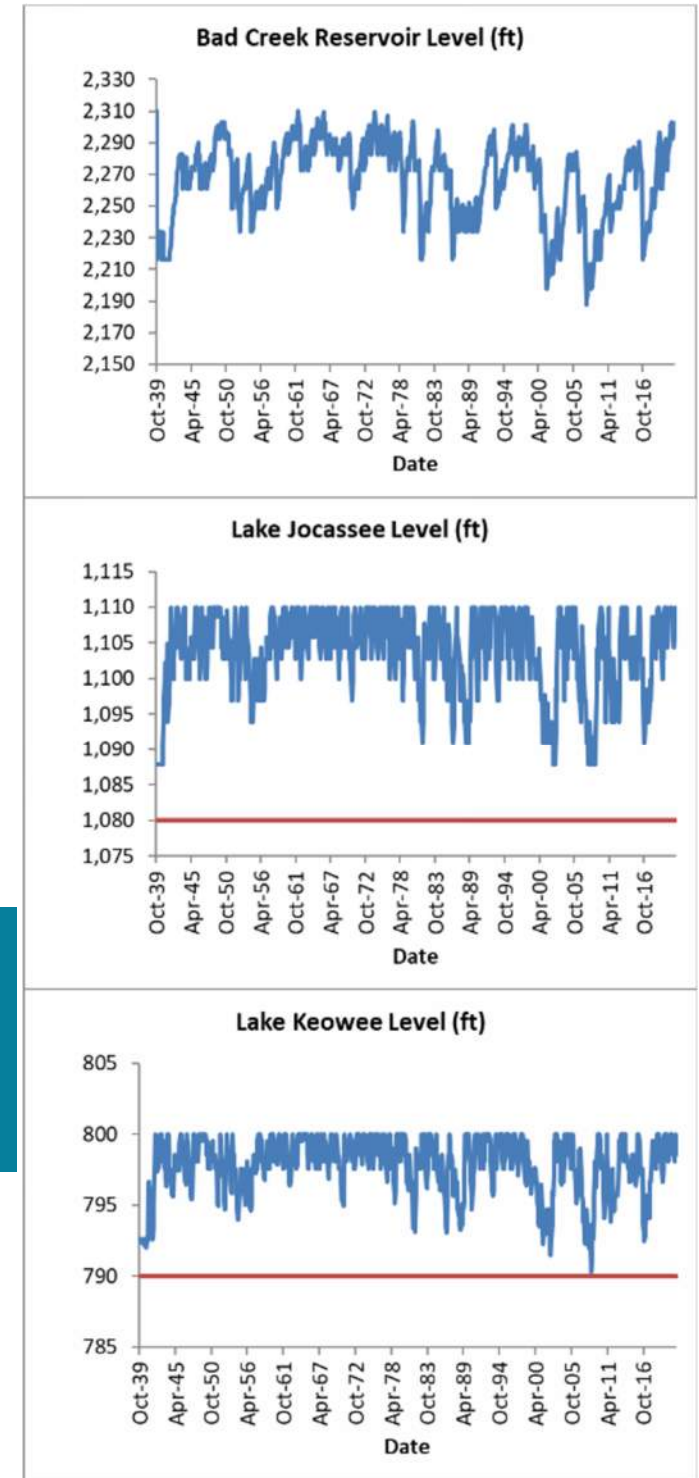
(as a system with Bad Creek and Jocassee)



Keowee Safe Yield:
 Baseline (Shown): 276 MGD
 2070 HD: 271 MGD
 Permitted and Registered: 235 MGD

Operating Rule Adjustments:

- Bad Creek: No operating changes
- Jocassee: No operating changes
- Keowee: Restricted to max elevation of 800 ft.



Lower USACE Reservoirs

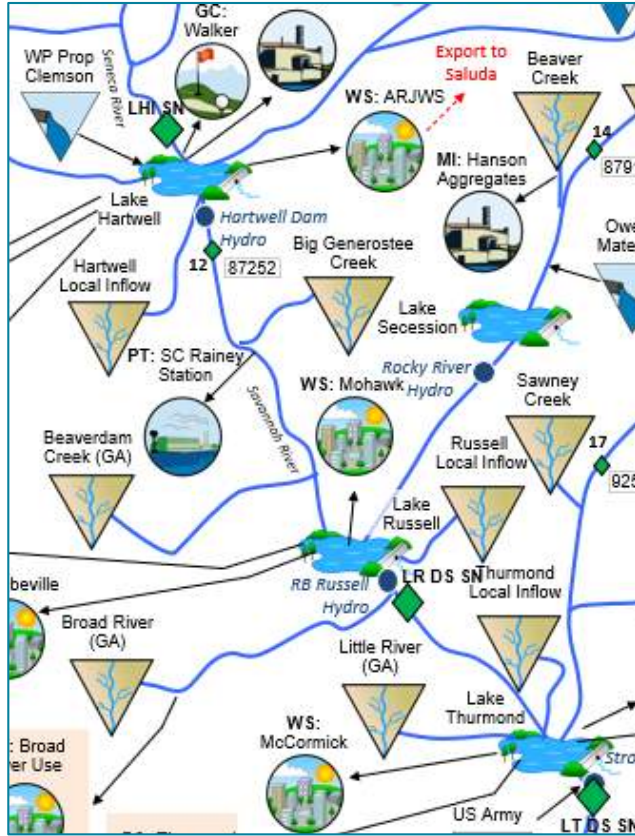
Lakes Hartwell, Russell, and Thurmond



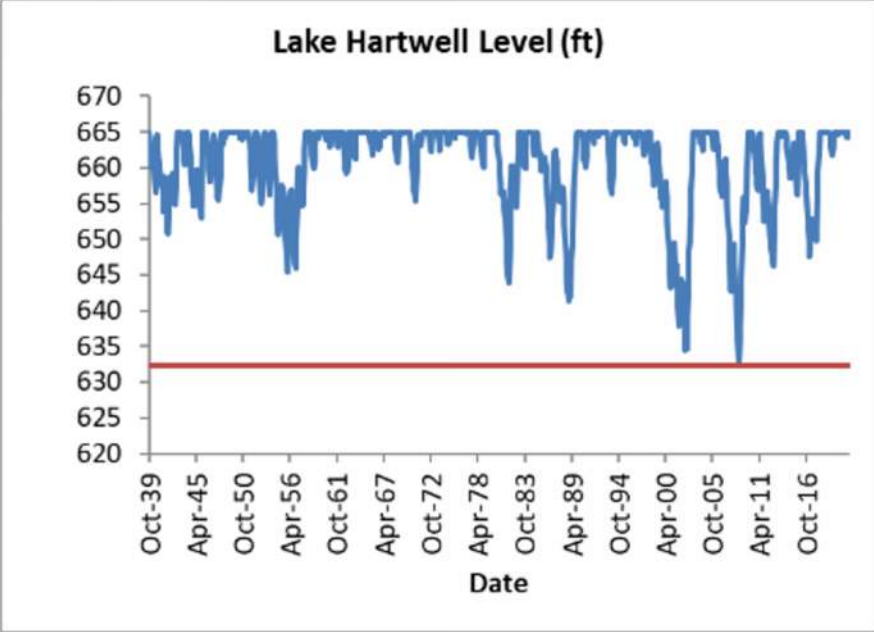
- Evaluated Individually
- Intake: highest critical intake
- Upstream rules unchanged
- Downstream rules unchanged
- Guide curves for Reservoir being tested suspended but downstream releases maintained
- Restricted the Reservoir being tested from going above the top of the flood pool

Lake Hartwell

Intake based on **WS: Pioneer (632.37 ft)***



Hartwell Safe Yield:
 Baseline (Shown): 687 MGD
 2070 HD: 567 MGD
 Permitted and Registered: 484 MGD



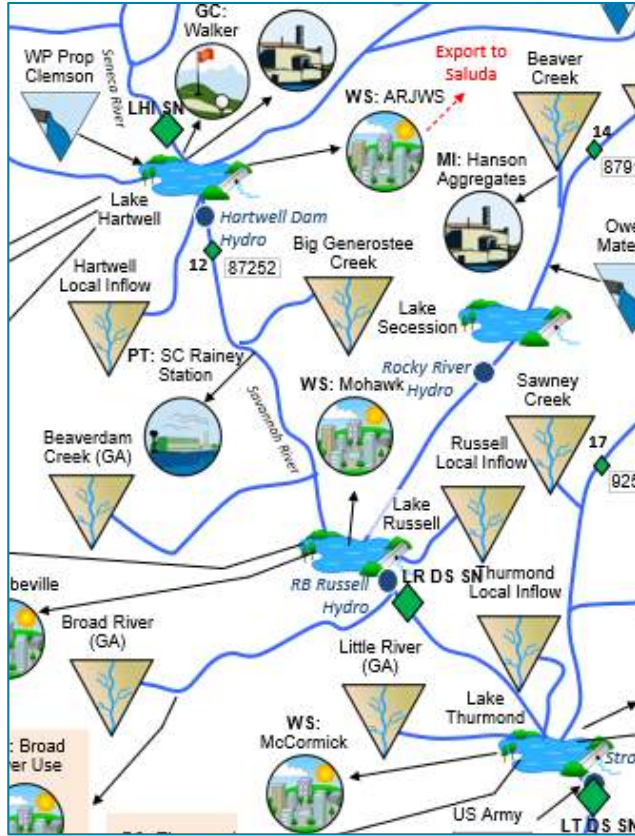
* Pioneer Rural Water District's intake is higher than the hydro operations limit of 625 ft used in the safe yield analysis presented previously.

Keowee-Toxaway Water Supply Study 2014, App H.

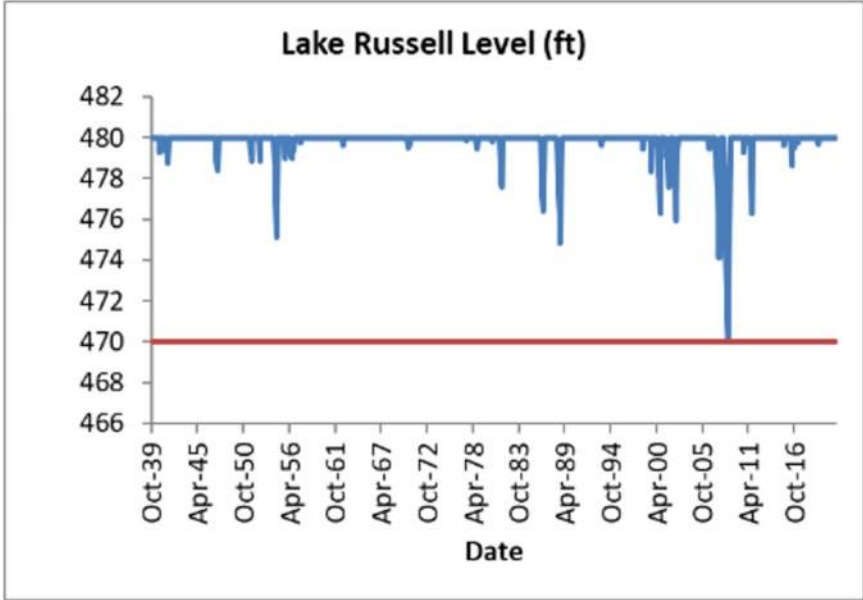
HARTWELL DAM ⁵					
Full Pond Elevation		Full Pond	660.00	Y	
Critical Boat Access Levels⁶		Public Access	652.00	Y	
Critical Swimming Access Levels		Public Access	654.00	Y	Level at which all USACE operated designated swimming areas are dry.
Anderson Regional Joint Water System	Hartwell Lake Filter Plant	Lake	Intake	615.00	Y
City of Hartwell	Hartwell WTP	Lake	Intake	612.00	Y
City of Lavonia	N/A	Lake	Intake	636.00	Y
Milliken & Company	Pendleton Finishing Plant	Lake	Intake	611.00	Y
J.P. Stevens	Westpoint Stevens Plant	Lake	Intake	610.00	Y
Clemson University	Central Energy Facility	Lake	Intake	638.00	Y
Clemson University Agriculture ⁷	Musser Fruit Farm	Lake	Intake	645.00	Y
Clemson Golf Course ⁸	Walker Golf Course	Lake	Intake	633.00	Y
					Can obtain water from City of Seneca if intake exposed, therefore not a critical intake
Hydro Operations		Hydro	625.00	Y	

Lake Russell

Intake based on Hydro Ops (470 ft)



Russell Safe Yield:
 Baseline (Shown): 1,750 MGD
 2070 HD: 1,709 MGD
 Permitted and Registered: 1,649 MGD



Keowee-Toxaway Water Supply Study 2014, App H.

RUSSELL DAM ⁶					
Full Pond Elevation		Full Pond	475.00	Y	
Critical Boat Access Levels ⁴		Public Access	466.00	Y	
Critical Swimming Access Levels		Public Access	N/A	Y	There are no USACE operated designated swimming areas on this reservoir.
City of Abbeville	Abbeville City WTP	Lake Intake	457.50	Y	
City of Elberton	Elberton WTP	Lake Intake	465.00	Y	
Town of Calhoun Falls ⁴	Calhoun Falls WTP	Lake Intake	457.00	Y	
Mohawk Industries, Inc.	Rocky River Plant	Lake Intake	464.75	Y	Highest intake elevation of 3
Santee Cooper	John Rainey Generating Station	Lake Intake	460.50	Y	
RBR State Park ³	RBR Golf Course	Lake Intake	468.80	Y	
Hydro Operations		Hydro	470.00	Y	