Saluda Hydro Proposed Guide Curve & Low Inflow Protocol

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Topics

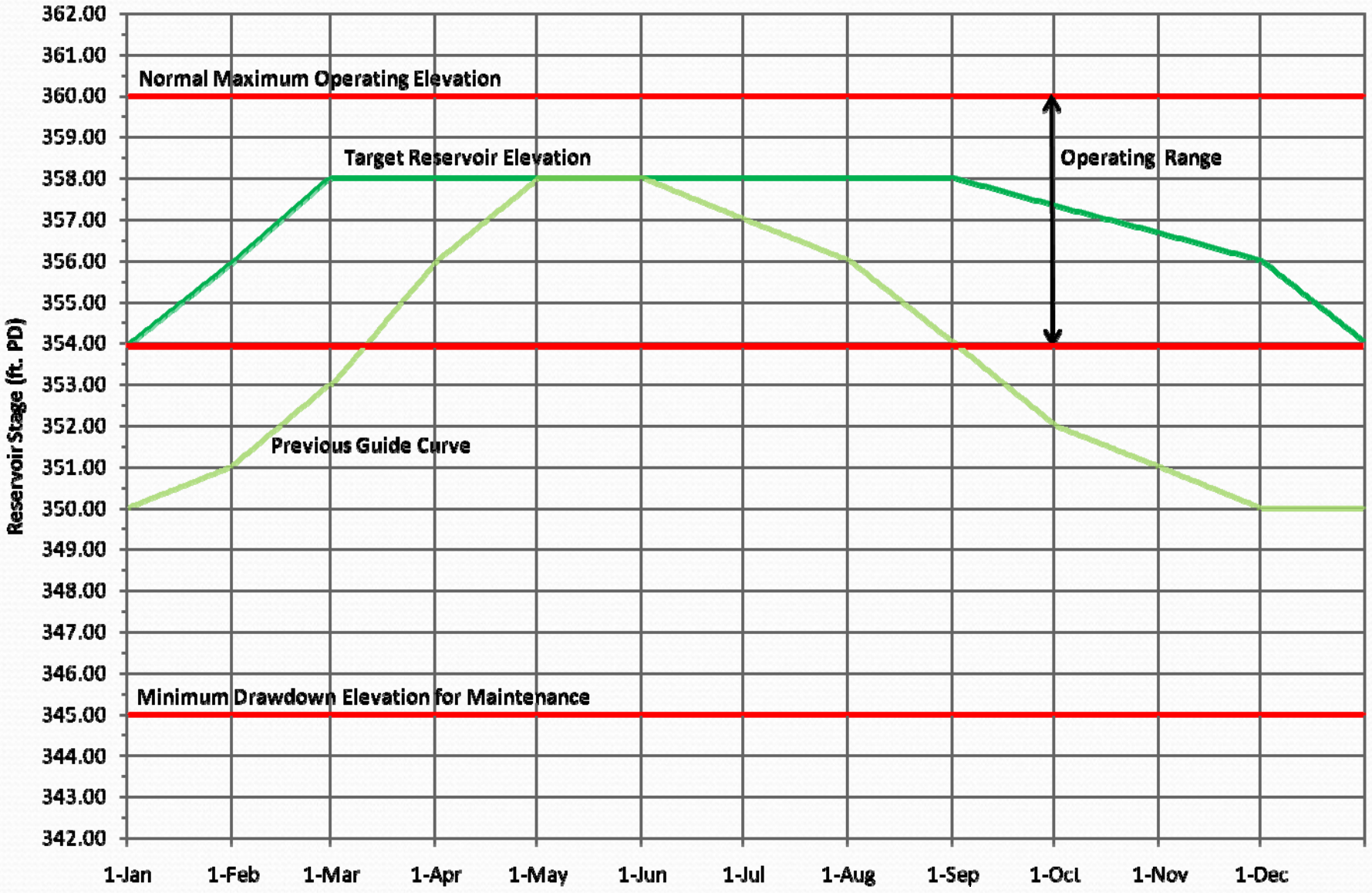
- Proposed Reservoir Guide Curve for Saluda Hydro
  - Purpose & Definitions
- Proposed Low Inflow Protocol for Saluda Hydro
  - Purpose
  - Definitions
  - How it works

Proposed Reservoir Guide Curve

Purpose

- To provide a set of target reservoir elevations which guides SCE&G's operation of the reservoir throughout the year.
- Not intended as a "rule curve" – provides an operating range between el. 354.0 ft. PD and el 360.0 ft. PD to provide flexibility under various operating conditions.
- Normal maximum reservoir elevation of 358.0 ft. PD.
- Minimum reservoir elevation of 345.0 ft. PD for maintenance activities.

Saluda Hydro Proposed Guide Curve



Saluda Hydro Proposed Guide Curve Table

	January	February	March	April	May	June	July	August	September	October	November	December
1	354.00	356.00	358.00	358.00	358.00	358.00	358.00	358.00	358.00	357.33	356.67	356.00
2	354.06	356.07	358.00	358.00	358.00	358.00	358.00	358.00	357.98	357.31	356.65	355.94
3	354.13	356.14	358.00	358.00	358.00	358.00	358.00	358.00	357.96	357.29	356.63	355.87
4	354.19	356.21	358.00	358.00	358.00	358.00	358.00	358.00	357.93	357.27	356.60	355.81
5	354.26	356.29	358.00	358.00	358.00	358.00	358.00	358.00	357.91	357.24	356.58	355.74
6	354.32	356.36	358.00	358.00	358.00	358.00	358.00	358.00	357.89	357.22	356.56	355.68
7	354.39	356.43	358.00	358.00	358.00	358.00	358.00	358.00	357.87	357.20	356.54	355.61
8	354.45	356.50	358.00	358.00	358.00	358.00	358.00	358.00	357.84	357.18	356.51	355.55
9	354.52	356.57	358.00	358.00	358.00	358.00	358.00	358.00	357.82	357.16	356.49	355.48
10	354.58	356.64	358.00	358.00	358.00	358.00	358.00	358.00	357.80	357.14	356.47	355.42
11	354.65	356.71	358.00	358.00	358.00	358.00	358.00	358.00	357.78	357.12	356.45	355.35
12	354.71	356.79	358.00	358.00	358.00	358.00	358.00	358.00	357.75	357.10	356.42	355.29
13	354.77	356.86	358.00	358.00	358.00	358.00	358.00	358.00	357.73	357.07	356.40	355.23
14	354.84	356.93	358.00	358.00	358.00	358.00	358.00	358.00	357.71	357.05	356.38	355.16
15	354.90	357.00	358.00	358.00	358.00	358.00	358.00	358.00	357.69	357.03	356.36	355.10
16	354.97	357.07	358.00	358.00	358.00	358.00	358.00	358.00	357.67	357.01	356.34	355.03
17	355.03	357.14	358.00	358.00	358.00	358.00	358.00	358.00	357.64	356.99	356.31	354.97
18	355.10	357.21	358.00	358.00	358.00	358.00	358.00	358.00	357.62	356.97	356.29	354.90
19	355.16	357.29	358.00	358.00	358.00	358.00	358.00	358.00	357.60	356.95	356.27	354.84
20	355.23	357.36	358.00	358.00	358.00	358.00	358.00	358.00	357.58	356.93	356.25	354.77
21	355.29	357.43	358.00	358.00	358.00	358.00	358.00	358.00	357.55	356.90	356.22	354.71
22	355.35	357.50	358.00	358.00	358.00	358.00	358.00	358.00	357.53	356.88	356.20	354.65
23	355.42	357.57	358.00	358.00	358.00	358.00	358.00	358.00	357.51	356.86	356.18	354.58
24	355.48	357.64	358.00	358.00	358.00	358.00	358.00	358.00	357.49	356.84	356.16	354.52
25	355.55	357.71	358.00	358.00	358.00	358.00	358.00	358.00	357.46	356.82	356.13	354.45
26	355.61	357.79	358.00	358.00	358.00	358.00	358.00	358.00	357.44	356.80	356.11	354.39
27	355.68	357.86	358.00	358.00	358.00	358.00	358.00	358.00	357.42	356.78	356.09	354.32
28	355.74	357.93	358.00	358.00	358.00	358.00	358.00	358.00	357.40	356.76	356.07	354.26
29	355.81	357.93	358.00	358.00	358.00	358.00	358.00	358.00	357.37	356.73	356.04	354.19
30	355.87		358.00	358.00	358.00	358.00	358.00	358.00	357.35	356.71	356.02	354.13
31	355.94		358.00		358.00		358.00	358.00		356.69		354.06

Proposed Reservoir Guide Curve

- SCE&G will strive to operate within the operating range under “normal” conditions.
- Reservoir may be above or below target elevation (guide curve) at a given time, based on actual or forecast inflow, system reserve requirements, minimum flow and scheduled releases, etc.
- Maintenance activities or low inflow conditions may require operation outside the operating range.
- Plant may be available for reserve operations whenever reservoir is above el. 345.0 PD.

Proposed Low Inflow Protocol

Purpose

- To allow staged reductions in minimum flow and other releases during periods of drought and low inflows to the reservoir.
- Conserves storage in the reservoir to delay the reservoir reaching el. 345.0 ft. PD, which is the critical elevation for most municipal water intakes on Lake Murray, and is the license minimum for SCE&G.
- “Shares the pain” of drought conditions between upstream and downstream interests, and preserves a critical level of flow downstream.

Proposed Low Inflow Protocol

L.I.P. Definitions

- "Usable Storage" - the storage available between el. 345.0 Plant Datum (PD) and el. 360.0 PD, which equals about 635,000 acre-feet.
- "Remaining Usable Storage" (RUS) – the water in storage in acre-feet above el. 345.0 PD remaining at any given time.
- "Target Usable Storage" (TUS) – the storage value in acre-feet above el. 345.0 corresponding to the target reservoir elevation for any given day of the year.
  - For example, on February 1, the target reservoir elevation is 356.0 ft. PD, and the TUS is 442,383 ac-ft.

Proposed Low Inflow Protocol

L.I.P. Definitions (cont'd.)

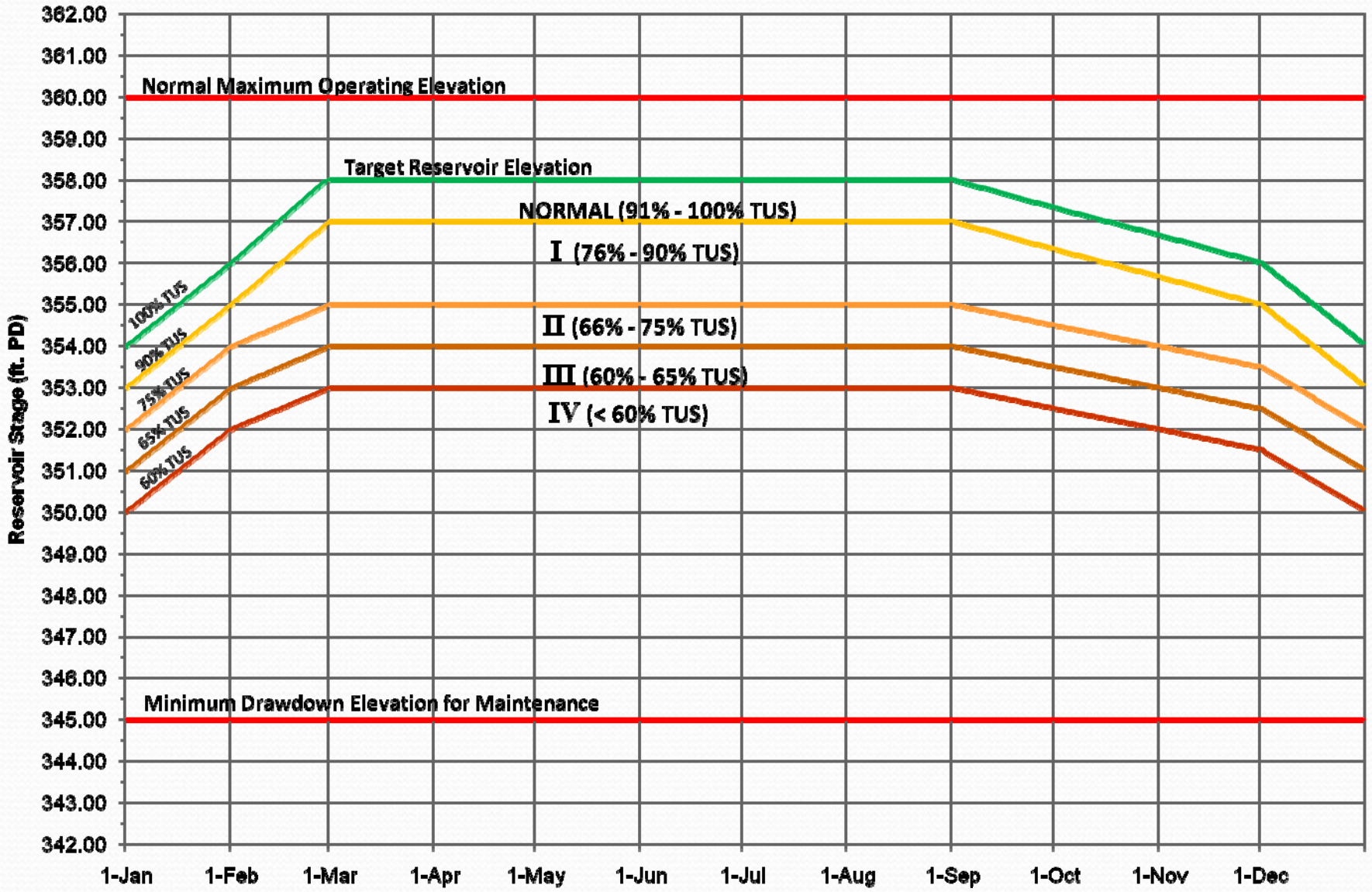
- "Percent TUS" – the ratio of Remaining Usable Storage (RUS) to Target Usable Storage (TUS) at a given time, expressed as a percentage.
  - Example – On March 22, the actual reservoir elevation is 356.80 ft. PD, which gives RUS value of 479,414 ac-ft. The target reservoir elevation for that day is 358.0 ft. PD, and the TUS is 536,341 ac-ft. The % TUS is (479,414/536,341) x 100% = **89.4%**.

Proposed Low Inflow Protocol

L.I.P. Overview

- Four L.I.P stages (I – IV) based on:
  - Percent TUS – primary index
  - U. S. Drought Monitor value for Saluda River Basin upstream of Lake Murray.
  - USGS 28 day percentile rank for three gauge stations:
    - Saluda River at Chappells, USGS No. 02167000
    - Little River near Silverstreet, USGS No. 02167450
    - Bush River near Prosperity, USGS No. 02167582

Saluda Hydro Proposed Guide Curve with L.I.P. Trigger Bands



Monthly Reservoir Operation Targets and Low Inflow Protocol Trigger Levels

Month	Target Stage (ft. PD)	Target Usable Storage TUS (ac-ft)	90% TUS Stage	75% TUS Stage	65% TUS Stage	60% TUS Stage
January 1st	354.0	352,925	353.0	352.0	351.0	350.0
February 1st	356.0	442,383	355.0	354.0	353.0	352.0
March 1st	358.0	536,341	357.0	355.0	354.0	353.0
April 1st	358.0	536,341	357.0	355.0	354.0	353.0
May 1st	358.0	536,341	357.0	355.0	354.0	353.0
June 1st	358.0	536,341	357.0	355.0	354.0	353.0
July 1st	358.0	536,341	357.0	355.0	354.0	353.0
August 1st	358.0	536,341	357.0	355.0	354.0	353.0
September 1st	358.0	536,341	357.0	355.0	354.0	353.0
October 1st	357.3	504,350	356.3	354.5	353.5	352.5
November 1st	356.7	473,347	355.7	354.0	353.0	352.0
December 1st	356.0	442,383	355.0	353.5	352.5	351.5

U. S. Drought Monitor Value

Return to U.S. Drought Monitor Return to Region

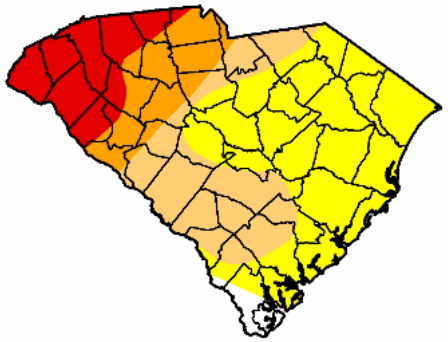
The data cutoff for Drought Monitor maps is Tuesday at 7 a.m. Eastern Standard Time. The maps, which are based on analysis of the data, are released each Thursday at 8:30 a.m. Eastern Time.

U.S. Drought Monitor
South Carolina

May 13, 2008
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	2.2	97.8	51.9	28.3	15.2	0.0
Last Week (05/06/2008 map)	2.2	97.8	51.9	28.3	14.3	0.0
3 Months Ago (02/19/2008 map)	0.2	99.8	92.8	67.4	40.1	15.7
Start of Calendar Year (01/01/2008 map)	1.0	99.0	95.3	76.5	41.9	19.5
Start of Water Year (10/02/2007 map)	9.9	90.1	82.0	65.6	42.7	18.3
One Year Ago (05/15/2007 map)	0.0	100.0	31.7	1.7	0.0	0.0



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements

http://drought.unl.edu/dm

Released Thursday, May 15, 2008
Author: Michael James, JAWF/CPC/NOAA

For a .pdf version of the South Carolina Drought Monitor, click here.

To view tabular statistics for South Carolina, click here.

For more information on the Drought Impact Reporter click here.

For local details and impacts, please contact your State Climatologist or Regional Climate Center.

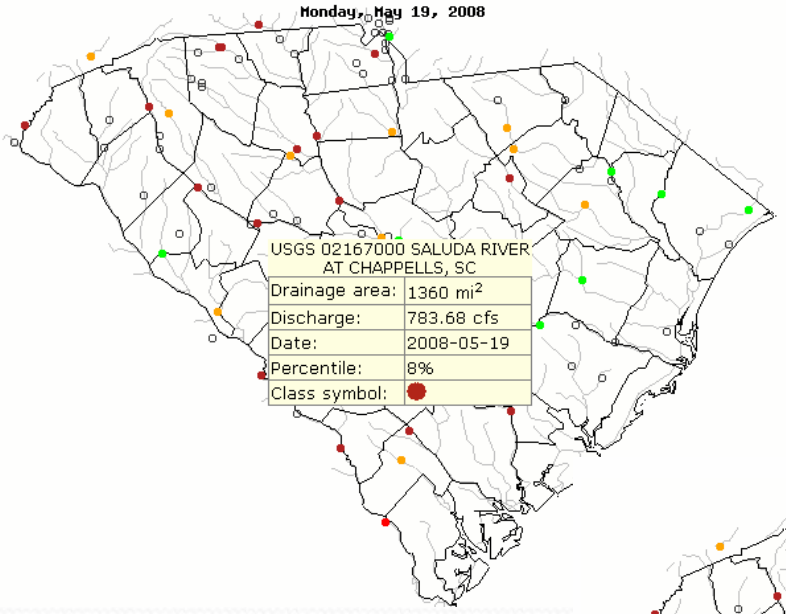
None (SC “Normal”)
D0 Abnormally Dry (SC “Incipient”)
D1 Moderate
D2 Severe
D3 Extreme

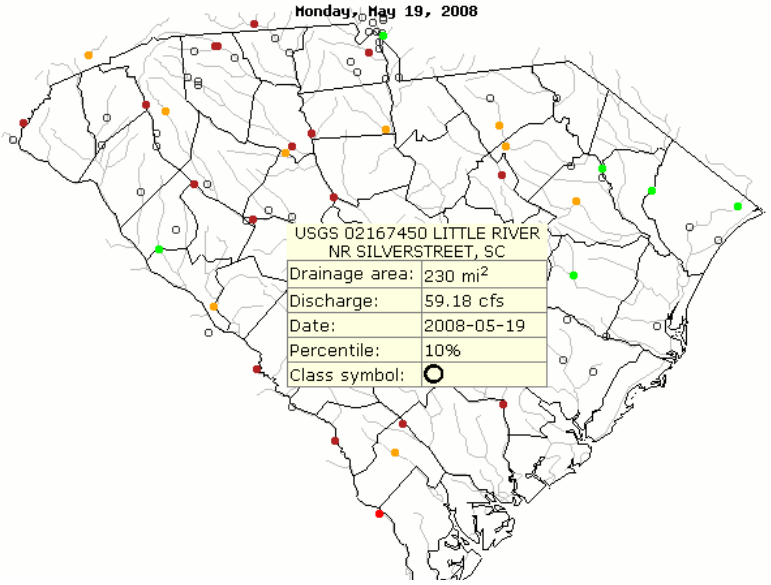
USDM “D4 Exceptional” is not used in the Saluda L.I.P.

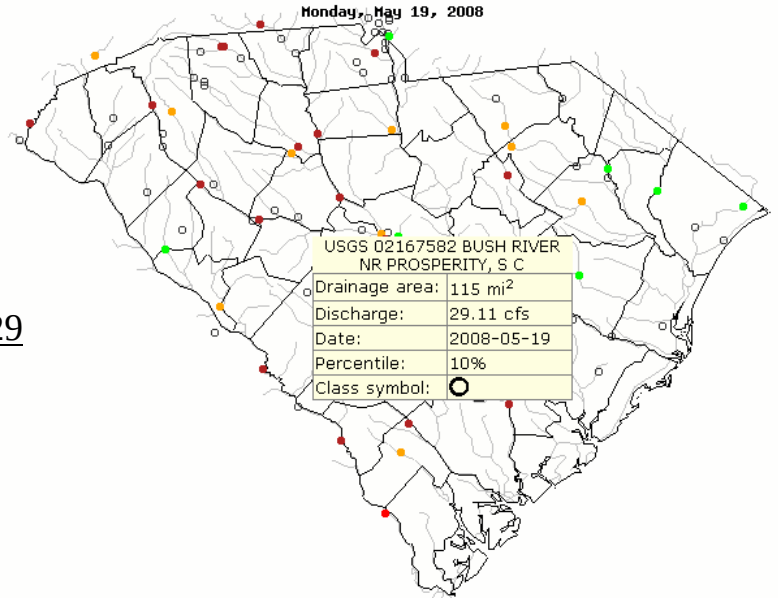
Highest USDM Value in effect in the Saluda River basin upstream of Lake Murray will be used as the L.I.P. trigger index.

USGS Percentile Rank Example

Map of 28-day average streamflow compared to historical streamflow for the day of the year (South Carolina)







Weighted Percentile Rank for 3 Gauges:

$$\frac{(8\% \times 784\ \text{CFS} + 10\% \times 59\ \text{CFS} + 10\% \times 29\ \text{CFS})}{(784+59+29)}$$

= **8.2%**

Proposed Low Inflow Protocol Trigger Points & Actions

LIP Stage	Percent Target Usable Storage[1]		U.S. Drought Monitor Value[2]		USGS 28 Day Streamflow Percentile[3]	Minimum Flows	Recreation Flow Reductions
Normal	90% TUS < RUS ≤ 100% TUS	**AND**	None	**AND**	≥ 25%	4/1 - 4/14: 1,000 CFS 4/15 - 5/14: 1,300 CFS 5/15 - 5/31: 1,000 CFS Rest of Year: 700 CFS	None
I	75% TUS < RUS ≤ 90% TUS	**AND**	D0	**OR**	15% - 24%	4/1 - 4/14: 700 CFS 4/15 - 5/14: 1,300 CFS 5/15 - 5/31: 700 CFS Rest of Year: 600 CFS	To Be Determined
II	65% TUS < RUS ≤ 75% TUS	**AND**	D1	**OR**	10% - 14%	4/1 - 4/14: 700 CFS 4/15 - 5/14: 700 CFS, pulse to 1,300 CFS 5/15 - 5/31: 700 CFS Rest of Year: 500 CFS	To Be Determined
III	60% TUS < RUS ≤ 65% TUS	**AND**	D2	**OR**	5% - 9%	4/1 - 4/14: 400 CFS 4/15 - 5/14: 400 CFS, pulse to 700 CFS 5/15 - 5/31: 400 CFS Rest of Year: 400 CFS	To Be Determined
IV	RUS ≤ 60% TUS	**AND**	≥ D3	**OR**	< 5%	4/1 - 4/14: 400 CFS 4/15 - 5/14: 400 CFS 5/15 - 5/31: 400 CFS Rest of Year: 400 CFS	To Be Determined

[1] "Percent Target Usable Storage" (%TUS) is the ratio of Remaining Usable Storage (RUS) to Target Usable Storage (TUS) expressed as a percentage.

[2] The highest U.S. Drought Monitor value (D0 – D3) in any part of the Saluda River Basin upstream of Lake Murray.

[3] Weighted average percentile rank of the USGS 28 Day Average Streamflows at Saluda R. (Chappells), Little R. (Silverstreet), and Bush R. (Prosperity) gage sites.

Proposed Low Inflow Protocol

L.I.P. Summary

- L.I.P. triggers require below target storage and one of the other two indices meet criteria for a given stage to trigger that stage.
- This means that flow reductions will not be triggered until remaining storage falls to below 91% of target level, even if inflow drops or drought conditions begin in the basin.
- Shares benefits of reservoir upstream/downstream by using some storage to maintain minimum flows, then reducing flows to conserve remaining storage.

Proposed Low Inflow Protocol

L.I.P. Summary – Drought Recovery

- During a recovery from a drought, all three L.I.P. triggers must meet criteria for the previous stage before returning to that stage.
- This keeps flow reductions in effect to allow storage to be replenished as inflow increases.

Proposed Low Inflow Protocol

L.I.P. Current Year Example

- Started 2008 in Stage II, reservoir at el. 352.62 ft. PD, USDM D4, USGS percentile < 10%.
- Currently, reservoir elevation is 358.7, target elevation is 358.0 (would not have occurred with proposed minimum flows).
- TUS is 536,341 ac-ft, RUS is 570,363, %TUS is 106%.
- U. S. Drought Monitor value for Saluda Basin above Lake Murray is D3, corresponding to L.I.P. Stage IV.
- Flow weighted USGS 28 day percentile rank for the three gauge stations is 8%, corresponding to L.I.P. Stage III.

- **Since we started the year in Stage II, and USDM and USGS indices have not recovered to Stage I or Normal, we would still be in Stage II, even with current above target reservoir storage value.**

Proposed Low Inflow Protocol

L.I.P. Example – Later in The Summer?

- If USDM value stays at D3, and flow weighted USGS 28 day percentile rank for the three gauge stations stays below 10%, then if target elevation is 358.0 ft. PD:
- **L.I.P. Stage II in effect → Min. flow reduced to 500 CFS.**
- **L.I.P. Stage III would be triggered when reservoir drops to below el. 354.0 → Min. flow reduced to 400 CFS.**
- **L.I.P. Stage IV would be triggered when reservoir drops to below el. 353.0 → Min. flow 400 CFS.**

Proposed Low Inflow Protocol

Next Steps for L.I.P.

- Evaluate L.I.P. operation using historical drought status and USGS flows – does it track other indices well, or does it lead or lag them?
- Develop a Maintenance/Emergency Protocol to deal with deliberate reservoir drawdowns – needs to coordinate with L.I.P. to allow reservoir to refill.
- Continue to work with RCGs to determine/finalize flow reduction schedule during low inflow periods.

Questions?

Saluda Dam Reservoir Operations Model

May, 2008

Jonathan Quebbeman, P.E.
Kleinschmidt Associates

Kleinschmidt
Energy & Water Resource Consultants

Saluda HYDRO RELICENSING

Mission Statement

"…establish a baseline of current hydrologic, hydraulic and operational conditions, and aid in analyzing and understanding the upstream and downstream effects of potential changes to project operation…."

Saluda HYDRO RELICENSING

Operations Model Process

1) Determine Historic Inflow to Lake Murray
2) Develop Proposed Operating Conditions
    1) Guide Curves
        1) Flood Stage Curve
        2) Annual Target Guide Curve
        3) Conservation Curves
        4) Inactive Pool Curve
    2) Flow Requirements
        1) Reserve Calls
        2) Minimum Flows
        3) Recreational Releases
        4) Others
3) Run the Model / Tabulate Results!

Saluda HYDRO RELICENSING

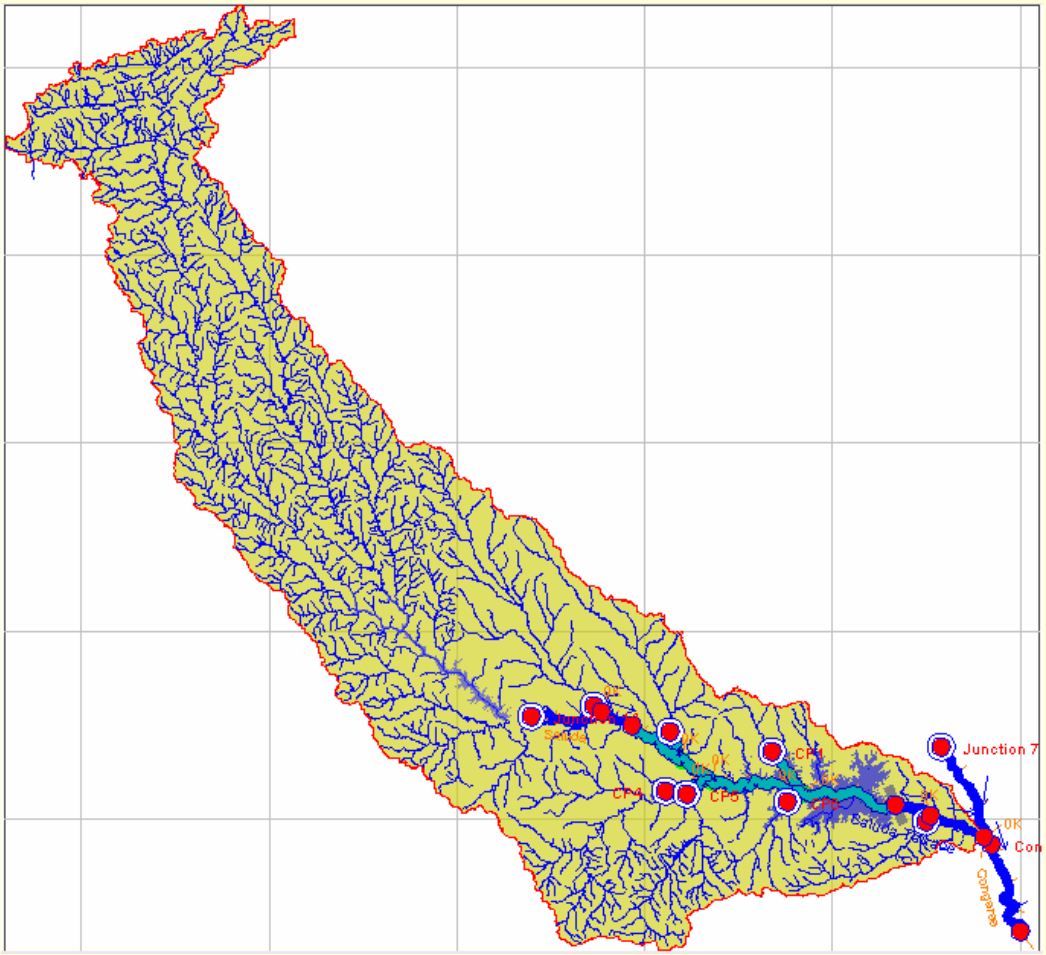
Operations Model

- Publicly available Army Corp of Engineers software (HEC-ResSim)
- Specifically created for reservoir modeling and management
- Flexibility in managing large datasets
- Rule based decisions on daily timesteps
- Application of seasonal rules
- Ability to prioritize rules
- Use If/Then Statements

US Army Corps of Engineers

Saluda HYDRO RELICENSING

Model Layout



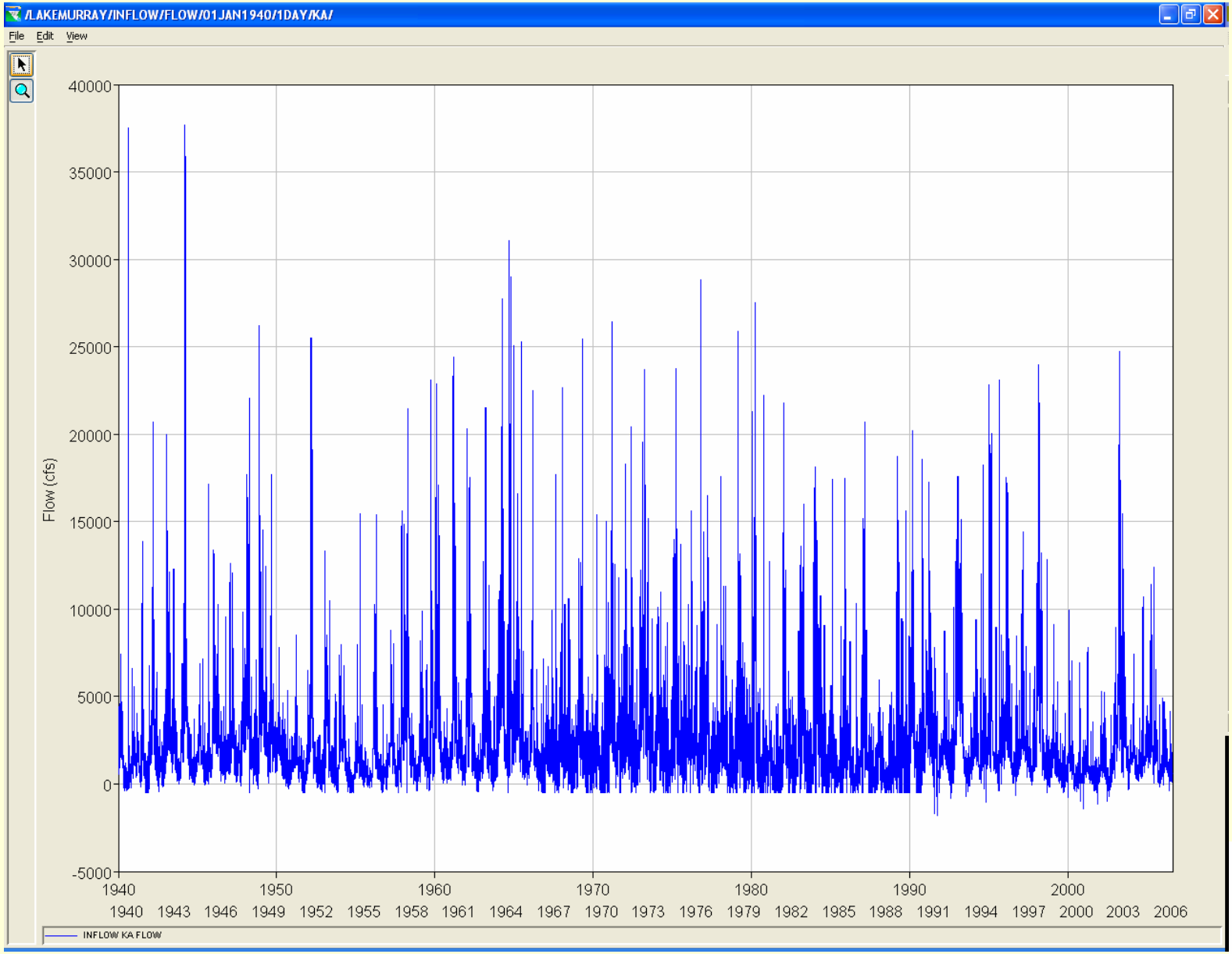
Saluda HYDRO RELICENSING

Inflow Hydrograph

- Two Methods Tested for Developing Inflow Data:
  - 1) Upstream Gage Rating
    - Utilize available USGS gage data and adjust for ungaged areas
  - 2) Mass Balance
    - Hindcast from outflow and lake level data historical lake level data

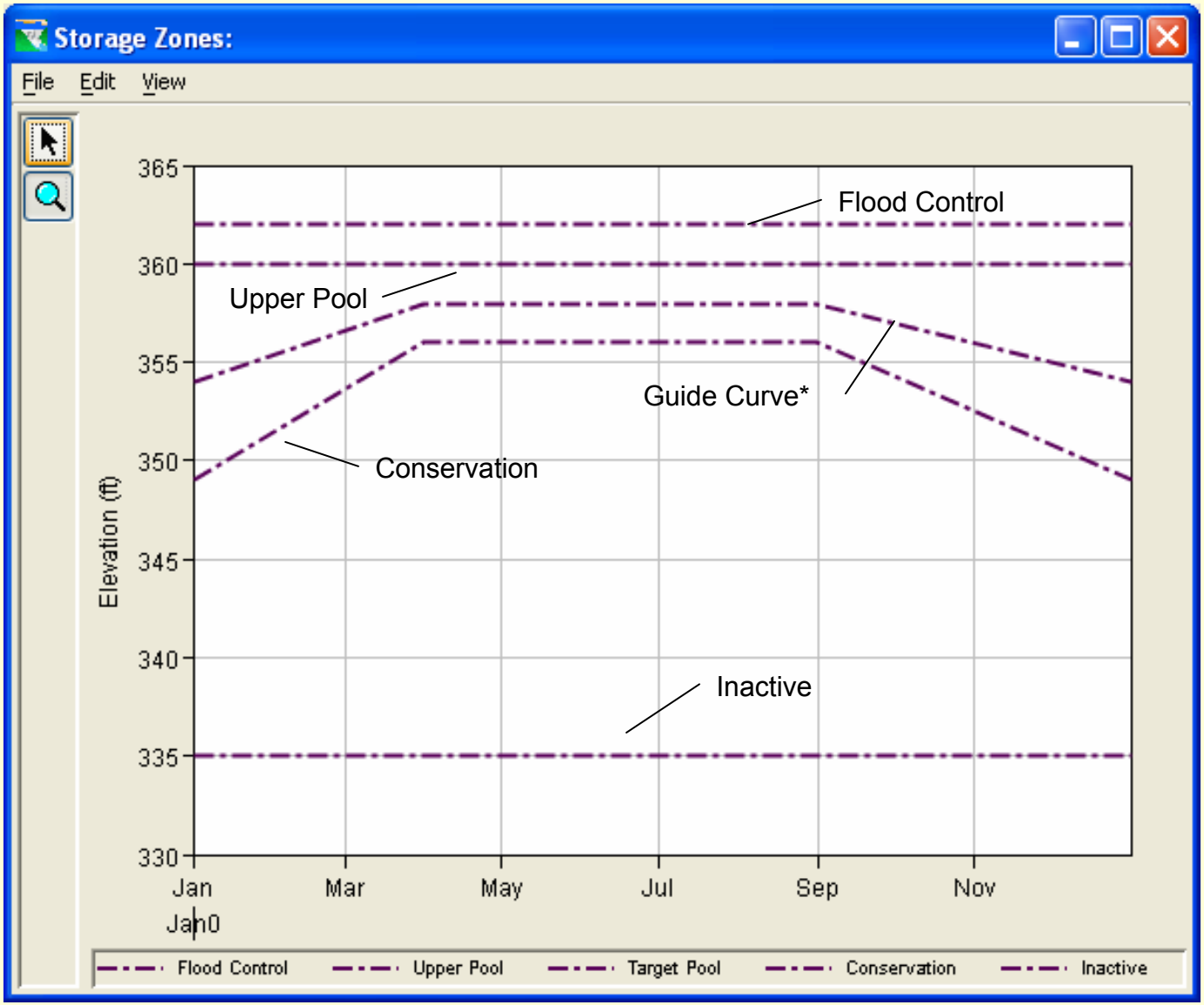
Saluda HYDRO RELICENSING

Saluda Reservoir Inflow Hydrograph



Saluda HYDRO RELICENSING

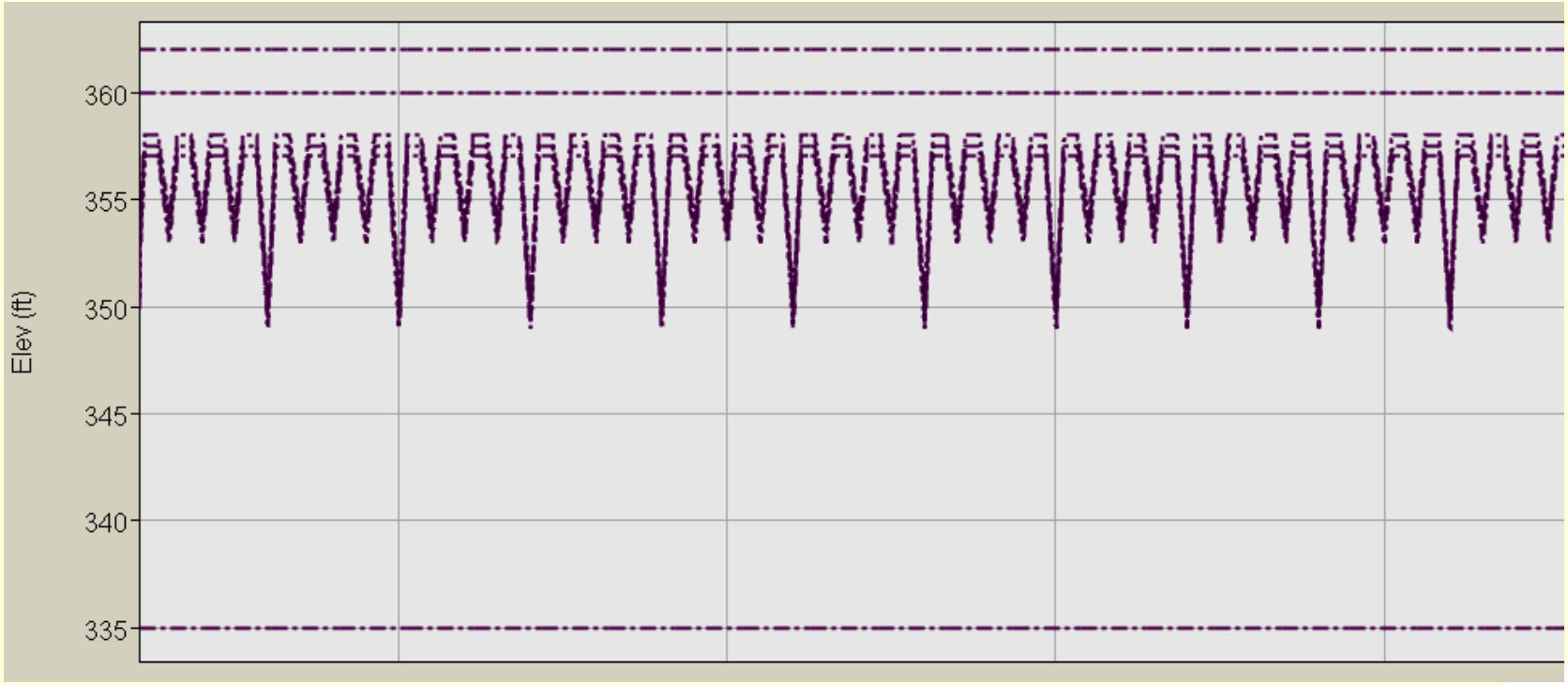
General Guide Curve



Saluda HYDRO RELICENSING

El. 350’ Cycles

- Two Year & Four Year Cycles
- Guide Curve lowers to El. 350’



Saluda HYDRO RELICENSING

Operations

- Zones vary with Time (Guide Curves)
- Operations vary with Current Zone

  (Operation Zone depends on Lake Level)

			Recreational Releases				
	Reserve Generation	**Minimum Flow**	**Tier 0**	**Tier 1**	**Tier 2**	**Max Release**	**Min Release**
Flood Stage	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Upper Pool	Y	n/a	Y	Y	Y	18kcfs	MinFlow
Guide Curve	Y	Y	Y	Y	Y	18kcfs	MinFlow
Low Pool	Y	Y	Y	Y	N	18kcfs	MinFlow
Conservation	Y	Y	Y	N	N	18kcfs	MinFlow
Drought	Y	Y	Y	N	N	18kcfs	400cfs
NoReserve	N	Y	N	N	N	18kcfs	400cfs
Inactive	N	N	N	N	N	0	n/a

Saluda HYDRO RELICENSING

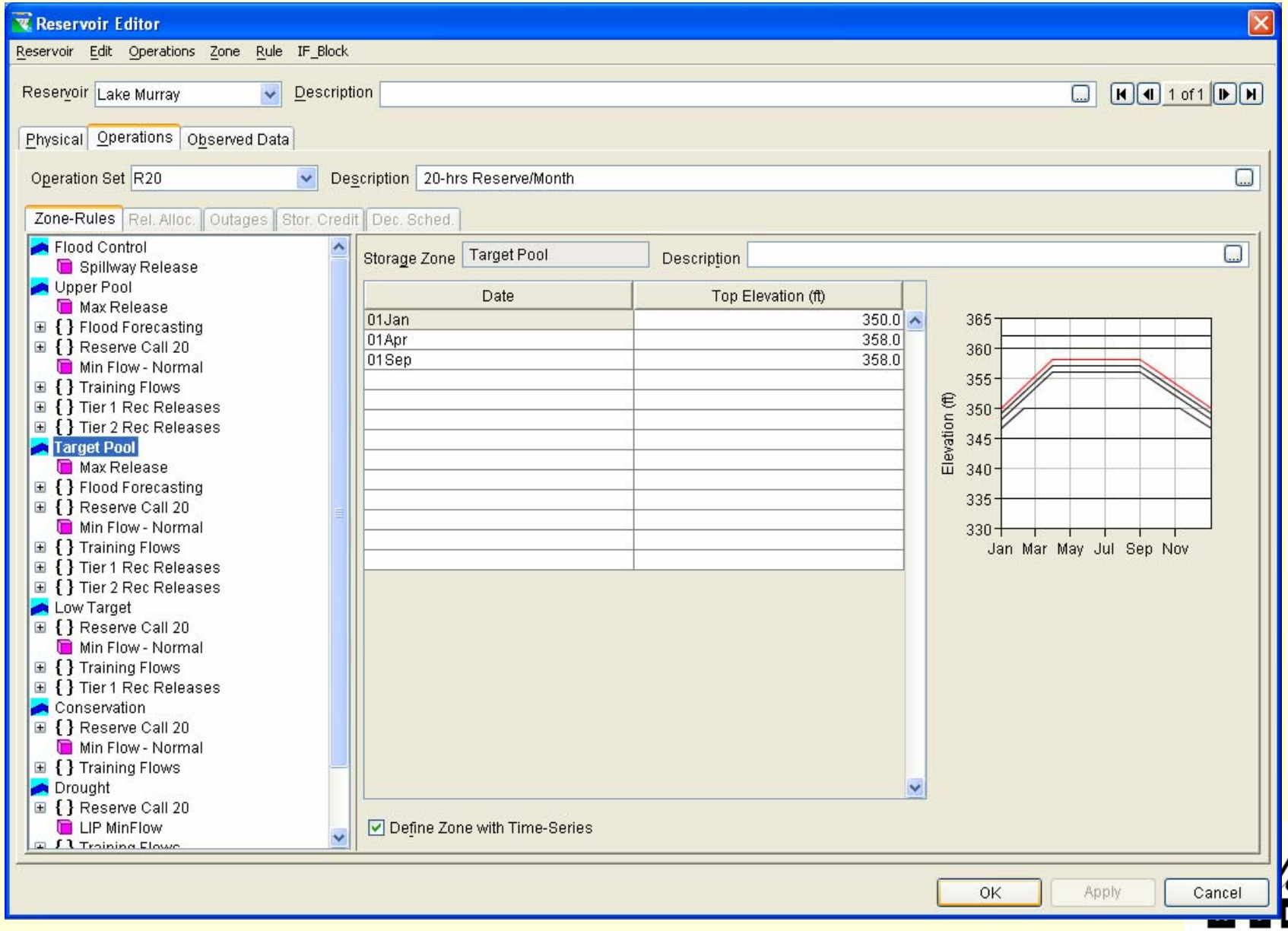
Recreational Flow Requests

Recreational Flow Requi

	Date	Day	Event	Days	Duration (hrs)	Min Flow	Rec Release	24-Hr Average (Includes Min Flow)	Priority Tier
January	1-Jan	1	Iceman Race	1	5	700	4,000	1,388	2
	3-Jan	3	Wade Fishing	1	5	700	700	700	2
	4-Jan	4	Wade Fishing	1	5	700	700	700	2
	13-Jan	13	Wade Fishing	1	5	700	700	700	2
	14-Jan	14	Wade Fishing	1	5	700	700	700	2
	21-Jan	21	MLK Day	1	5	700	700	700	2
	3-Feb	34	Wade Fishing	1	5	700	700	700	2
	24-Apr	114	New Cert - Mandatory	1	14	1,300	8,000	5,208	0
	30-Apr	120	New Cert - Available	2	9	1,300	8,000	7,625	1
May	1-May	121	CFK	1	9	1,300	10,000	4,563	1
	13-May	133	Wade Fishing	1	9	1,300	1,000	1,188	2
	27-May	147	Memorial Day	1	9	1,000	1,000	1,000	2
June	1-Jun	152	Rescue Rodeo	2	9	700	2,111	2,458	2
	3-Jun	154	Wade Fishing	1	9	700	700	700	2
	4-Jun	155	Wade Fishing	1	9	700	700	700	2
	13-Jun	164	Wade Fishing	1	9	700	700	700	2
	14-Jun	165	Wade Fishing	1	9	700	700	700	2
July	1-Jul	182	WW Rodeo	2	8	700	3,300	3,133	2
	4-Jul	185	Ind. Day	1	9	700	1,000	813	2
	26-Jul	207	Wade Fishing	1	9	700	700	700	2
	27-Jul	208	Wade Fishing	1	9	700	700	700	2
August	3-Aug	215	USTWWR Prac.	2	8	700	10,000	7,600	1
	15-Aug	227	Wade Fishing	1	9	700	700	700	2
	16-Aug	228	Wade Fishing	1	9	700	700	700	2
September	5-Sep	248	Labor Day	1	9	700	1,000	813	2
	13-Sep	256	High Boating	2	6	700	4,500	3,300	2
October	1-Oct	274	CFK	1	6	700	2,400	1,125	1
	15-Oct	288	High Boating	2	6	700	4,500	3,300	2
	22-Oct	295	ReCert-Mandatory	1	14	700	12,000	7,292	0
	23-Oct	296	ReCert-Mandatory	1	14	700	12,000	7,292	0
	24-Oct	297	ReCert-Mandatory	1	14	700	12,000	7,292	0
	27-Oct	300	ReCert-Available	2	6	700	4,500	3,300	1
November	5-Nov	309	Low Boating	1	6	700	2,400	1,125	2
	25-Nov	329	High Boating	1	6	700	4,500	1,650	2
December	1-Dec	335	Low Boating	1	6	700	2,400	1,125	2
	3-Dec	337	Wade Fishing	1	5	700	700	700	2
	4-Dec	338	Wade Fishing	1	5	700	700	700	2
	17-Dec	351	High Boating	1	5	700	700	700	2
	23-Dec	357	Wade Fishing	1	6	700	4,500	1,650	2
	24-Dec	358	Wade Fishing	1	5	700	700	700	2

Saluda HYDRO RELICENSING

Zone Rules



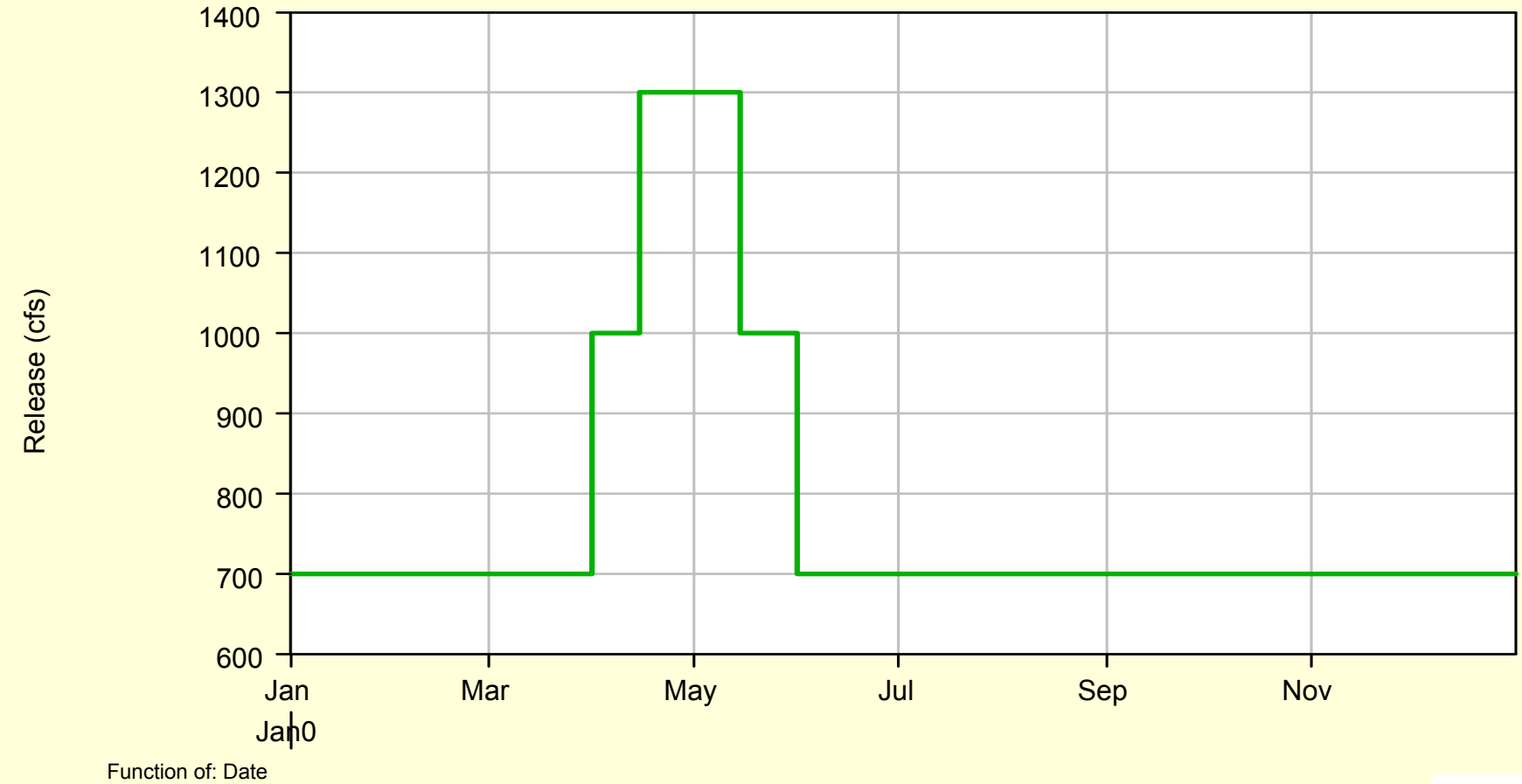
RELICENSING

Reserve Generation

- Past Performance ≠ Future Requirements
- Average Hours of 18kcfs/month
- 10th & 20th of Every Month
- Evaluated 40, 20, 10, 0 hrs/month

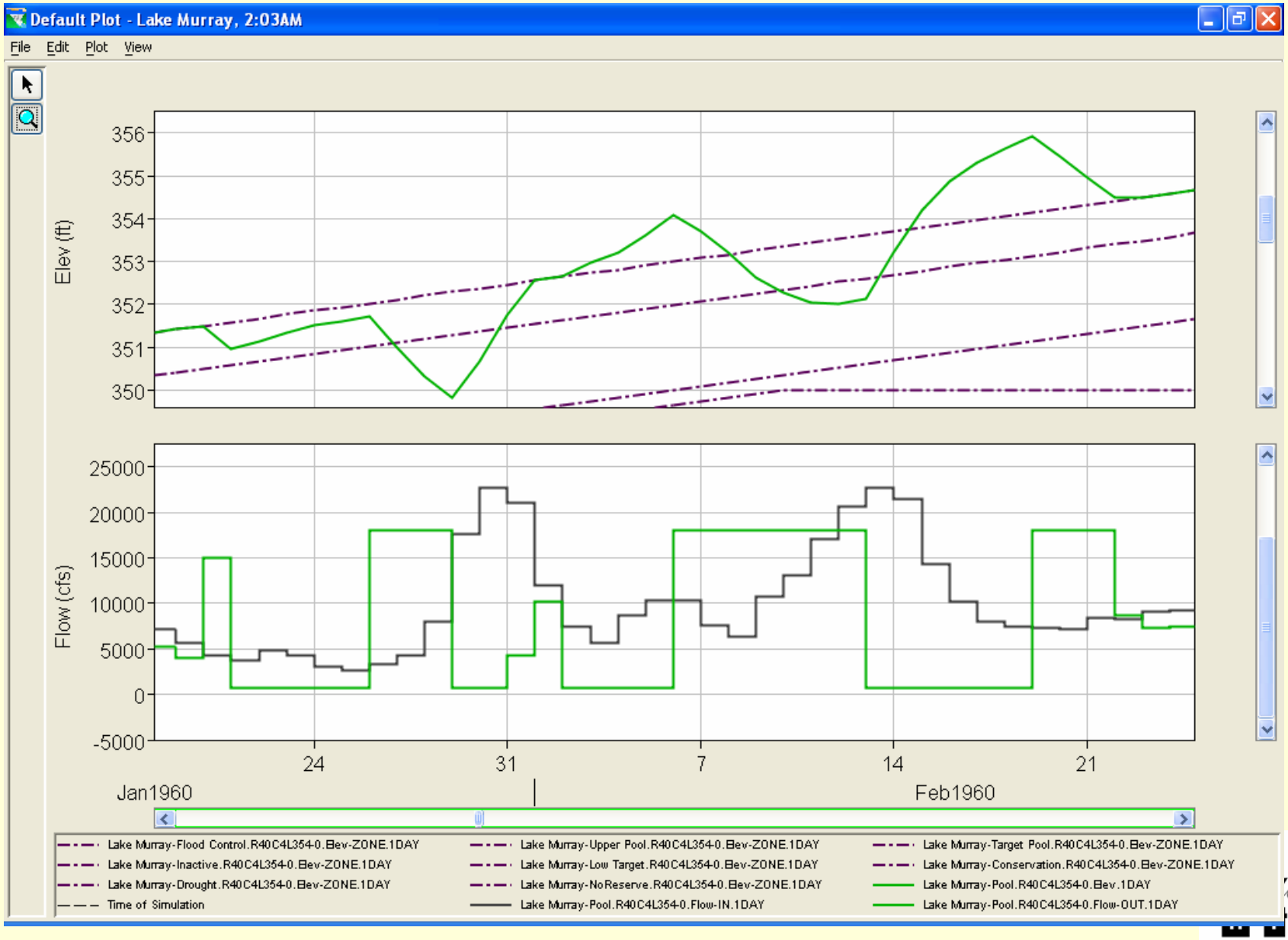
Saluda HYDRO RELICENSING

Minimum Flows



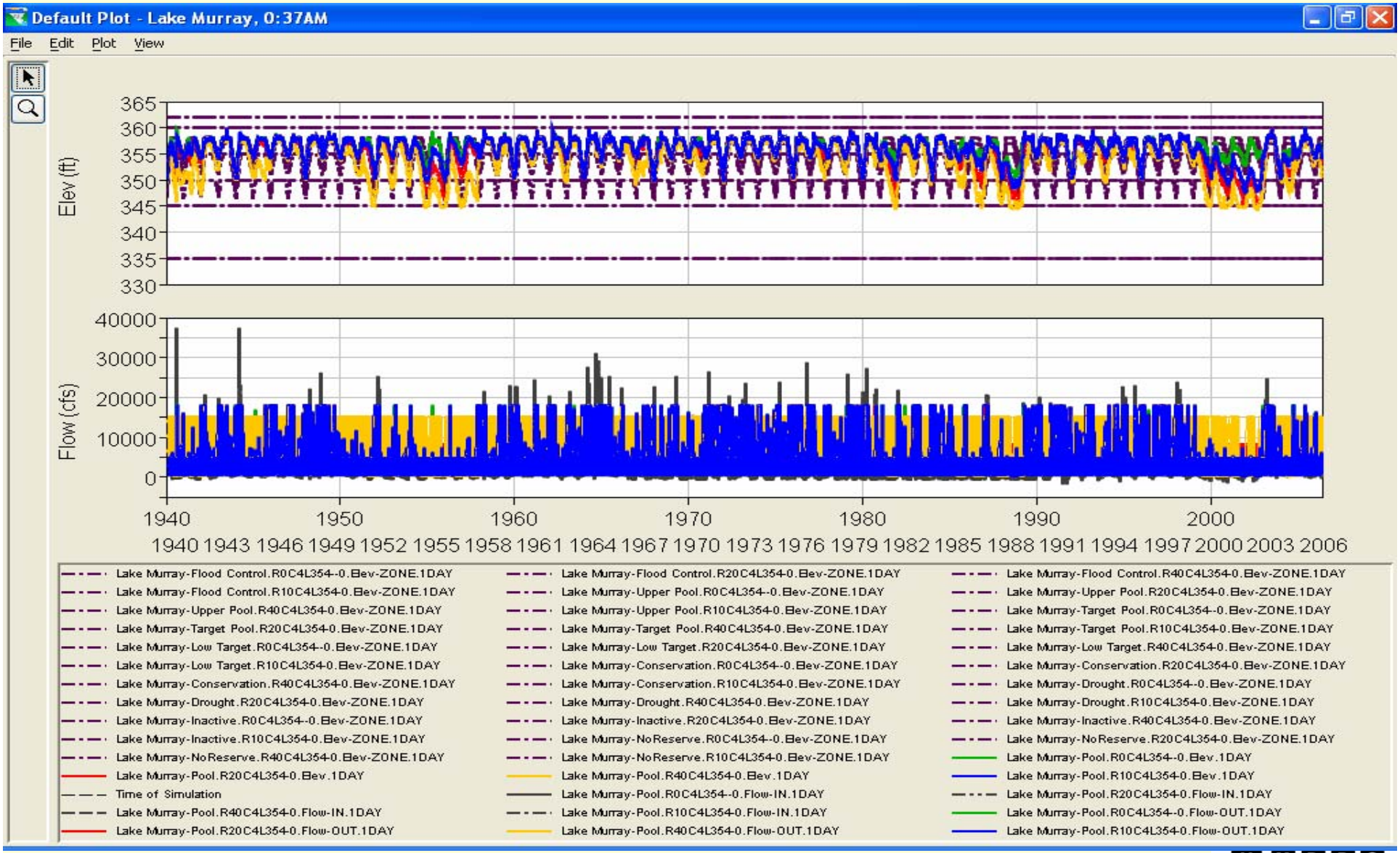
Saluda HYDRO RELICENSING

Flood Forecast



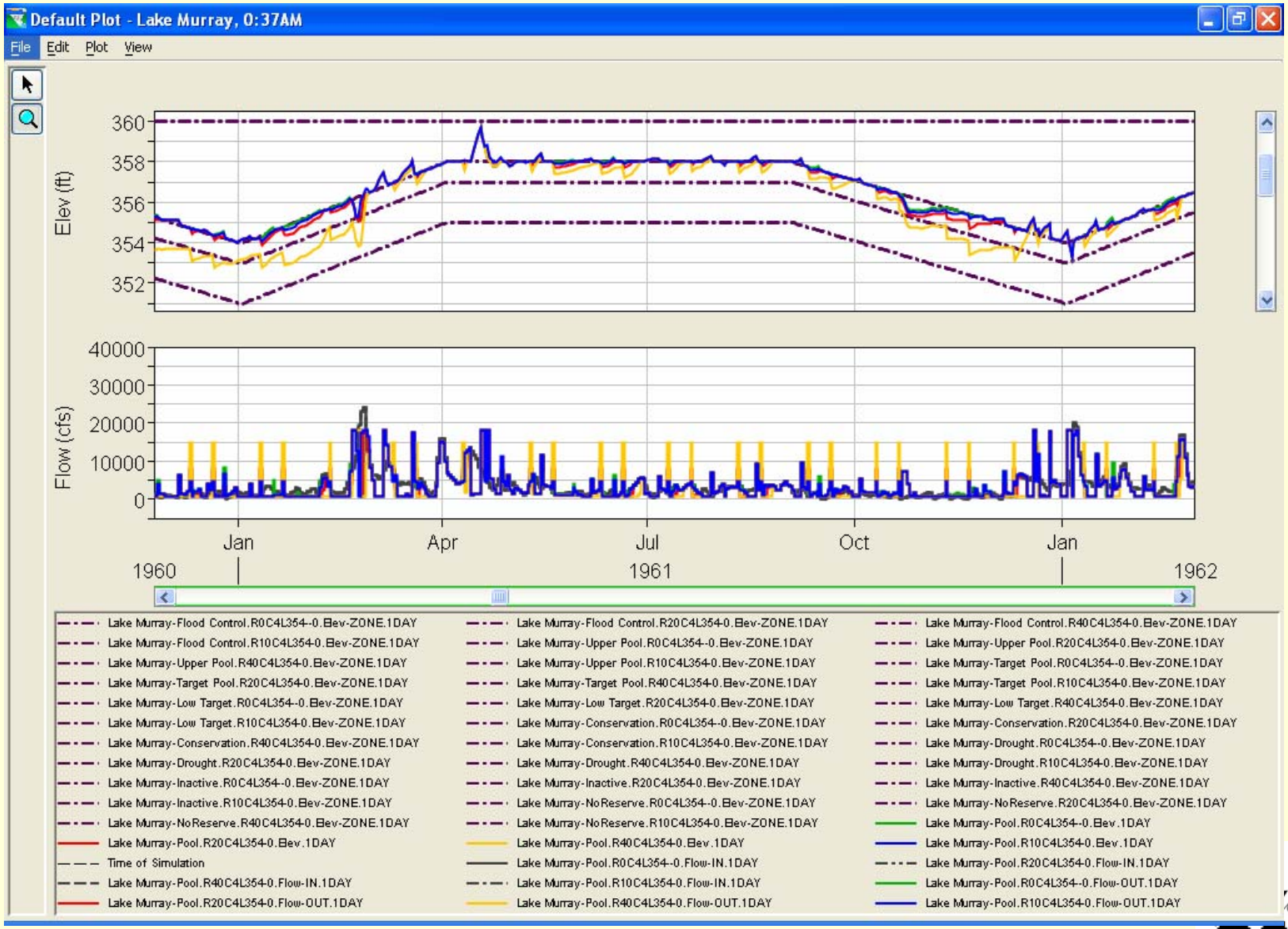
RELICENSING

66 Year Results

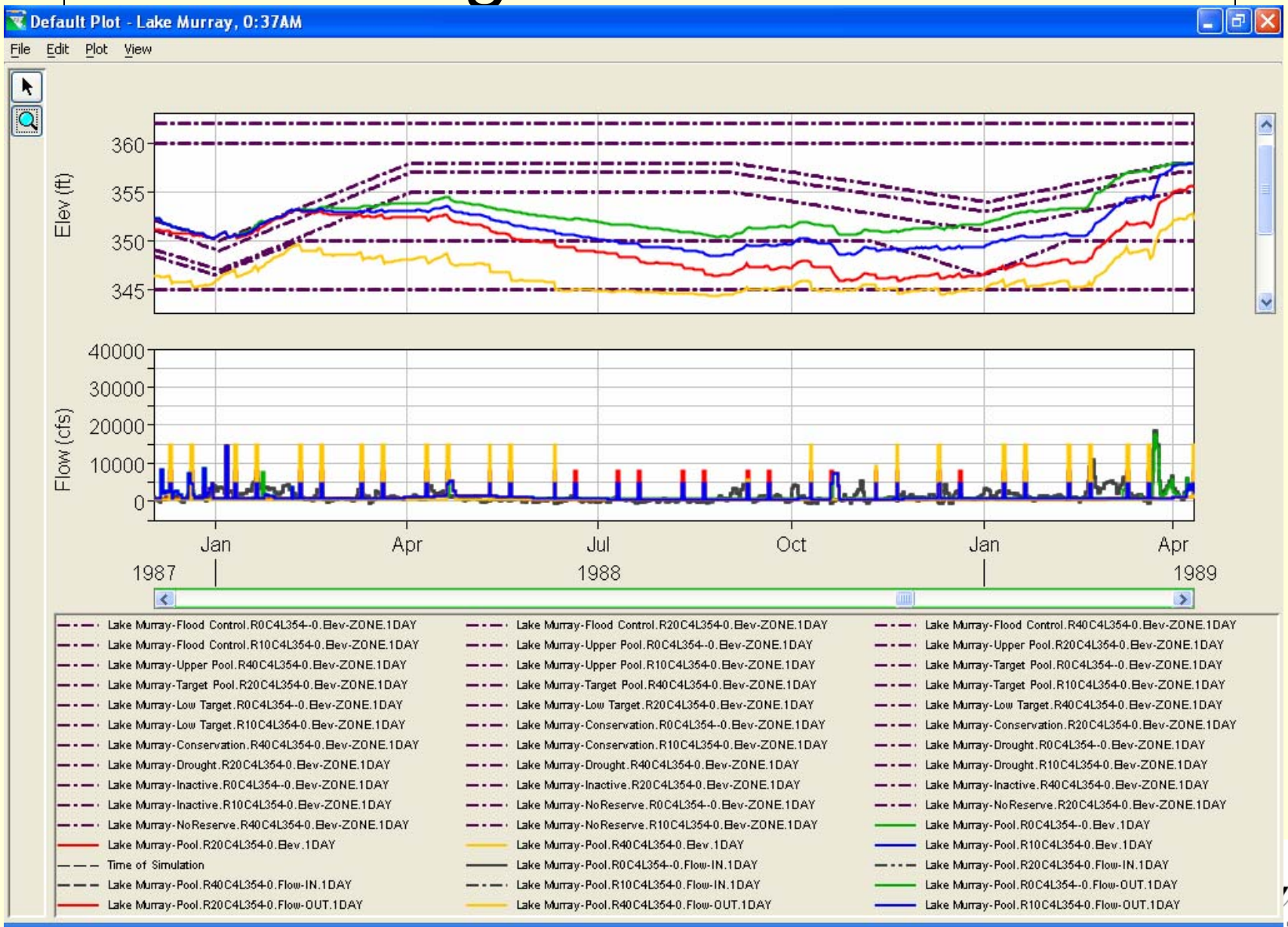


HYDRO RELICENSING

Typical Wet-Year Operations



Drought in Late 80's



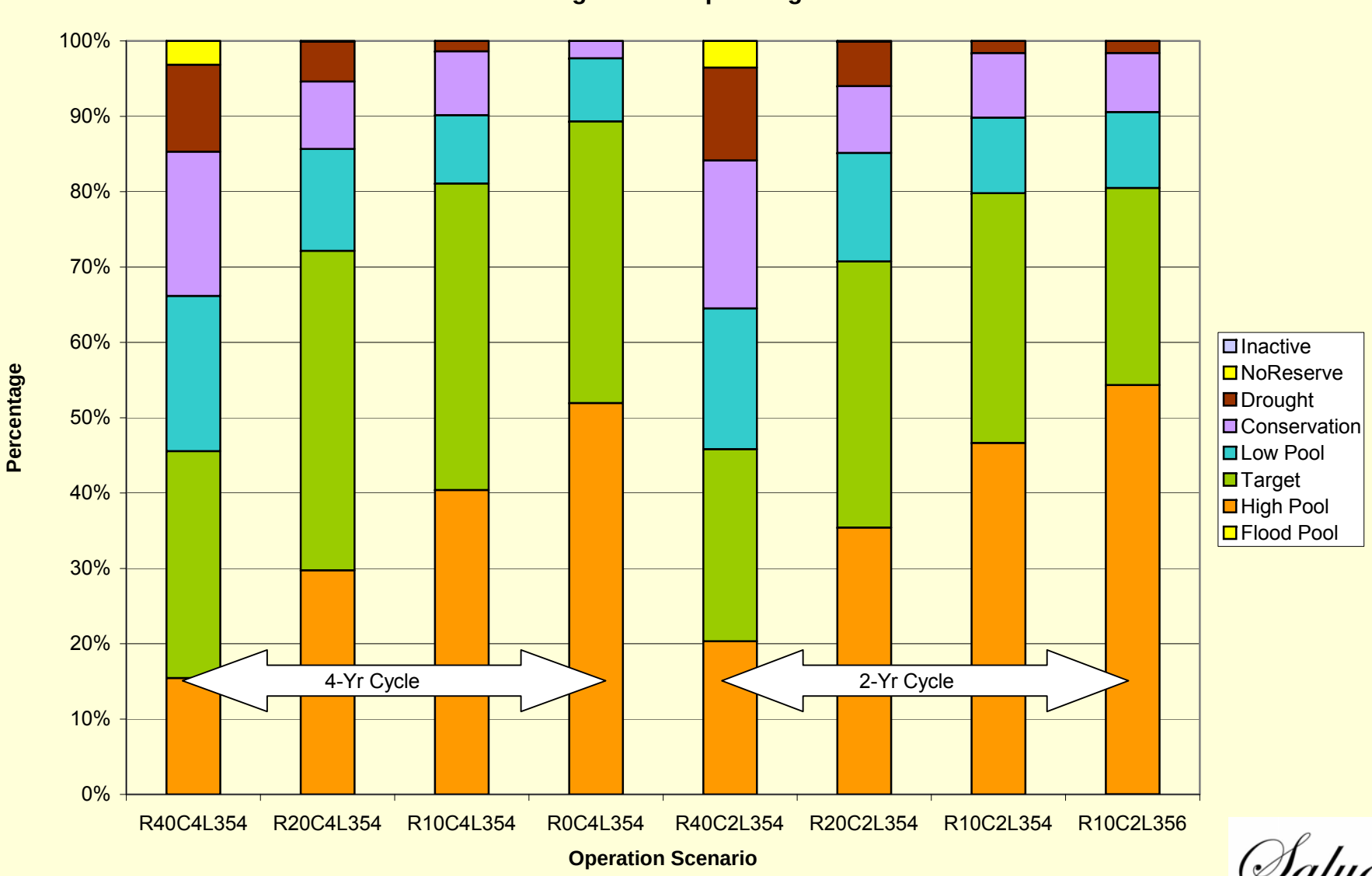
RELICENSING

Zone Frequencies

		Flood Pool	High Pool	Target	Low Pool	Conservation	Drought	NoReserve	Inactive
4-Year Cycle	R40C4L354	0.0%	15.4%	30.1%	20.6%	19.1%	11.5%	3.2%	0.0%
	R20C4L354	0.0%	29.8%	42.4%	13.5%	9.0%	5.3%	0.1%	0.0%
	R10C4L354	0.0%	40.4%	40.7%	9.1%	8.5%	1.4%	0.0%	0.0%
	R0C4L354	0.0%	52.0%	37.4%	8.4%	2.3%	0.0%	0.0%	0.0%
2-Year Cycle	R40C2L354	0.0%	20.3%	25.5%	18.7%	19.6%	12.3%	3.5%	0.0%
	R20C2L354	0.0%	35.4%	35.3%	14.4%	8.9%	5.9%	0.1%	0.0%
	R10C2L354	0.0%	46.7%	33.1%	10.0%	8.6%	1.6%	0.0%	0.0%
	R10C2L356	0.0%	54.3%	26.2%	10.1%	7.8%	1.6%	0.0%	0.0%

Saluda HYDRO RELICENSING

Zone Frequencies



Saluda HYDRO RELICENSING

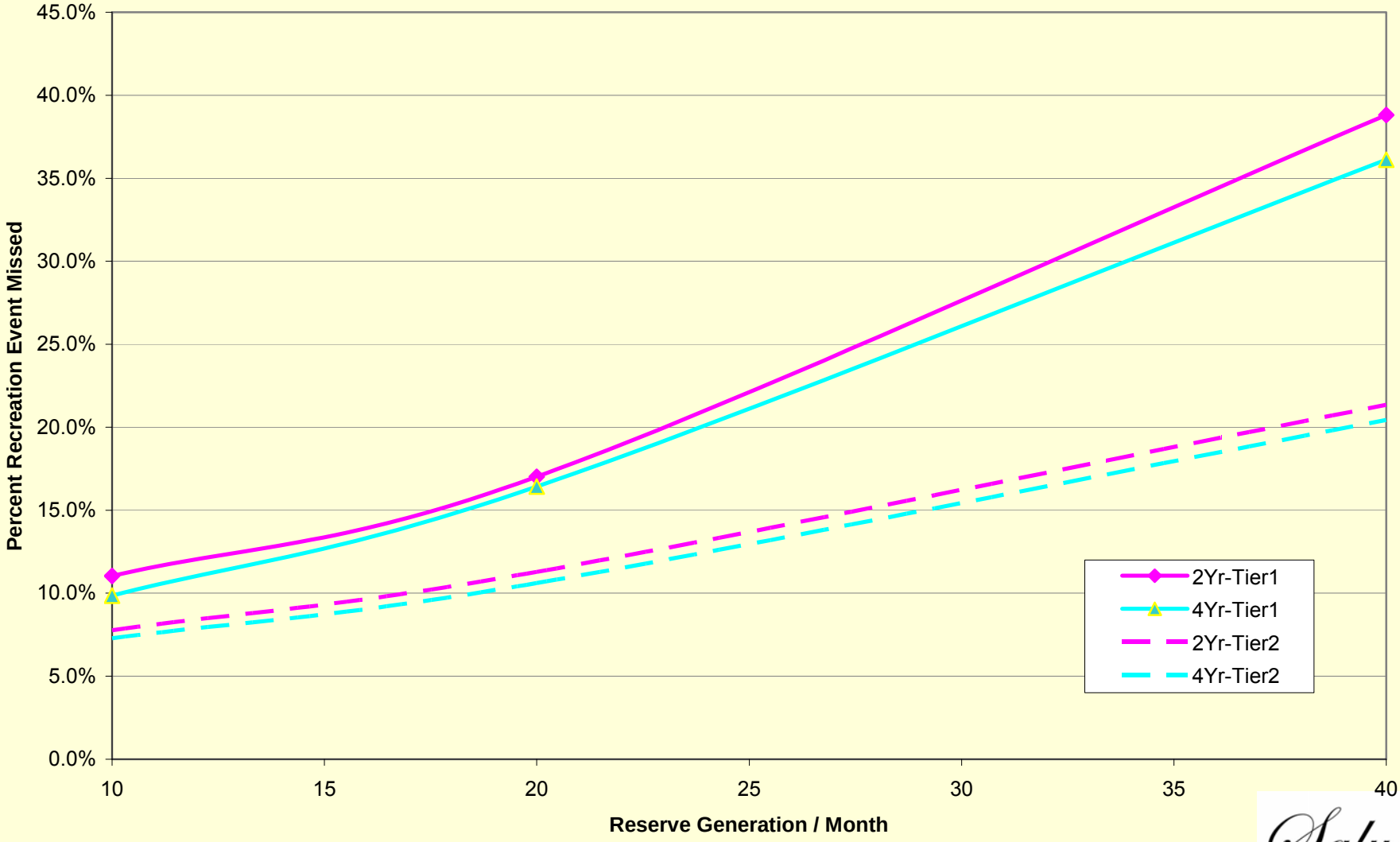
Missed Recreation Days

			Missed Rec Days	% Missed
4-Year Cycle	R40C4L354	Tier 1	121	36.1%
		Tier 2	589	20.4%
	R20C4L354	Tier 1	55	16.4%
		Tier 2	306	10.6%
	R10C4L354	Tier 1	33	9.9%
		Tier 2	210	7.3%
	R0C4L354	Tier 1	13	3.9%
		Tier 2	119	4.1%
2-Year Cycle	R40C2L354	Tier 1	130	38.8%
		Tier 2	615	21.3%
	R20C2L354	Tier 1	57	17.0%
		Tier 2	325	11.3%
	R10C2L354	Tier 1	37	11.0%
		Tier 2	224	7.8%
	R10C2L356	Tier 1	34	10.1%
		Tier 2	218	7.6%

Saluda HYDRO RELICENSING

Recreational Violations

Reserve Generation and Lake Level Cycling
Impacts to Recreational Releases



Saluda HYDRO RELICENSING

Periods Below El.354’ & El.345’

		<354'	<345'
4-Year Cycle	R40C4L354	42.2%	3.2%
	R20C4L354	21.9%	0.1%
	R10C4L354	16.7%	0.0%
	R0C4L354	10.7%	0.0%
2-Year Cycle	R40C2L354	49.1%	3.5%
	R20C2L354	29.6%	0.1%
	R10C2L354	24.5%	0.0%
	R10C2L356	23.9%	0.0%
		7.2%	

Saluda HYDRO RELICENSING

Next Steps

- Finalize Model Inputs
- Summarize Duration & Magnitude of Violations
- Evaluate March 1st El.358’ (vs. April 1st)
- Present Final Model Results

Saluda HYDRO RELICENSING

Questions?

Saluda Operation Workshop Fall - 2005

Lee Xanthakos
SCE&G System Control

Contents

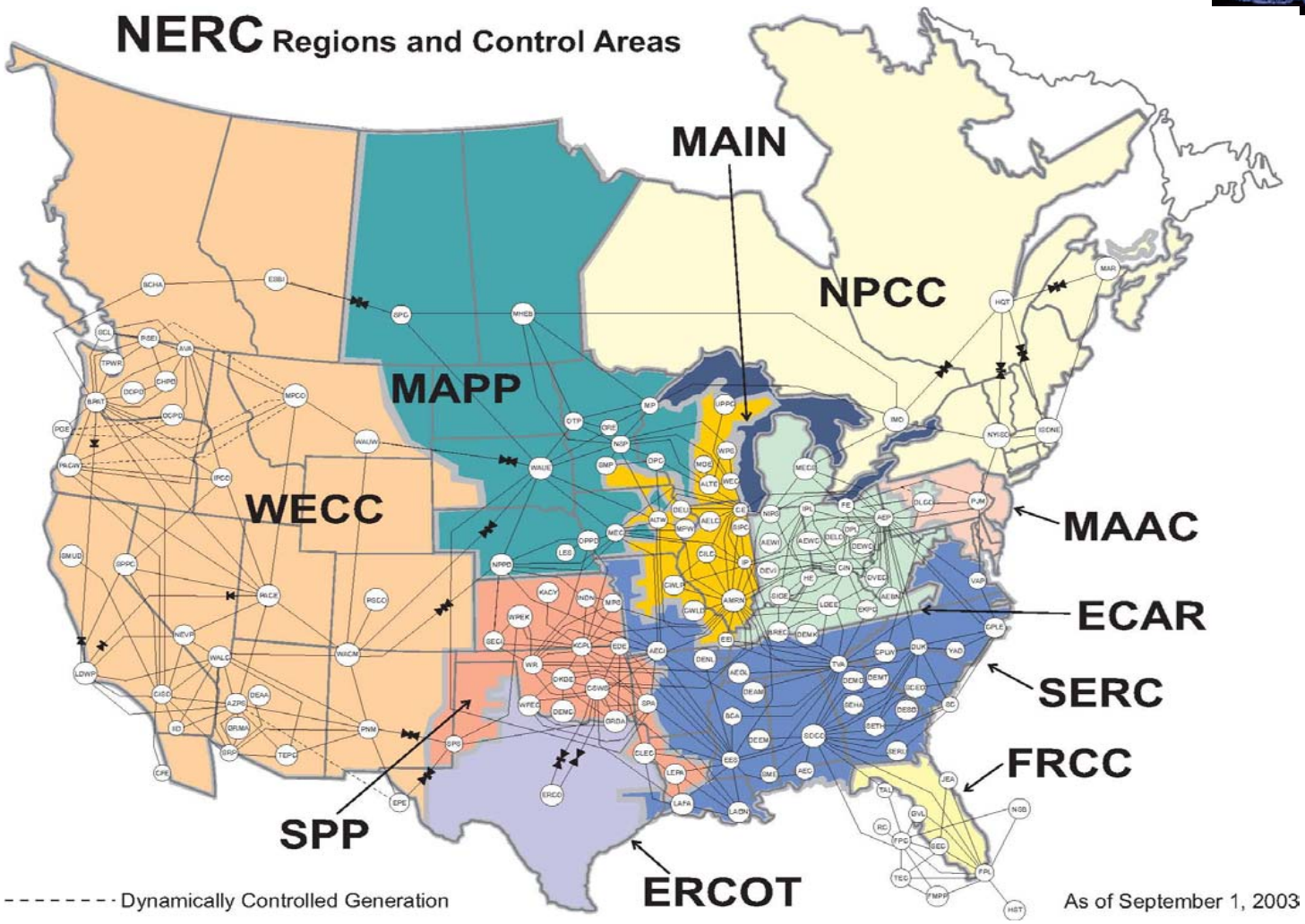
- We are going to talk about The Grid
- We'll talk about How The Grid Work
- We'll talk about Balancing the Grid
- We'll talk about The Grid Rules and who makes them
- We'll talk about Emergencies on the Grid
- We'll talk about why Saluda is used in Emergencies

The Grid

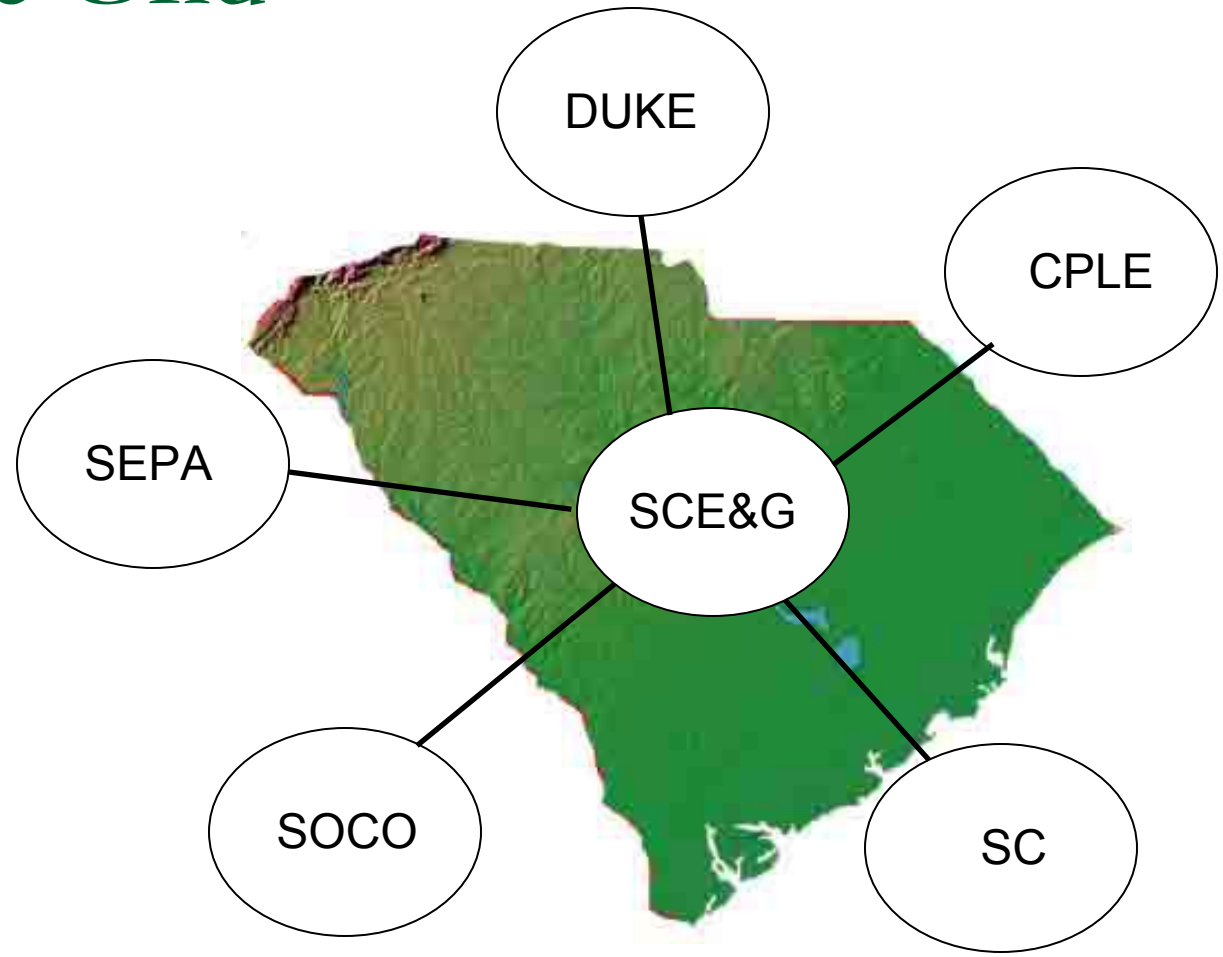
What is The Grid? (aka the Bulk Power System)

- The large towers you see crossing the highway make up the grid
- Hop on one of these to get across the country at the speed of light

The Grid


NERC Regions and Control Areas
MAIN
NPCC
MAPP
WECC
MAAC
ECAR
SERC
FRCC
SPP
ERCOT
Dynamically Controlled Generation
As of September 1, 2003

The Grid



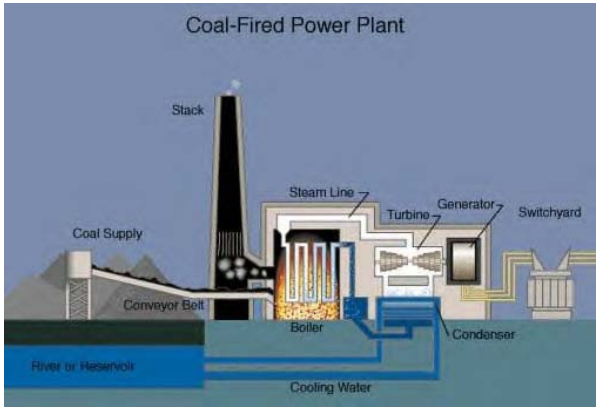
SCE&G is a Control Area that is connected to 5 other Control Areas

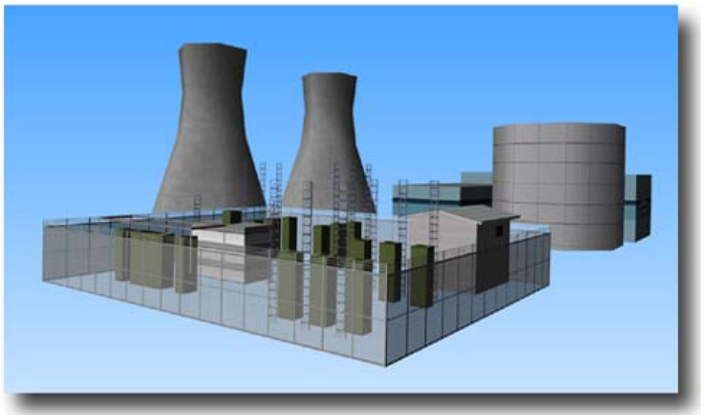
How the Grid Words

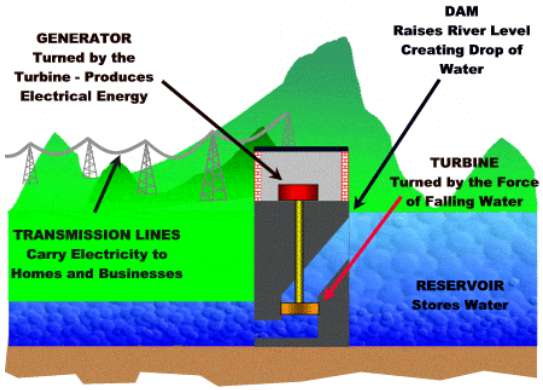
The Customers inside Control Areas demand power.

How the Grid Works

Power companies make enough power to meet that demand.







- Fossil
- Nuclear
- Hydro

Balancing the Grid

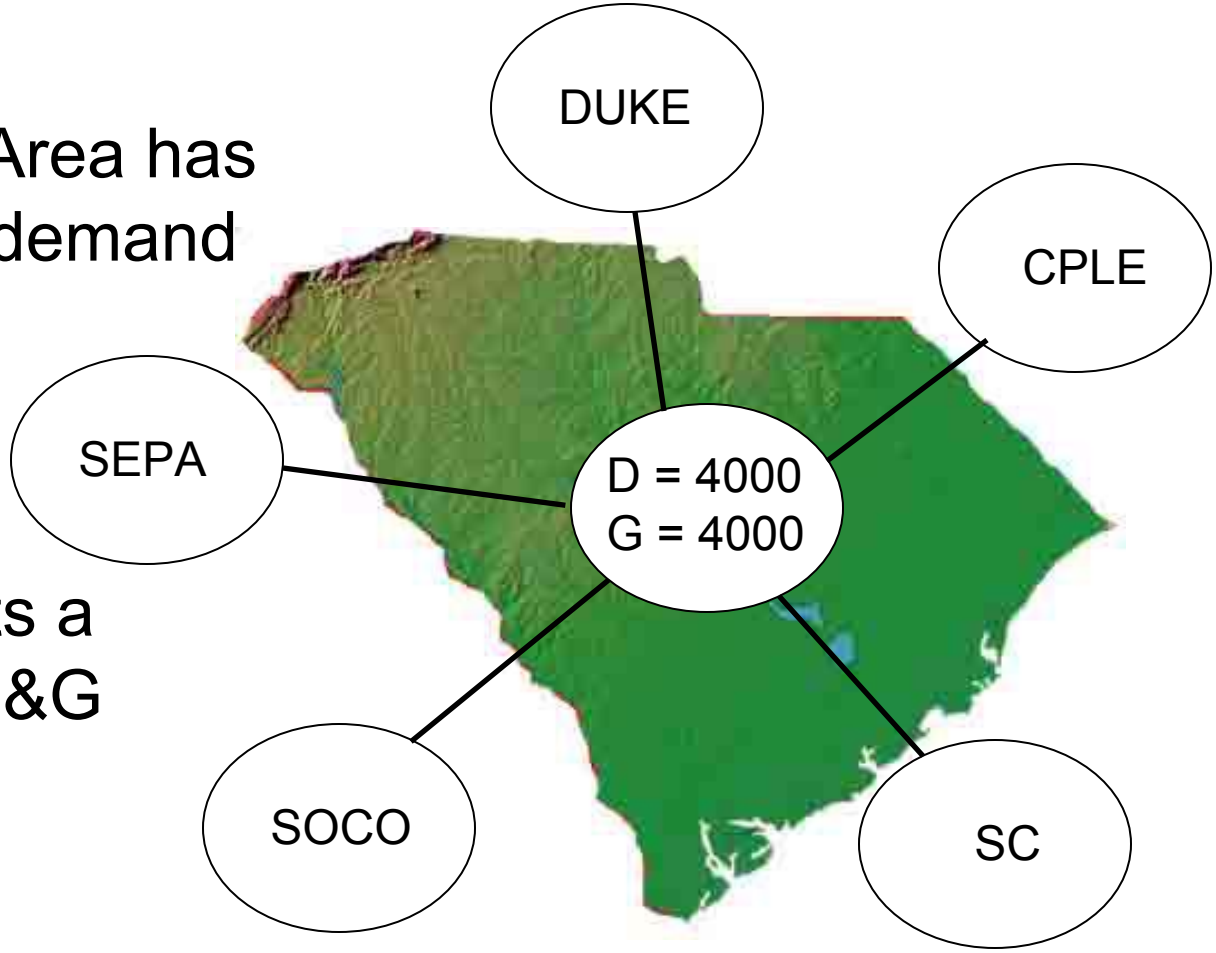
- Once the Demand and Generators are in place. They must be balanced.
- “Balanced” means that there is enough electricity flowing from the Generators to meet the Customer’s demand.
- This balance is measured in real time.
  - Remember the speed of light comment?

Balancing the Grid

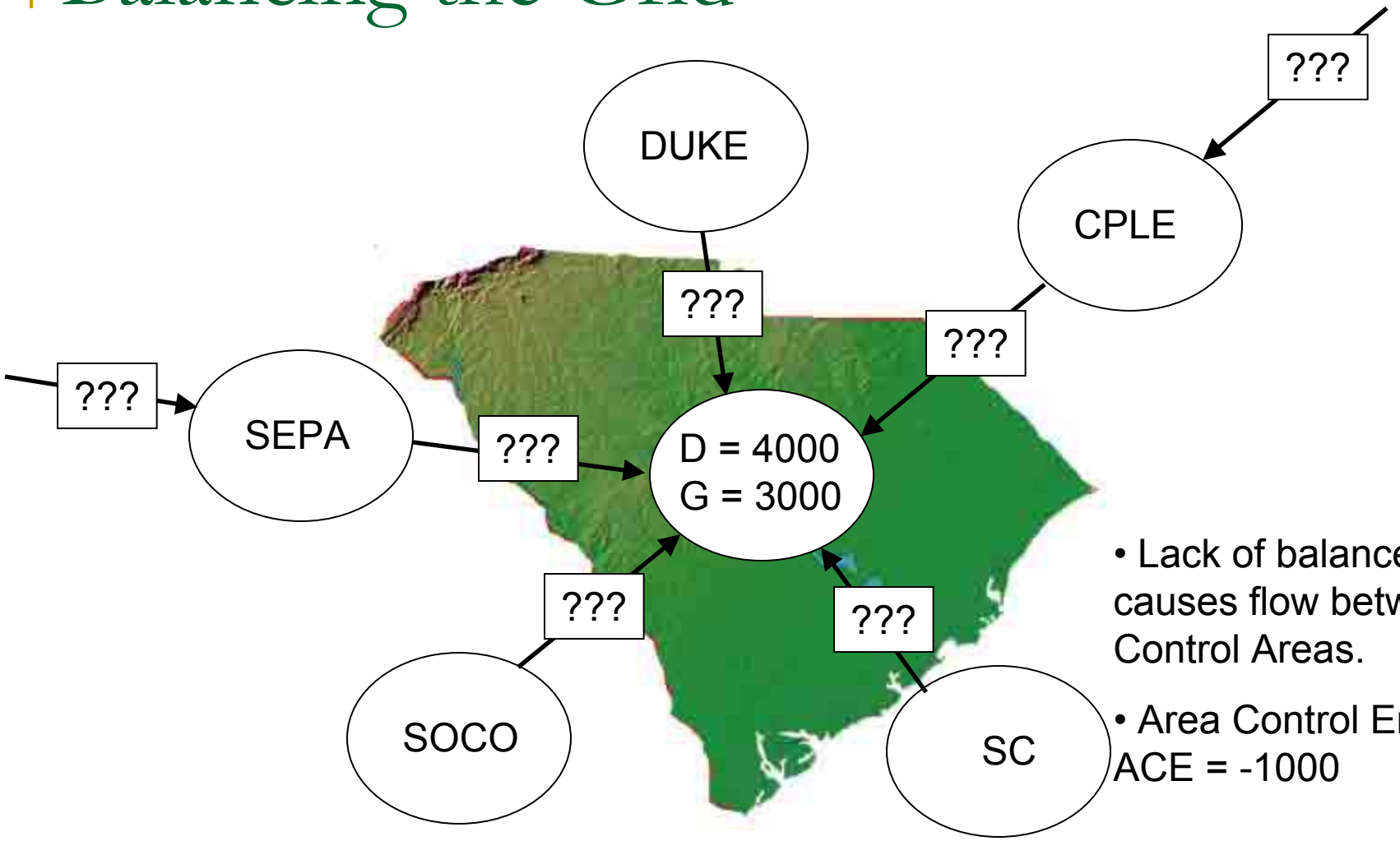
- System Controllers match changes in Demand by dispatching Generation
  - Load changes through out the day, but seasonal patterns are basically the same.
  - Winter patterns peak in the morning
  - Summer days peak in the afternoon

Balancing the Grid

- Each Control Area has to balance its demand
- This represents a balanced SCE&G Control Area

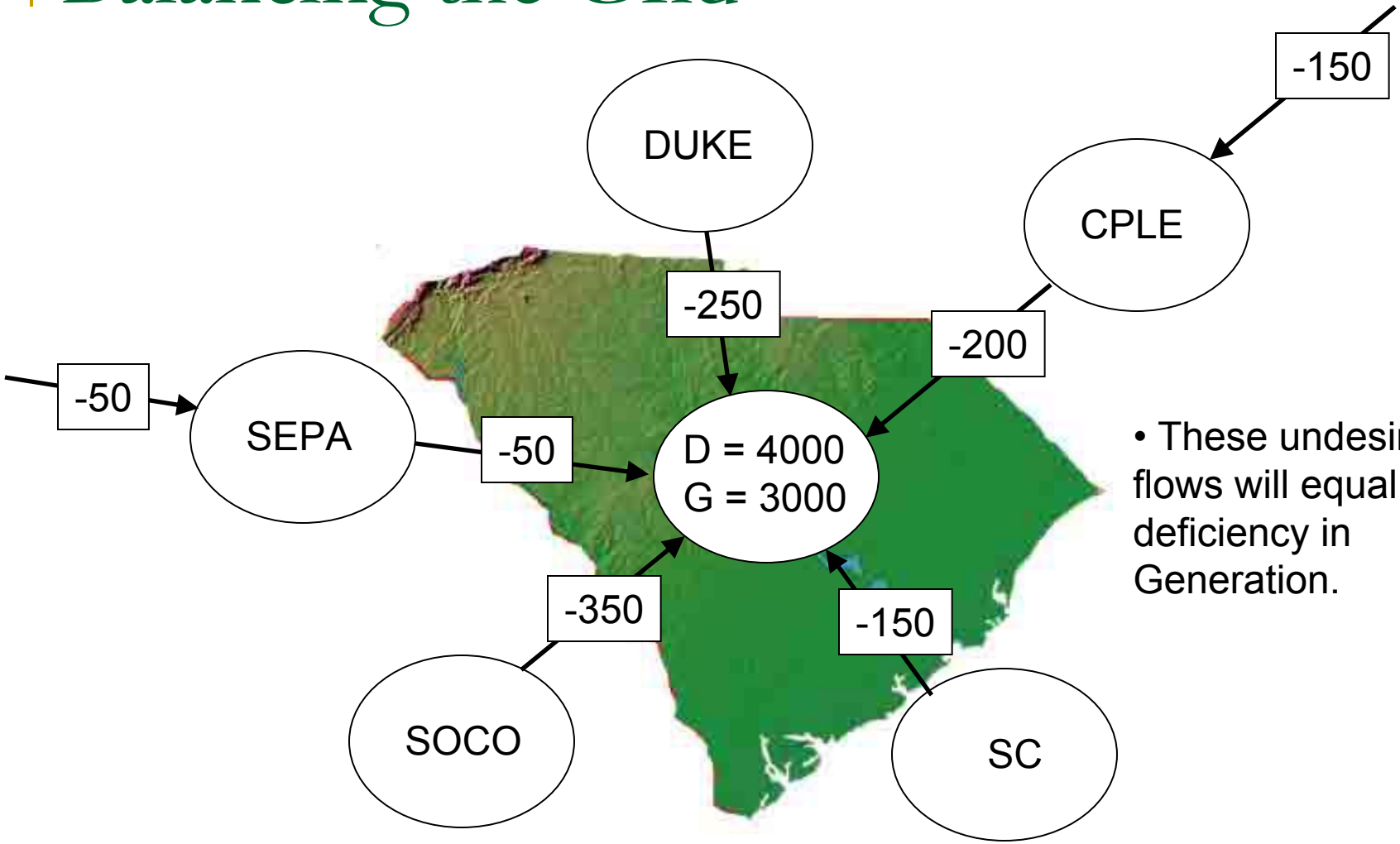


Balancing the Grid



- Lack of balance causes flow between Control Areas.
- Area Control Error ACE = -1000

Balancing the Grid



- These undesirable flows will equal the deficiency in Generation.

Balancing the Grid

- What causes imbalance? (4)
  - Power plants break down – After all, they are only machines.
  - Fuel problems.
  - Power lines don't allow power to flow.
  - Purchased power is curtailed.
  - Etc…

Balancing the Grid

- In such a case, what must SCE&G do to return balance? (2)
  - 1 – Increase generation
  - 2 – Reduce Demand
- What if SCE&G does not return balance?

The Grid Rules

- Who Makes the rules?
  - North American Electric Reliability Council (www.nerc.com)
  - Southeastern Electric Reliability Council (www.serc1.org)
  - VACAR – Virginia/Carolinas Subregion.
- What are the Rules?
  - The “NERC Reliability Standards” – over 800 requirements
  - The SERC Compliance Subcommittee monitors compliance.
  - VACAR Taskforces is how we coordinate with our neighbors.

The Grid Rules

- BAL–002– 0 is what requires us to run Saluda the way we do.
- It says that:
  - As a minimum, the Balancing Authority or Reserve Sharing Group shall carry at least enough Contingency Reserve to cover the most severe single contingency.
- What is SCE&G's most severe single contingency?

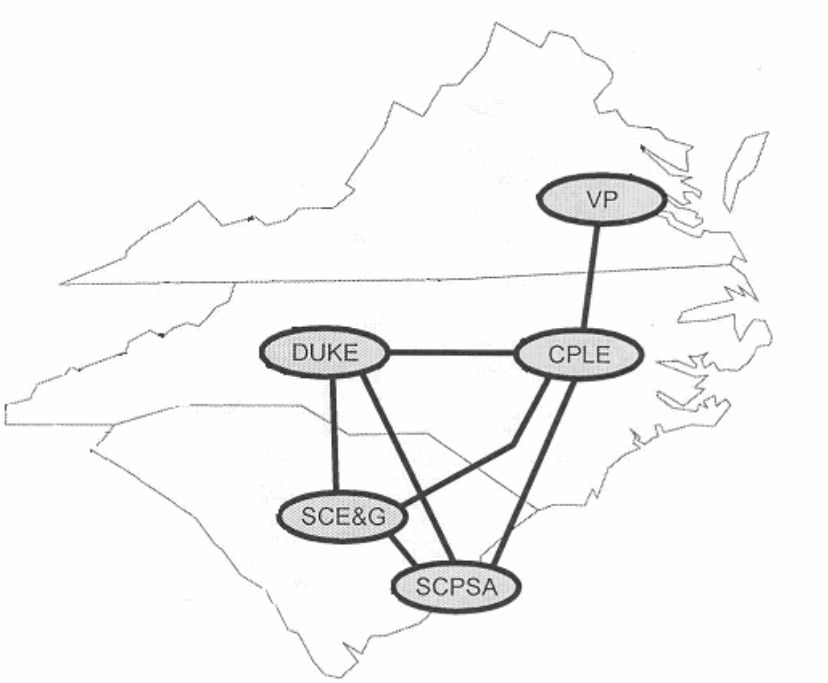
The Grid Rules

VC Summer Nuclear Station is in Jenkinsville, SC. This plant generates enough power in one hour to power over 1000 homes for 1 month!

Generation Capacity = 1000MWs >>>> We don't want to carry 1000MW in reserves

The Grid Rules

- To avoid carrying 1000MWs in reserves, SCE&G has joined the VACAR Reserve Sharing group.
- The VACAR RSG collectively carries 1500MW in reserves
- SCE&G must carry ~200 of the 1500.



Emergencies on the Grid

- If a Generator trips, the Balancing Authority must recover 100% of the loss in 15 minutes.
- Only a few units on SCE&G's system can generate up to 200MWs in 15 minutes.

Emergencies on the Grid

- Compliance reported per incident to VACAR
- Compliance reported Quarterly to SERC.

Emergencies on the Grid

- Example:
  - Williams Station trips
  - SCE&G ACE = -600MW
  - SCE&G has 15 minutes to get 600MW on its system.
  - Load up 150MW of available units at Fairfield
  - Load up 200MW at Saluda & call on 250MW of reserves from Duke
  - Buy 600MW from spot energy market next hour.

Emergencies on the Grid

- Example 2:
  - CPLE calls SCE&G and calls on 150MWs of contingency reserves.
  - SCE&G deliver in 1 minute on 0MW ramp
  - SCE&G ACE instantly become -150
  - SCE&G now has ??? minutes to recover balance
  - SCE&G loads up 1 last unit at Fairfield Pumped Storage and loads up 1 unit at Saluda.
  - Is that enough?
  - No – SCE&G loads up one more unit at Saluda.

Emergencies on the Grid

- This is not just a spreadsheet. This is how it really happens.
- And it happens without warning.

- After the fact, SCE&G and CPLE report compliance to each other.

Why use Saluda?

- Increasing generation by 200MW in 15 minutes is not easy.
- That's about 13.5MW/minute
- VC Summer Nuclear increases at 1MW/minute
- SCE&G coal averages 5MW/minute
- SCE&G can "Quick start" gas turbines for 75MWs – only 50% success rate; not reliable!

Review

- Generation trips can happen at any time.
  - There is always exposure
  - Summer afternoons and Winter mornings are more likely for sudden emergencies
- There are many factors that can cause an interruption of generation.
- There are few warnings.
- Saluda is the reliable option for assuring the lights stay on.

Questions?