Aquatic, Water Quality, Geomorphology, & Hydrology Resources Water Balance Model Subcommittee

Technical Working Group Meeting

Date: November 10, 2003

Time: 9:00 AM to 4:00 PM

Location: SMUD Customer Service Center
White Rock Room
6301 S Street
Sacramento, California

Directions

Parking: 10 Spaces in the CSC South Lot

Discussion Topic:

Agenda

Attendees

Summary

Handouts, Attachments & Presentations

Project Overview and Base Case Description Presentation

Hydrology Schematic

Directions to SMUD's Customer Service Center

SMUD has two four-story buildings located adjacent to Highway 50 on the north side, between 59th Street exit and 65th Street exit. The Customer Service Center (CSC) is the newer building of the two located at 6301 S Street, and houses the Rubicon Room, Forestview 1,2, & 3, Sequoia 1,2,& 3, Timberline 1,2, & 3, and the HRL Conference Room located on the third floor (Northwest wing). The Headquarters building is located at 6201 S Street, directly west of the CSC. It houses the Headquarters' Customer Center (HCC), the Auditorium and several other conference rooms.

The Field Reporting Facility (aka FRF) is located behind the SMUD Headquarters building: go under the Light Rail overpass, then to the left about 150 yards.

Directions:

Heading East: From downtown Sacramento, head east on Highway 50, exit at **59th Street.** This exit will take you up-and-over Highway 50. Go straight at the first intersection, travel about a half mile. On your left (north) is the SMUD Headquarters building, the next building is the Customer Service Center.

Heading West: From Placerville, take Highway 50 to Sacramento and exit at **65th Street.** Go straight about one block after the first intersection. The Customer Service Center is the four-story building on your right (north).

You should be able to find parking spaces for visitors located in the area between the two buildings. There is also parking available in a parking lot on Folsum Blvd. behind the SMUD complex.

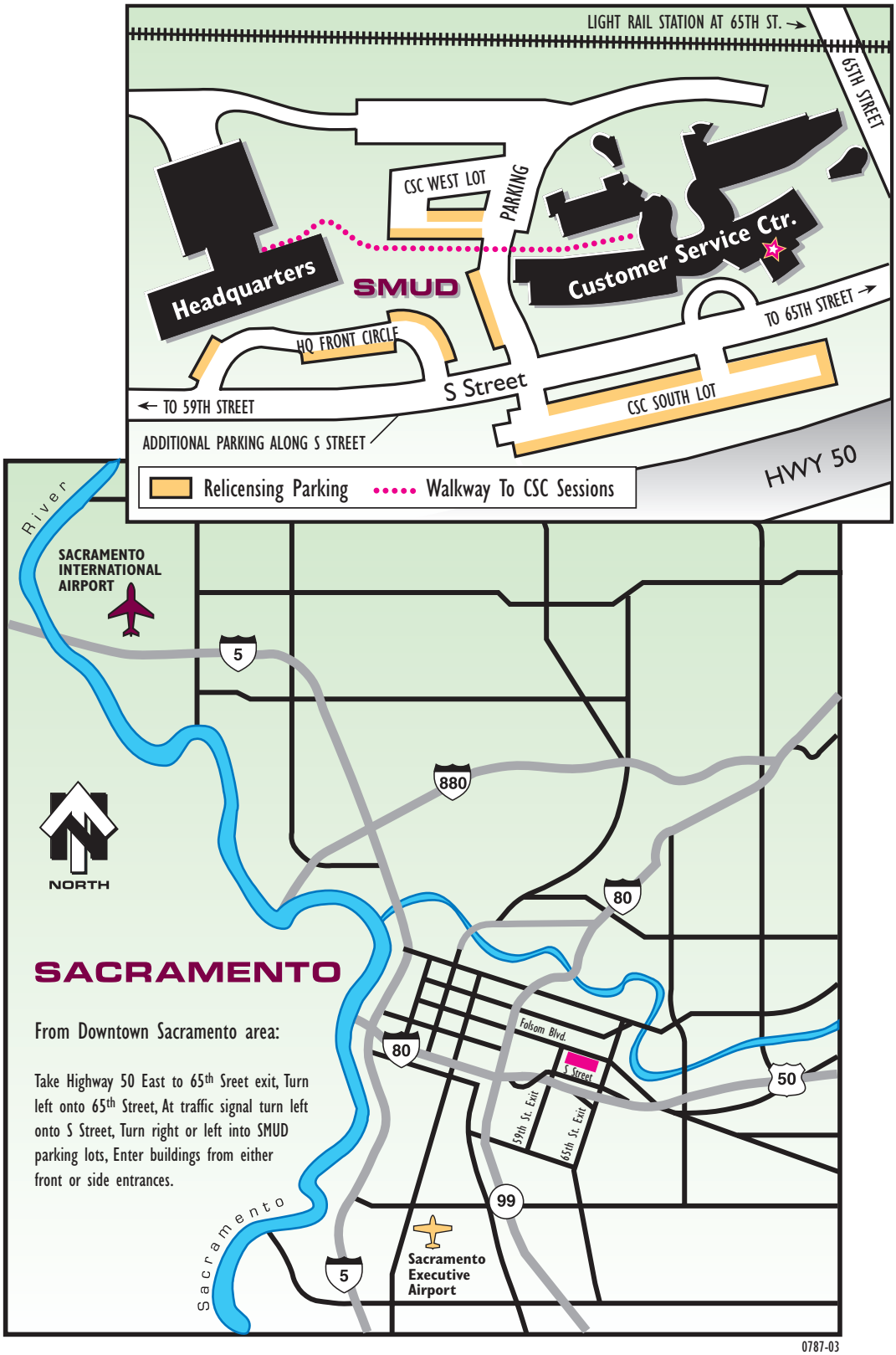
If you need assistance to find the Rubicon Room, Timberline 1,2,& 3, Sequoia 1,2,& 3, Forestview 1,2, & 3, and the Hydro Relicensing's Conference Room located on the third floor of the Northwest wing, see the guard at the lobby desk. The Headquarters Customer Center (HCC) room is located in the Headquarters building opposite the board of directors Auditorium in the first floor. Drive Safely.

Note: Downloadable maps can be found at hydrorelicensing.smud.org/meetings/meet_loc.htm

Maps To

SMUD HEADQUARTERS AND CUSTOMER SERVICE CENTER

Relicensing Parking Lot Locations



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Sacramento Municipal Utility District
White Rock Room
6301 S Street
Sacramento, CA 95817

Water Balance Model Subcommittee
Upper American River Project Relicensing
Monday, November 10, 2003
9:00 pm to 4:00 pm

NOTE: PLEASE BRING YOUR CALENDAR TO THE MEETING SO WE CAN SET FUTURE SUBCOMMITTEE MEEING DATES.

Agenda

Administration

- Introductions
- Approve/Modify Agenda
- Approve October 8, 2003 Water Balance Model Subcommittee Meeting Summary
- Identify Time Sensitive Items Not on the Agenda

Status Reports

- Review Action Items from October 8, 2003 Subcommittee Meeting
- Receive Report from Water Year Type Subgroup on November 6 Meeting

Identify Meeting Action Items

Schedule Next Subcommittee Meetings & Set Meeting Agenda

Sacramento Municipal Utility District (SMUD)
Upper American River Project (UARP) Hydro Relicensing Project

Water Balance Model Subcommittee Meeting Summary
November 10, 2003
9:00AM – 3:30PM

The Water Balance Model Subcommittee (WBMS) met on November 10, 2003, at SMUD's Customer Service Center, White Rock Room. A notice of and agenda for the meeting was distributed to all interested parties on October 21, 2003. Meeting participants included:

- Bill Center – *Camp Lotus*
- Margaret Hannaford – *Hydro Consultants*
- Dave Hanson – *SMUD (afternoon only)*
- Bill Hetland - *EDCWA*
- Bob Hughes – *CDFG*
- Jim Eicher - *BLM*
- Jim Lynch – *DTA*
- Bruce McGurk – PG&E
- Parvez Mody – *SMUD*
- Beth Paulson - *ENF*
- Mike Preszler – *Mead & Hunt*
- Dan Steiner - *Consultant*
- Pam Taheri – *SMUD*

SUMMARY

- The subcommittee approved the October 8, 2003 subcommittee meeting summary
- The subcommittee received a presentation on the UARP Water Balance Model validation process and Base Case (without Chili Bar or Iowa Hill in the model)
- The next subcommittee meeting is scheduled for December 8 from 9 a.m. to 4 p.m.

ADMINISTRATION

Subcommittee Approved October 8, 2003 Meeting Summary – The Subcommittee approved the October 8, 2003, meeting summary with minor changes proposed by Bob Hughes. The subcommittee agreed the revised summary would not need to be re-approved.

Action Item 1: Parvez Mody to reissue the October 8 meeting summary with the revisions Bob requested.

Subcommittee Scheduled Meetings Through June 2004 – The subcommittee scheduled the following meeting dates through June 2004 *[These email dates were emailed to the Plenary Group by SMUD on November 11.]*:

December 8
January 5 & 26
February 23
March 29
April 26
May 24
June 28

STATUS OF ACTION ITEMS

The Subcommittee Reviewed The Status Of Outstanding Action Items – Based on the October 8 subcommittee meeting summary, the subcommittee had identified seven outstanding action items. The subcommittee reviewed the status of each and concluded that the following three outstanding items had been completed:

- SMUD's Expert User to issue an email stating SMUD will make EDCWA's model run request (the first request) before November 10, 2003 meeting. Completed on November 5.
- Parvez Mody to update Model Run Request Form. Completed and presented to Plenary Group on November 5.
- Water Year Type Subgroup to meet on November 6 to continue development of Water Year types for consideration by the Subcommittee, and to report at November 10 Subcommittee meeting. The meeting was cancelled since the subgroup agreed prior to the meeting on the water year types, which were included in the model Run Request Form that presented to the Plenary Group on November 5.

The following four action items remain outstanding:

2. Dave Hanson to call John Gangemi. Jim Lynch said he would do this by the December 8 subcommittee meeting. [Jim left a voicemail with John on November 11.]
3. Bill Hetland to report on JBIT's discussions JBIT's November 13 meeting regarding whether consumptive withdrawals should be included in the model used in the UARP Relicensing (as compared to the model used by the JBIT). Bill to report due to the subcommittee at its December 8 meeting.
4. SMUD to add Chili Bar and Iowa Hill to the CHEOPS model. No date assigned, but Pam Taheri said that SMUD was working diligently on incorporating these facilities/features into the model.
5. Margaret Hannaford to calculate total unimpaired flows at all nodes in the List of Nodes. The subcommittee agreed that the information would be incorporated into the Hydrology Report, which includes the Hydrology CD, and provided to the subcommittee by mid-December.

AGENCIES' MODEL

Agencies Reported Status Of Agencies' Water Balance Model – Bob Hughes reported that the agencies were using the HEC RES-SIM model, a daily time-step model. Bob said that the agencies were building the framework, and adding Project facilities interaction information into their model. In response to a question, Bob said that he was not sure if the agencies would make runs if requested by a non-agency party, but that he thought the model would be made available for others to use.

Action Item 6: Agencies to report out briefly at each subcommittee meeting on the status of the agencies model.

PROJECT OVERVIEW AND BASE CASE ASSUMPTIONS

Licensee Presented The UARP Water Balance Model & Model Validation, And Subcommittee Requested Additional Information **–** Pam Taheri, Margaret Hannaford, and Dan Steiner made a presentation to the subcommittee on the model and its validation. The Microsoft PowerPoint presentation can be found on the

UARP Relicensing Web Site and is entitled "*Project Overview and Base Case Description*" dated November 10, 2003. Pam explained that the model did not have Chili Bar or Iowa Hill in it yet, but the model validation could go forward. The Model would need to be re-verified as needed when these other facilities were added. Margaret pointed out that the model used the current version of the unimpaired hydrology, which would be replaced with the revised unimpaired hydrology when available in mid December. She did not believe that this would make a noticeable difference since the hydrology revisions are relatively minor. After viewing the presentation, the subcommittee requested some additional information it would need prior to recommending to the Plenary Group that it accept the model as validated. The subcommittee members said that if they received the information by no later than November 28, they would review the information by the December 8 subcommittee meeting at which time the subcommittee could consider a "can-you-live-with-it" decision regarding model validation: that is, the validation shows that in the model the water mass balance is correct and the relationships used to represent the Licensee's facilities provide representative system results. The requested information included:

- Comparison of the model simulated and actual (historic) power generation (MWh) at each powerhouse in 2-week time steps from Calendar Year 1994 through 2000.
- Comparison of the model simulated and actual (historic) flow (acre-feet) through each powerhouse in 2-week time steps from Calendar Year 1994 through 2000.
- Mass water balance validation at each node for Calendar Year 1994 through 2000 in 2-week time steps.
- The daily output from the validation model run (all parameters at each node).

Action Item 7: Licensee to provide the above information to the subcommittee members by no later than November 28.

SMUD Offered To Re-Do Presentation To Interested Parties – Pam Taheri noted that some members of the subcommittee who might be interested in the "*Project Overview and Base Case Description*" presentation were not present. She offered to re-do the presentation upon request for those individuals so that they can be prepared for the December 8 subcommittee meeting.

Action Item 8: Any interested party who was not at the November 10 meeting to contact Pam Taheri to schedule a presentation. The presentation should occur prior to the December 8 subcommittee meeting which includes a "can you live with it" agenda item.

Bill Center Requested White Rock Powerhouse Generation - Bill Center said that he would find it useful to review the White Rock Powerhouse generation from 1994 through 2000 in one-hour time steps. Pam Taheri said she would have to consider this request since these data are proprietary to SMUD. Pam and Bill agreed to discuss the request outside the meeting.

Action Item 9: Bill Center and Pam Taheri to discuss Bill's request.

Licensee Presented The Base Case, And Subcommittee Requested Additional Information – Pam Taheri, Margaret Hannaford, and Dan Steiner made a presentation to the subcommittee on the Base Case (see the "*Project Overview and Base Case Description*" dated November 10, 2003 on the Relicensing Web Site). As with the Model, the Base Case at this time does not include Chili Bar or Iowa Hill, both of which will be added to the Base Case. Margaret pointed out the conceptual Base Case approved by the Plenary Group had the South Fork American River and EID's Eldorado Powerhouse daily flows assuming operation under the new EID license, but information was not available from 1996 through 2000. Bill Hetland said he

would pursue obtaining that information. The subcommittee also noted that, as described in the conceptual description of the Base Case approved by the Plenary Group, should any substantial information/data/etc. be identified in the future and with the approval of the Plenary Group, the Base Case would be revised. After viewing the presentation, the subcommittee requested a brief written description of the Base Case assumptions. The subcommittee members said that if they received the information by November 28, they would review it by the December 8 subcommittee meeting at which time the subcommittee could consider a "can-you-live-with-it" decision regarding the Base Case; that is, the model results are representative of the UARP system and the model is an acceptable tool for performing future modeling studies. The subcommittee said that dissemination of this description was a higher priority than the model validation material, and the Licensee agreed that it would distribute the description out to the subcommittee as soon as possible but definitely no later than November 28.

Action Item 10: Licensee to provide an expanded written description of the Base Case assumptions to the subcommittee members as soon as possible but no later than November 28.

Action Item 11: Bill Hetland to obtain South Fork American River and EID's Eldorado Powerhouse daily flows from 1996 through 2000 assuming operation under the new EID license, and provide the data to Parvez Mody.

Bill Hetland Requested That The Licensee Make EDCWA's Requested Model Runs Using The Current Base Case – Bill Hetland noted that EDCWA had submitted three model run requests to SMUD. He said it would be useful to have these runs made now even if the Base Case was not formally approved by the Plenary Group. Pam Taheri and Bill agreed to discuss this outside the meeting.

Action Item 12: Bill Hetland and Pam Taheri to discuss Bill's request.

NEXT MEETING

Next Water Balance Model Subcommittee Meeting Is Scheduled For December 8 – The next Water Balance Subcommittee meeting is scheduled for Monday, December 8, at SMUD from 9:00 a.m. to 4:00 p.m. As agreed to by the Subcommittee, agenda items will include:

- Review/Approve Agenda
- Identify "Hot" Items
- Approve November 10, 2003 Subcommittee Meeting Summary
- Review Status of Outstanding Action Items
- Review Additional Information on Model Validation ("Can you live with it" decision)
- Review Additional Information on Base case ("Can you live with it" decision)
- Identify Meeting Action Items
- Set Agenda for Next Subcommittee Meeting

Note that the January meeting will likely include a discussion of the revised hydrology, which Margaret Hannaford said should be available in mid December.

Upper American River Project
Relicensing Water Balance Subcommittee

Project Overview and
Base Case Description

Presented November 10, 2003

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Overview and Base Case Description
Today's Goals

- Provide an Overview of Project Locale and Features
- Recap Project Area Hydrology
- Present Modeling Overview
- Present Model Validation
- Describe Base Case Assumptions and Results – Excluding PG&E Chili Bar Project

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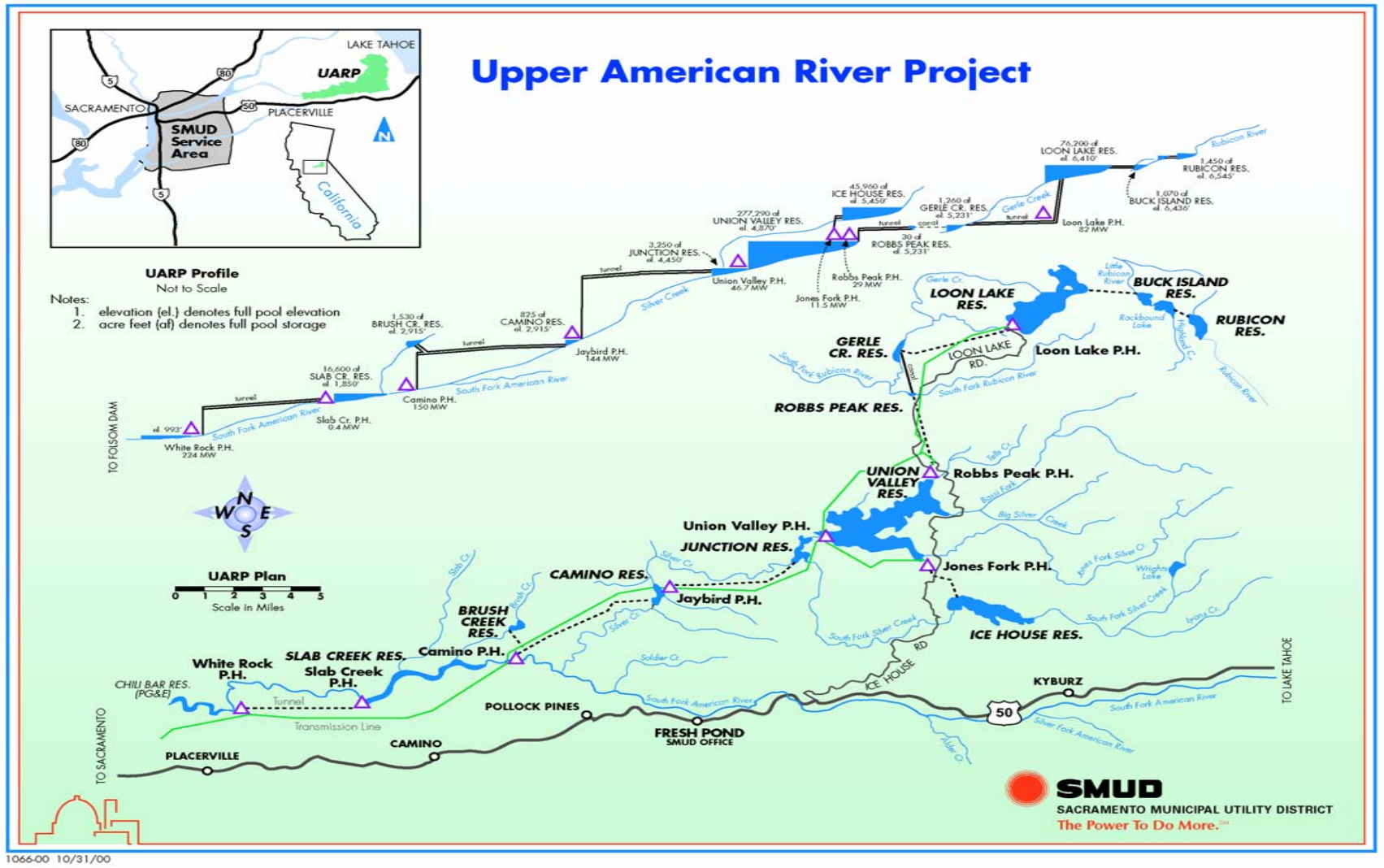
Project Locale and Features



Project Overview

- Project consists of eleven reservoirs and eight powerhouses
- In an average year provides approximately 1.8 billion kilowatt-hours of generation, about 20 percent of SMUD's customer energy
- Project provides operational flexibility, system reliability and economical power generation
- Key principles to the efficient and reliable operation of the Project:
  - Operate the Project reservoirs in a manner that avoids spilling water without providing generation
  - Contribute generation towards system needs
  - Safeguard the availability of an economical resource during periods of drought

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Project Area Hydrology

- Project utilizes runoff from the Rubicon River and tributaries of the South Fork American River

Average Annual Flow at Project Facilities

Rubicon River

207,000 acre-feet

South Fork American River at Slab Creek Reservoir

792,000 acre-feet

Range

132,000 (1977) – 1,751,000 (1983)

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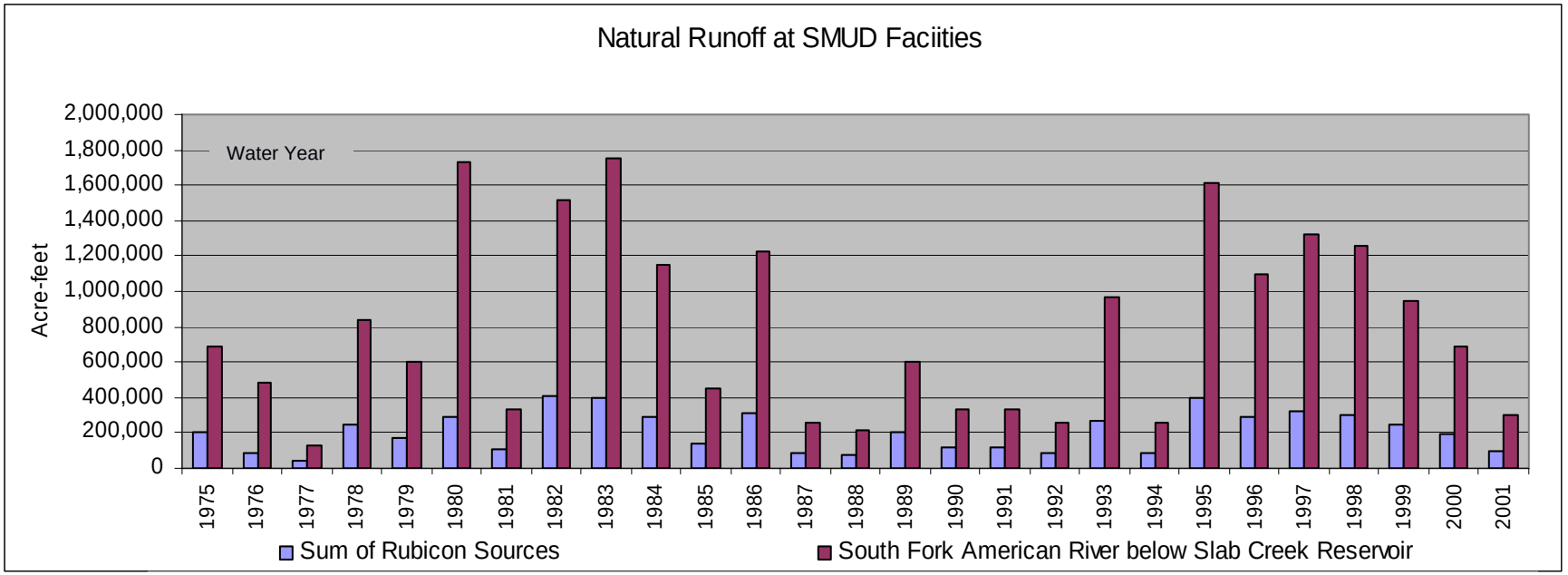
Project Area Hydrology



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Project Area Hydrology

Sacramento Municipal Utility District
Upper American River Project
Underlying Hydrology and Base Case Routing
Graphic

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Modeling Overview

- Long-term planning level studies
- Used to apply overarching planning and operation concepts consistently over a long-term hydrologic sequence
- Measures system performance under different circumstances

Modeling Overview

- CHEOPS Model
- Results generated on a finer resolution, but presented on a monthly resolution
- Limitations in the interpretation of results

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Model Validation

- Used to validate the hydraulic functionality of model
- Implemented a “forced” CHEOPS Model simulation for 1994 through 2000
- Historical reservoir elevations and in-stream releases provided as input to the model
- Historical power unit outages incorporated when information was available
- Powerhouse releases became the result of the forced operation

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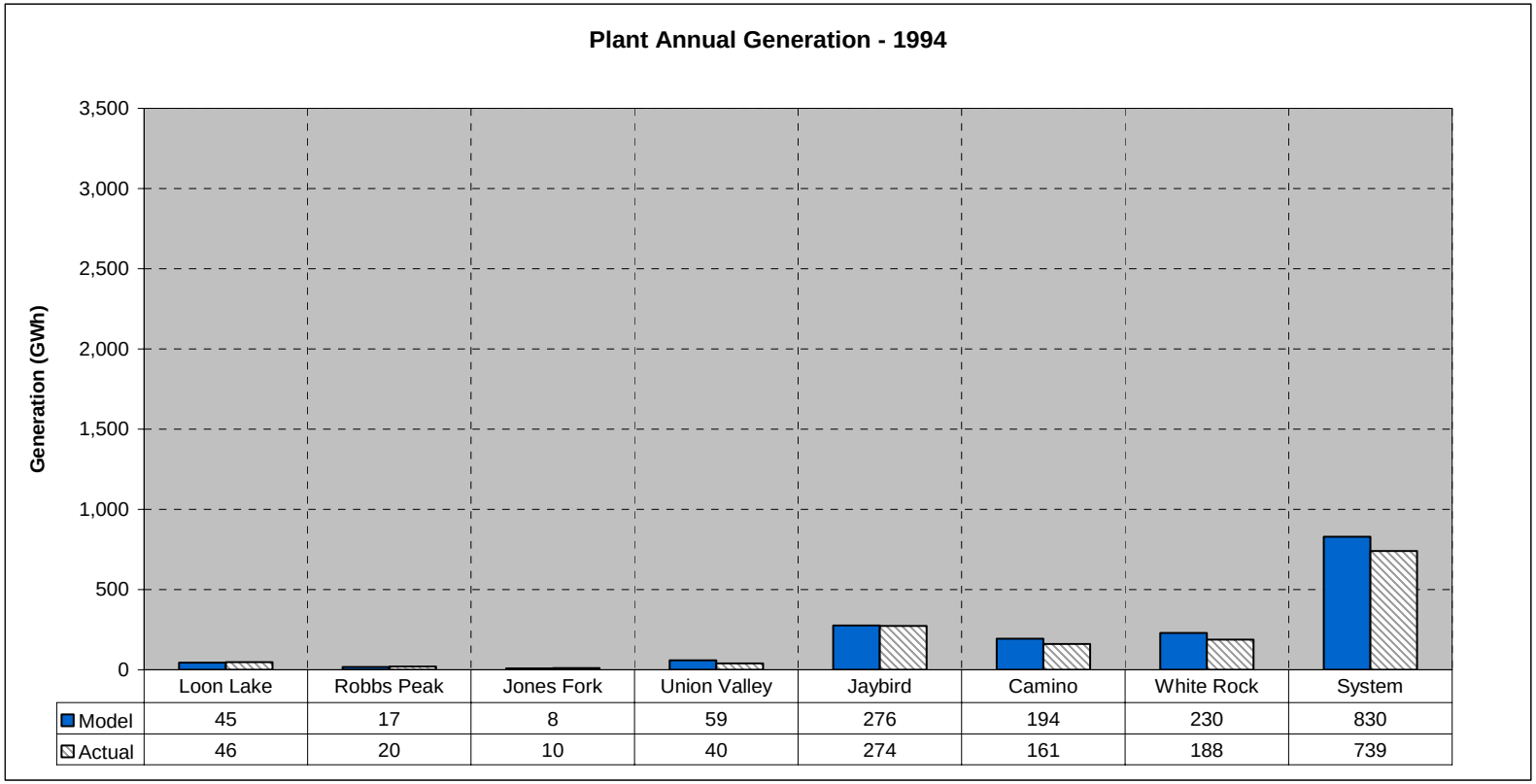
Model Validation

- Annual system-modeled and plant-modeled generation closely matches historical record



	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model	45	17	8	59	276	194	230	830
Actual	46	20	10	40	274	161	188	739

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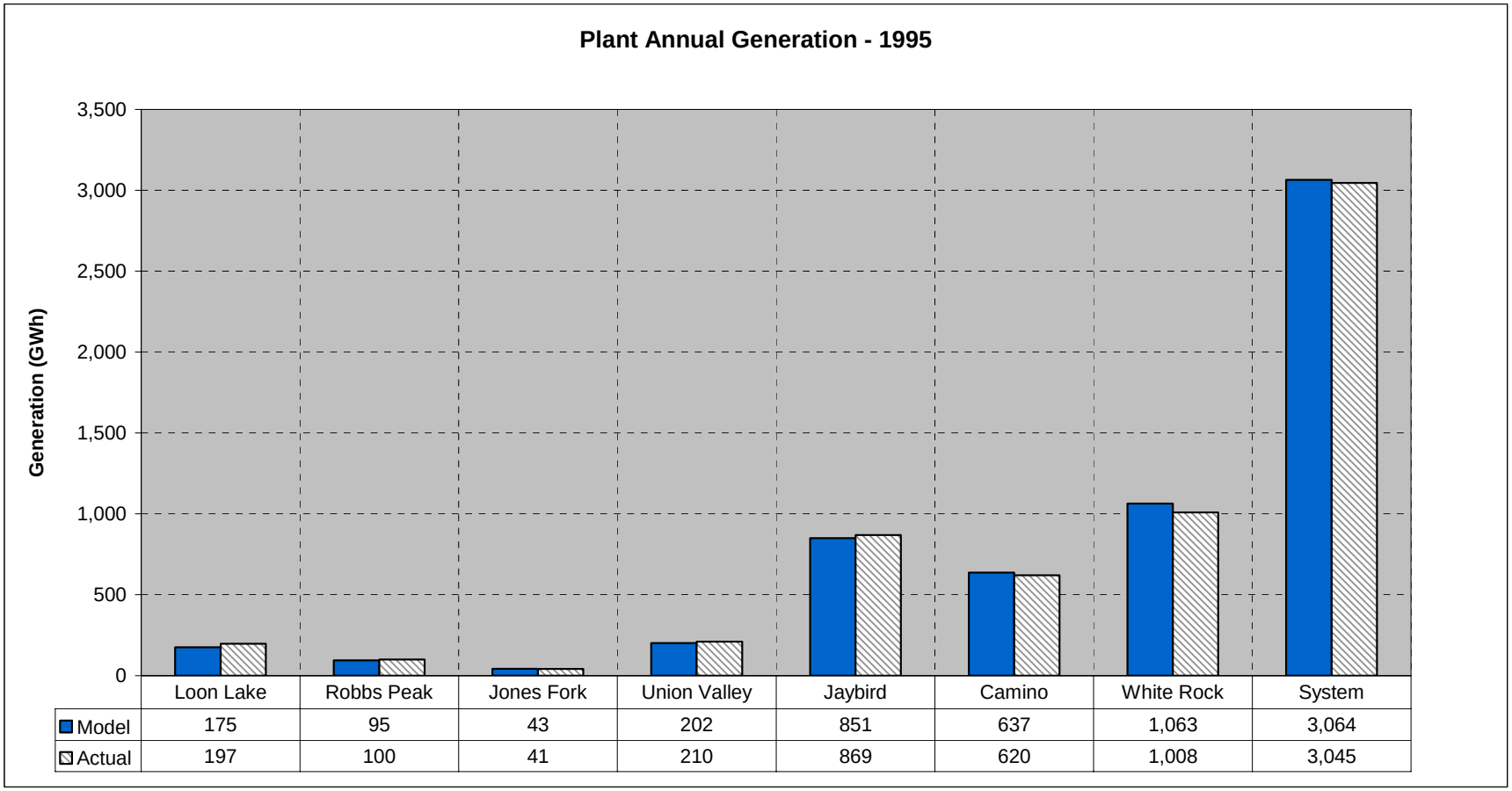
Model Validation



	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model	175	95	43	202	851	637	1,063	3,064
Actual	197	100	41	210	869	620	1,008	3,045

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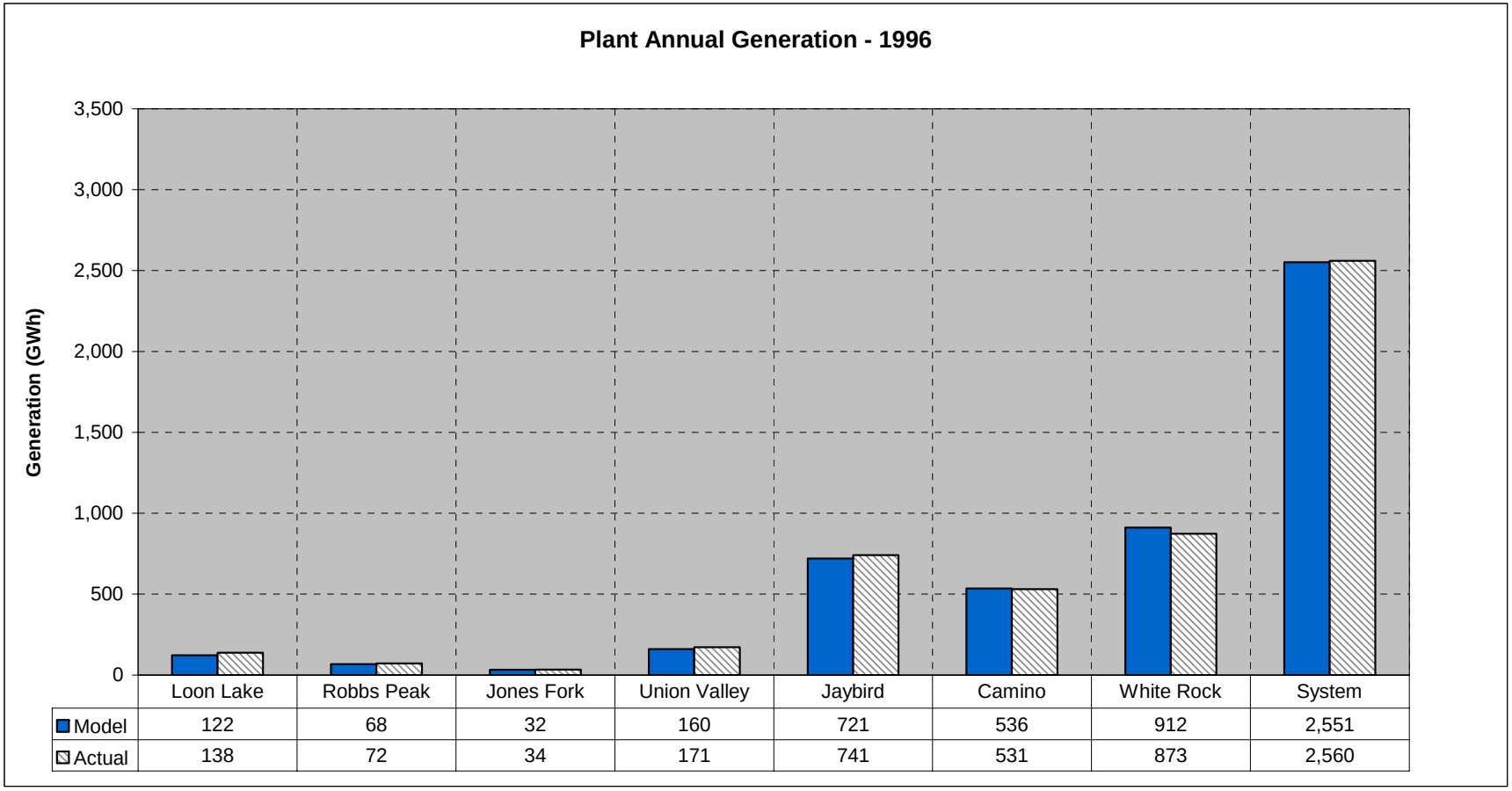

	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model	122	68	32	160	721	536	912	2,551
Actual	138	72	34	171	741	531	873	2,560

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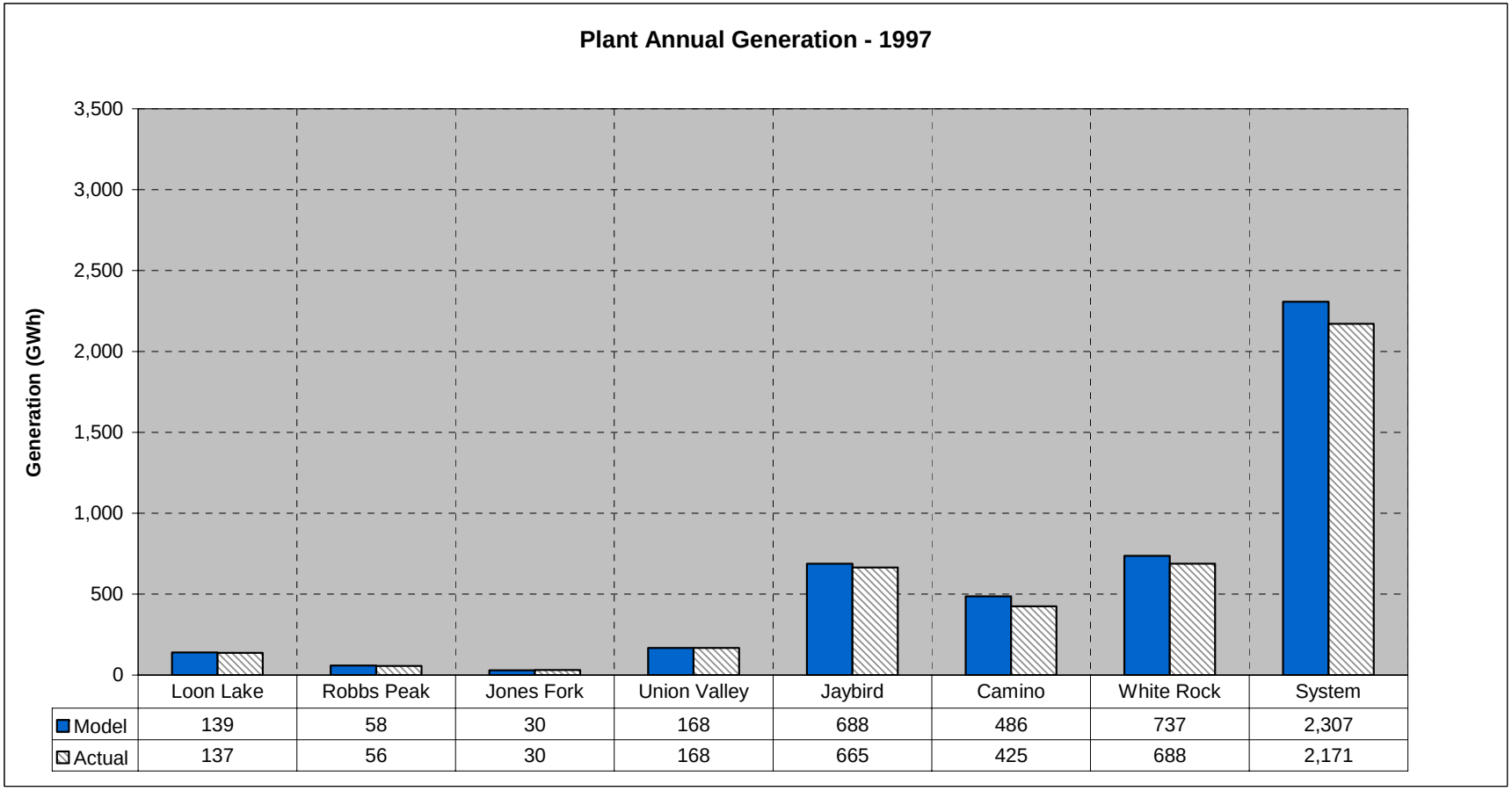

	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model	139	58	30	168	688	486	737	2,307
Actual	137	56	30	168	665	425	688	2,171

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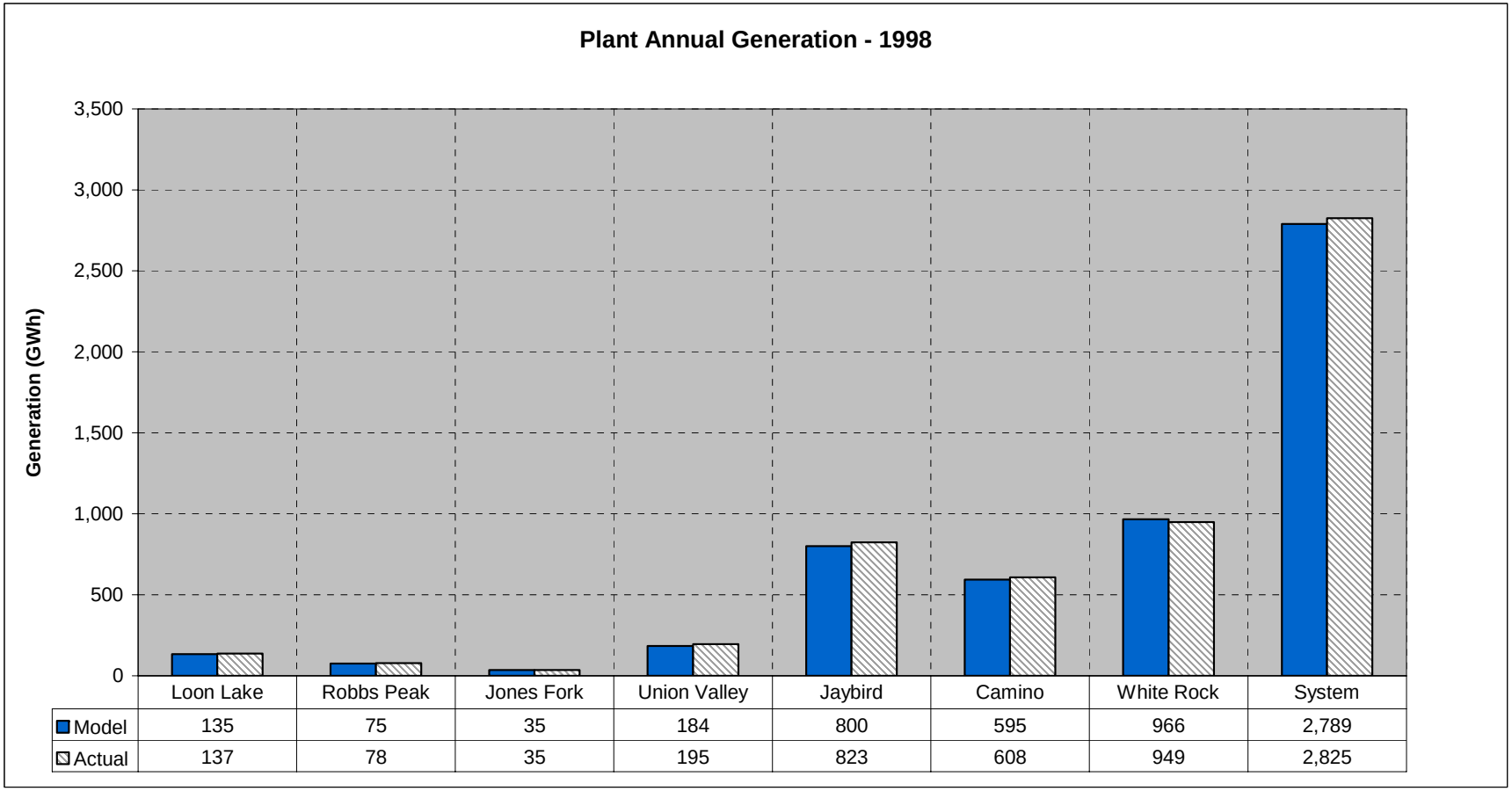

	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model	135	75	35	184	800	595	966	2,789
Actual	137	78	35	195	823	608	949	2,825

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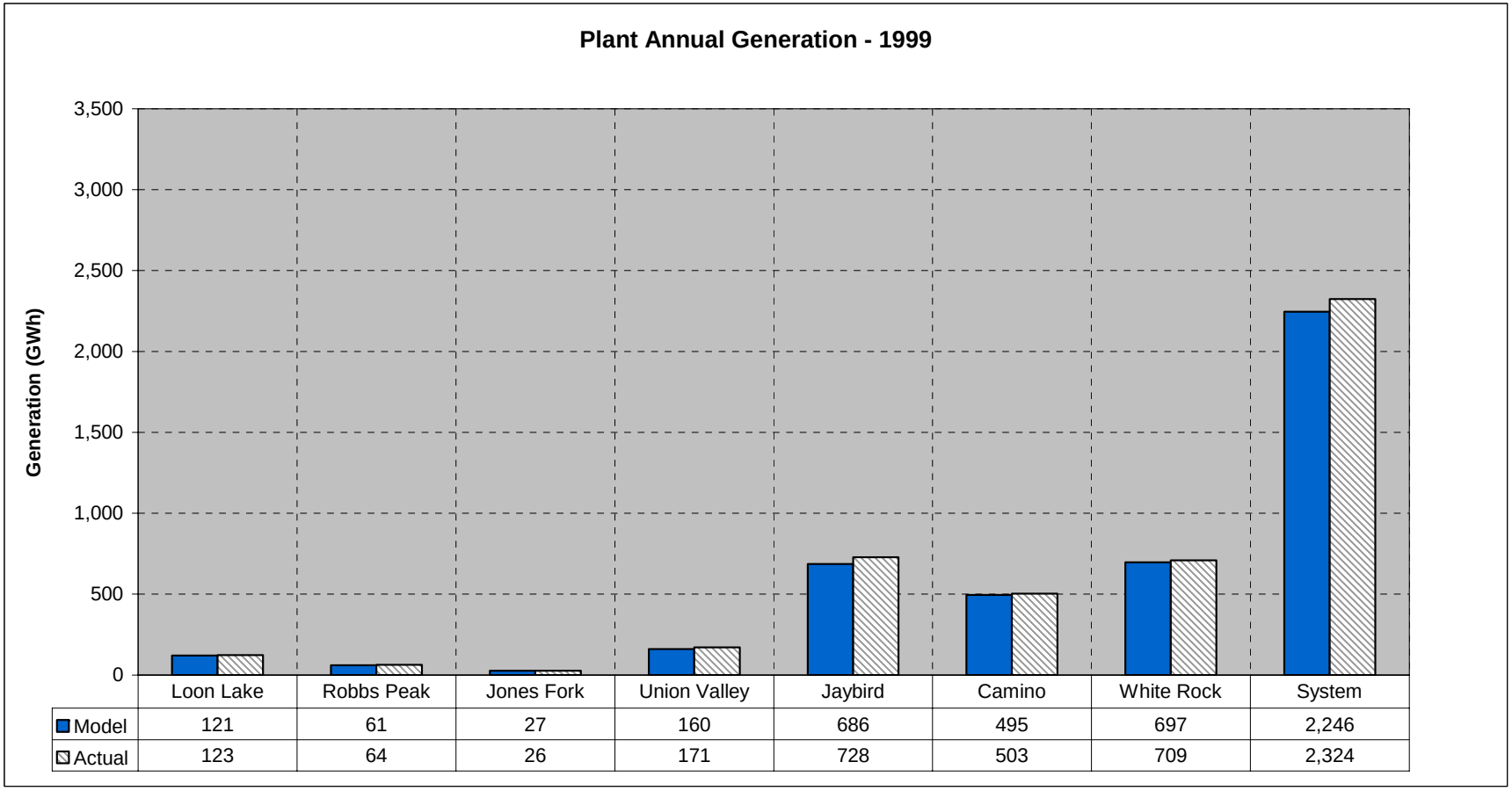

	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model	121	61	27	160	686	495	697	2,246
Actual	123	64	26	171	728	503	709	2,324

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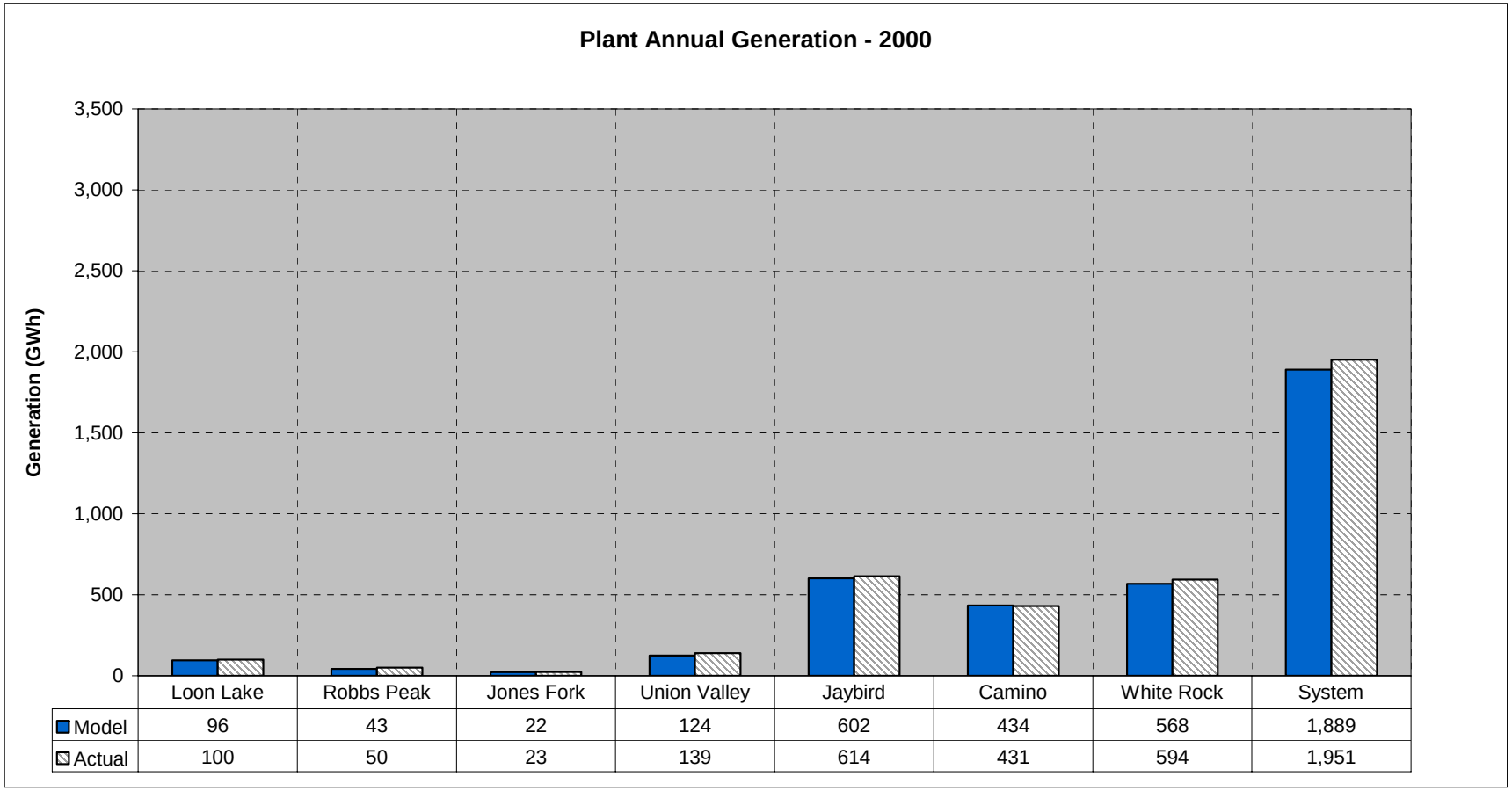

	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model	96	43	22	124	602	434	568	1,889
Actual	100	50	23	139	614	431	594	1,951

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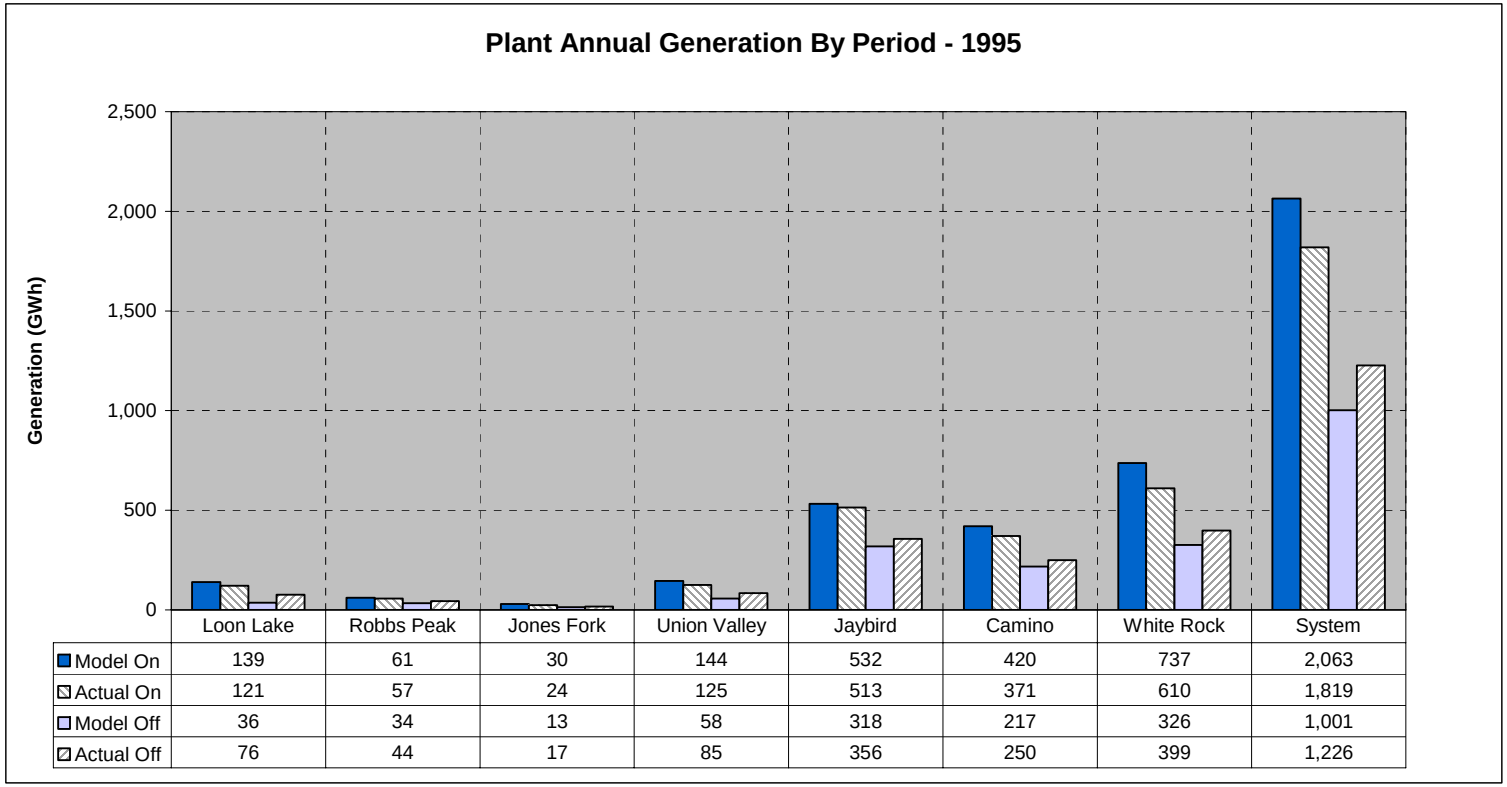
Model Validation

- On-peak and off-peak disaggregated generation compares also, and the differences are explainable and acceptable



	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model On	139	61	30	144	532	420	737	2,063
Actual On	121	57	24	125	513	371	610	1,819
Model Off	36	34	13	58	318	217	326	1,001
Actual Off	76	44	17	85	356	250	399	1,226

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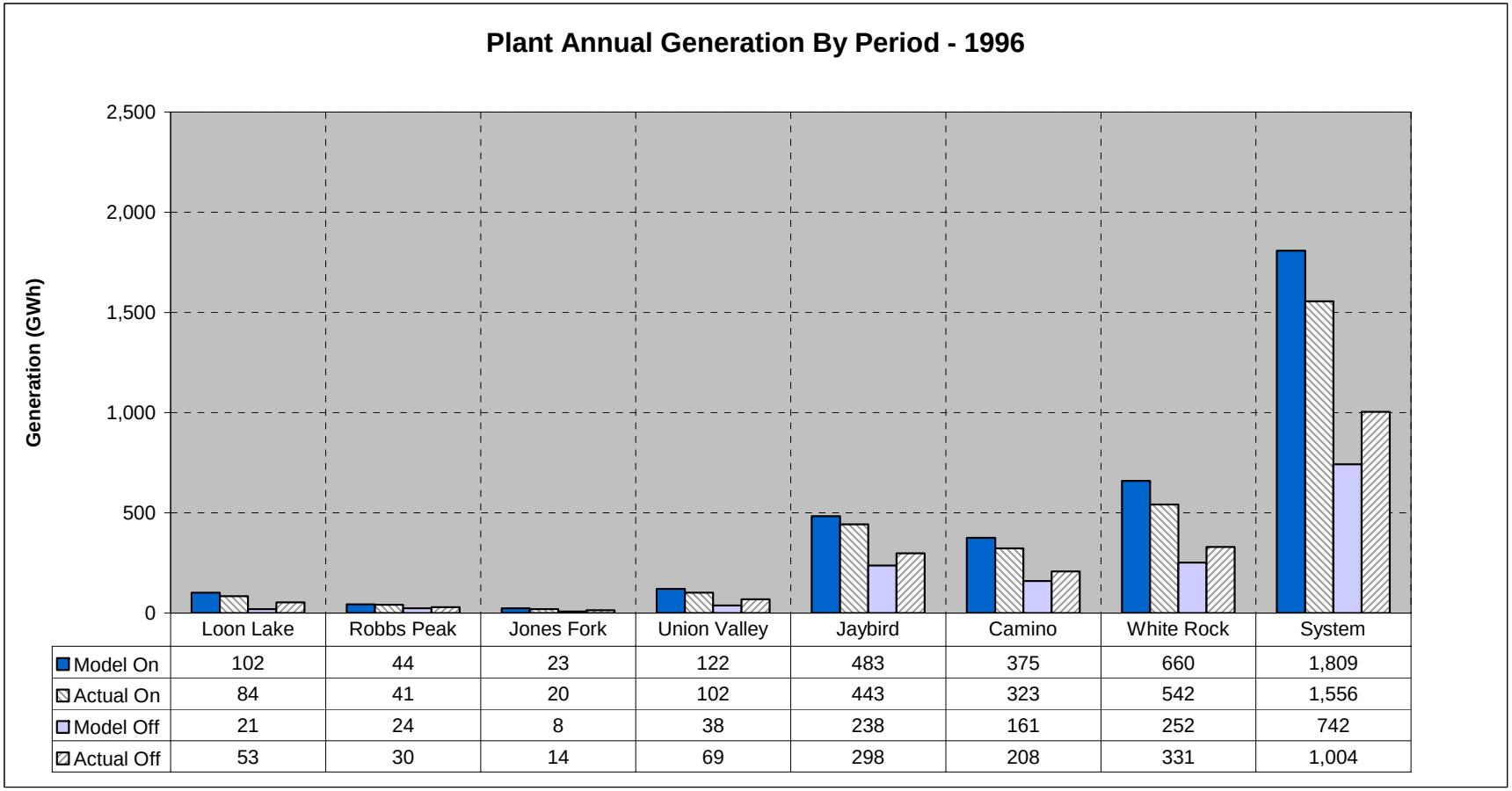

	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model On	102	44	23	122	483	375	660	1,809
Actual On	84	41	20	102	443	323	542	1,556
Model Off	21	24	8	38	238	161	252	742
Actual Off	53	30	14	69	298	208	331	1,004

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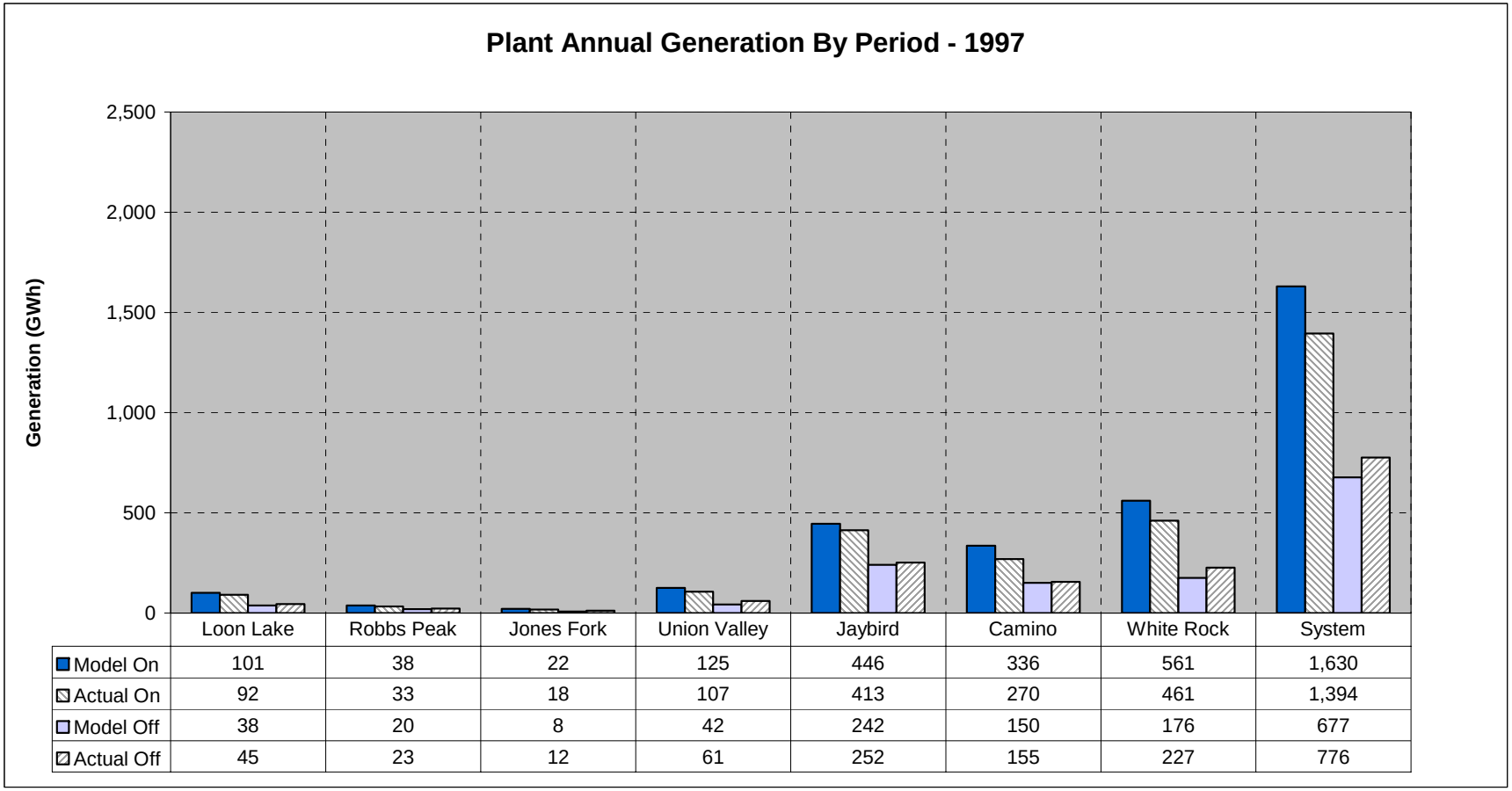

	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model On	101	38	22	125	446	336	561	1,630
Actual On	92	33	18	107	413	270	461	1,394
Model Off	38	20	8	42	242	150	176	677
Actual Off	45	23	12	61	252	155	227	776

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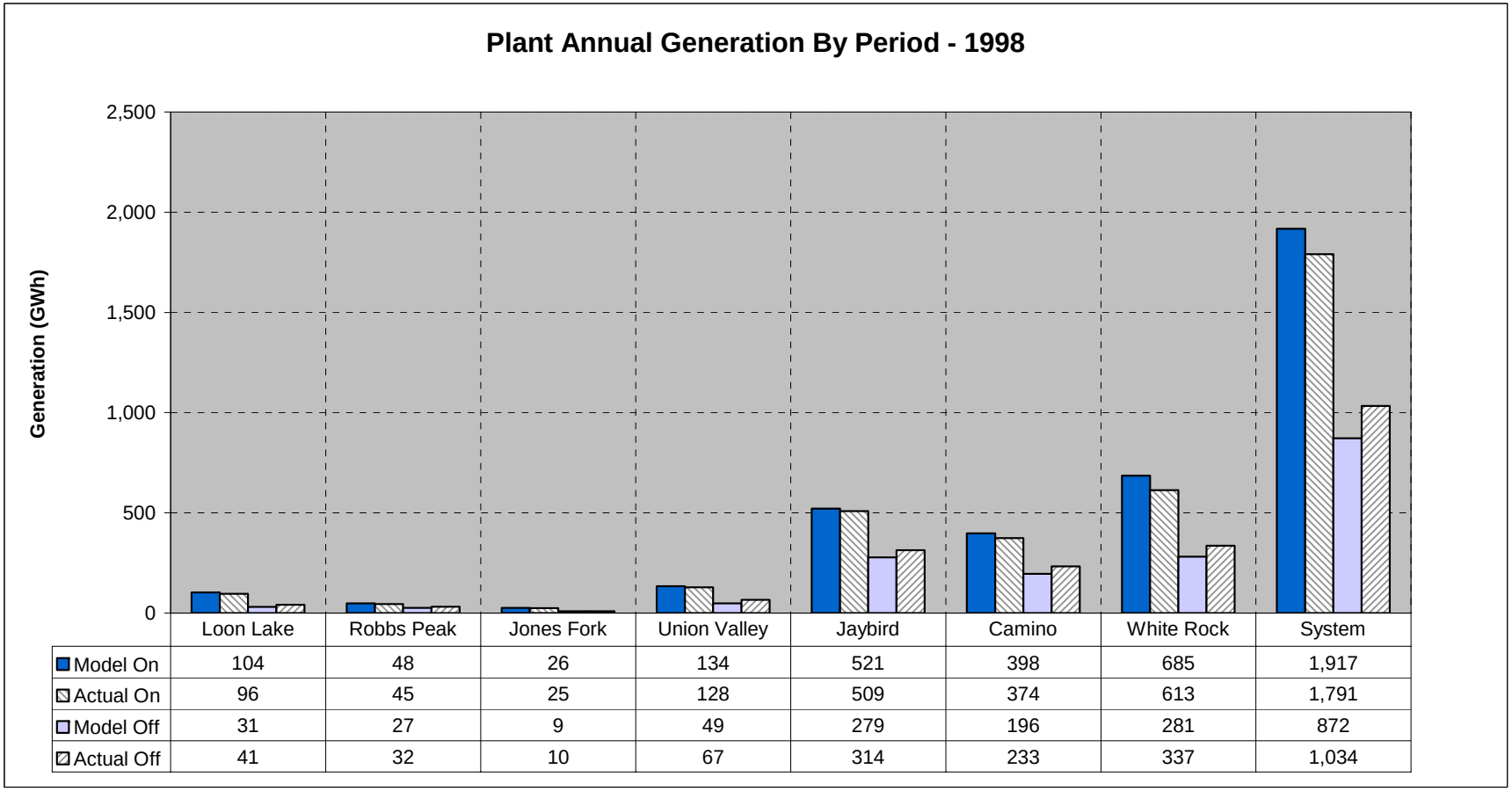

	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model On	104	48	26	134	521	398	685	1,917
Actual On	96	45	25	128	509	374	613	1,791
Model Off	31	27	9	49	279	196	281	872
Actual Off	41	32	10	67	314	233	337	1,034

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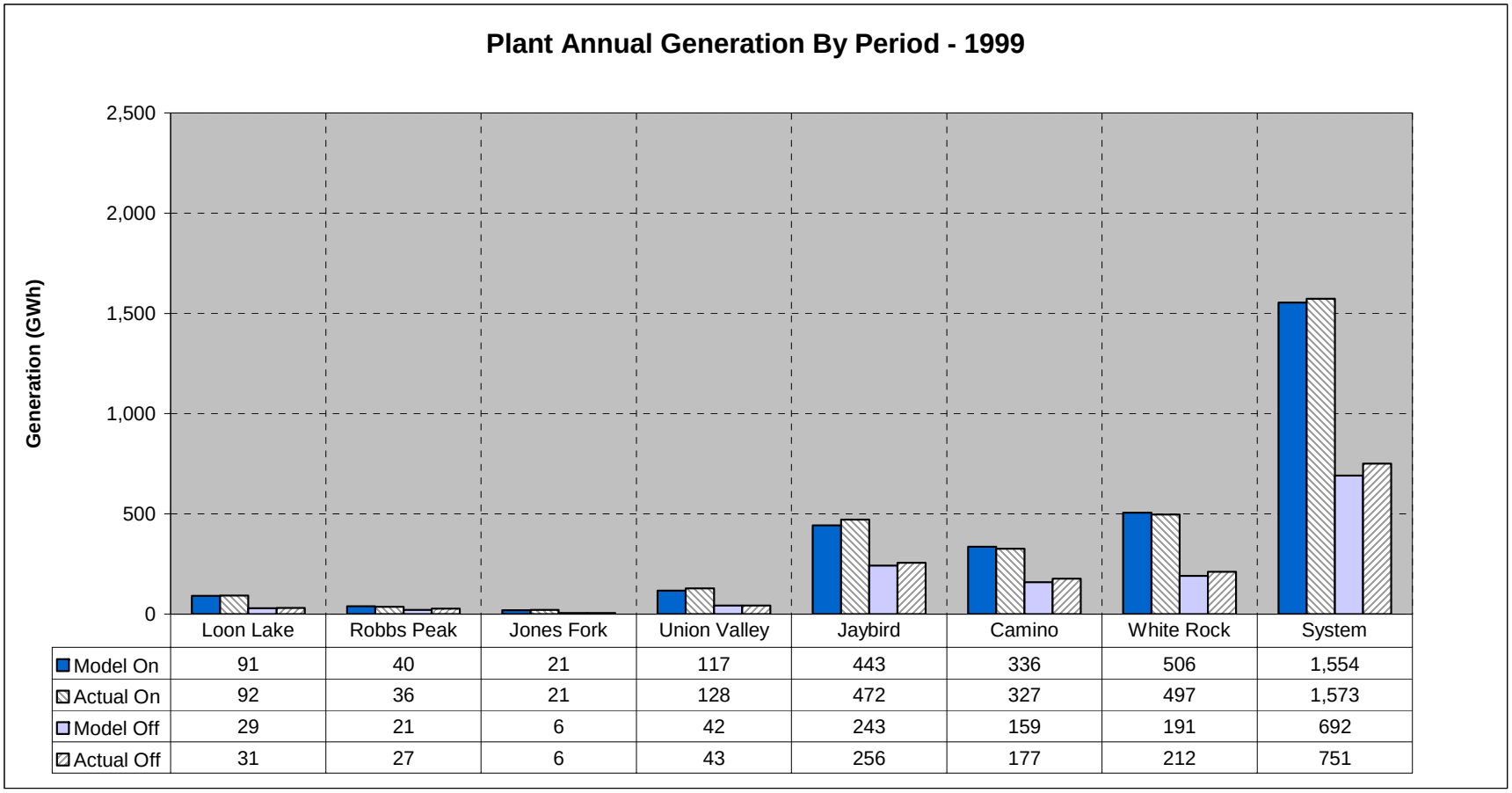

	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model On	91	40	21	117	443	336	506	1,554
Actual On	92	36	21	128	472	327	497	1,573
Model Off	29	21	6	42	243	159	191	692
Actual Off	31	27	6	43	256	177	212	751

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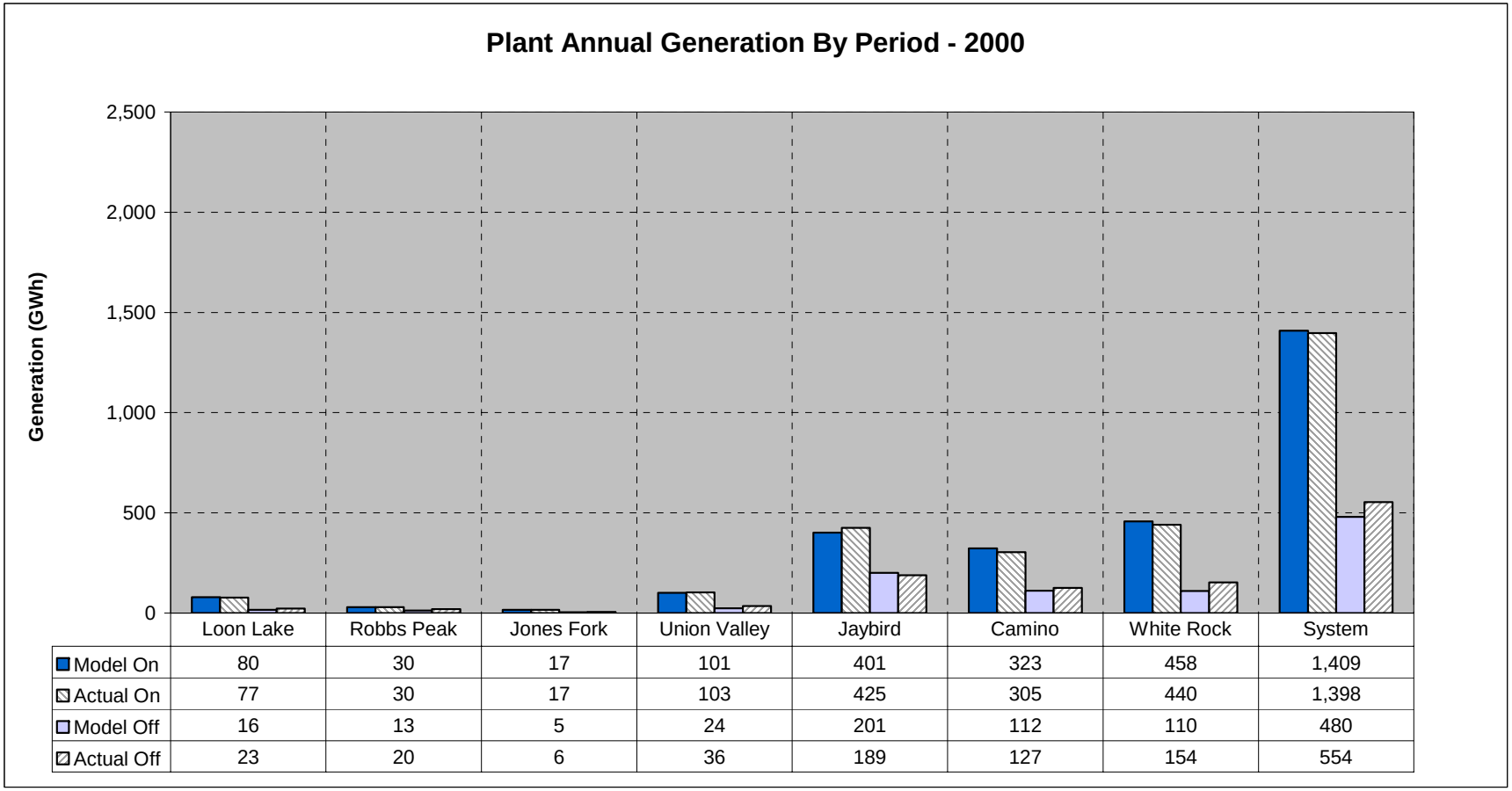

	Loon Lake	Robbs Peak	Jones Fork	Union Valley	Jaybird	Camino	White Rock	System
Model On	80	30	17	101	401	323	458	1,409
Actual On	77	30	17	103	425	305	440	1,398
Model Off	16	13	5	24	201	112	110	480
Actual Off	23	20	6	36	189	127	154	554

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Base Case Assumptions

- System Characteristics
- Overarching Planning and Operation Goals
- Operational Constraints / Objectives

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Base Case Assumptions
System Characteristics

- Generator / turbine efficiency curves
- Tunnel / penstock flow constraints
- Spillway radial gates / flashboard operation

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Base Case Assumptions
Overarching Planning and Operation Goals

- Management of water for generation
  - Avoidance of spill without generation
  - Carry-over storage into summer season
  - Carry-over storage for drought

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Base Case Assumptions
Overarching Planning and Operation Goals

- Preferred Reservoir Storage Objectives
  - Five families of storage targets based on basin wetness
  - Mimics the forecasting of inflow – used to create available reservoir space for upcoming runoff, more during wetter years
  - “Pushes” water through the system

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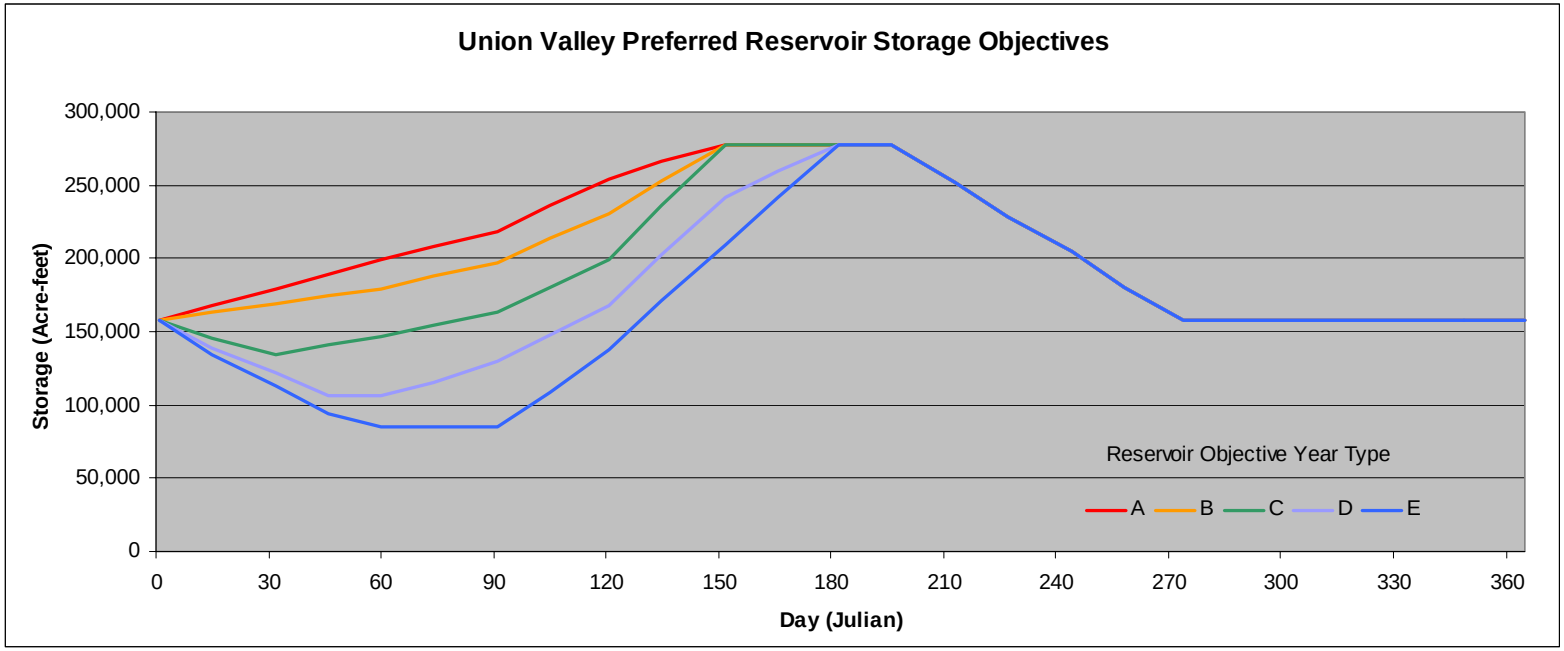
Base Case Assumptions
Overarching Planning and Operation Goals

- Preferred Reservoir Storage Objectives

Example



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Base Case Assumptions
Overarching Planning and Operation Goals

- Preferred Monthly Reliability Objective
  - Mimics the draw of energy / water during months when storage objectives do not provide releases
  - Mimics the need / use of energy from Project for reliability / economy purposes
  - Leads to a dependable source of energy from the Project during the worst drought of history (drought year protection)

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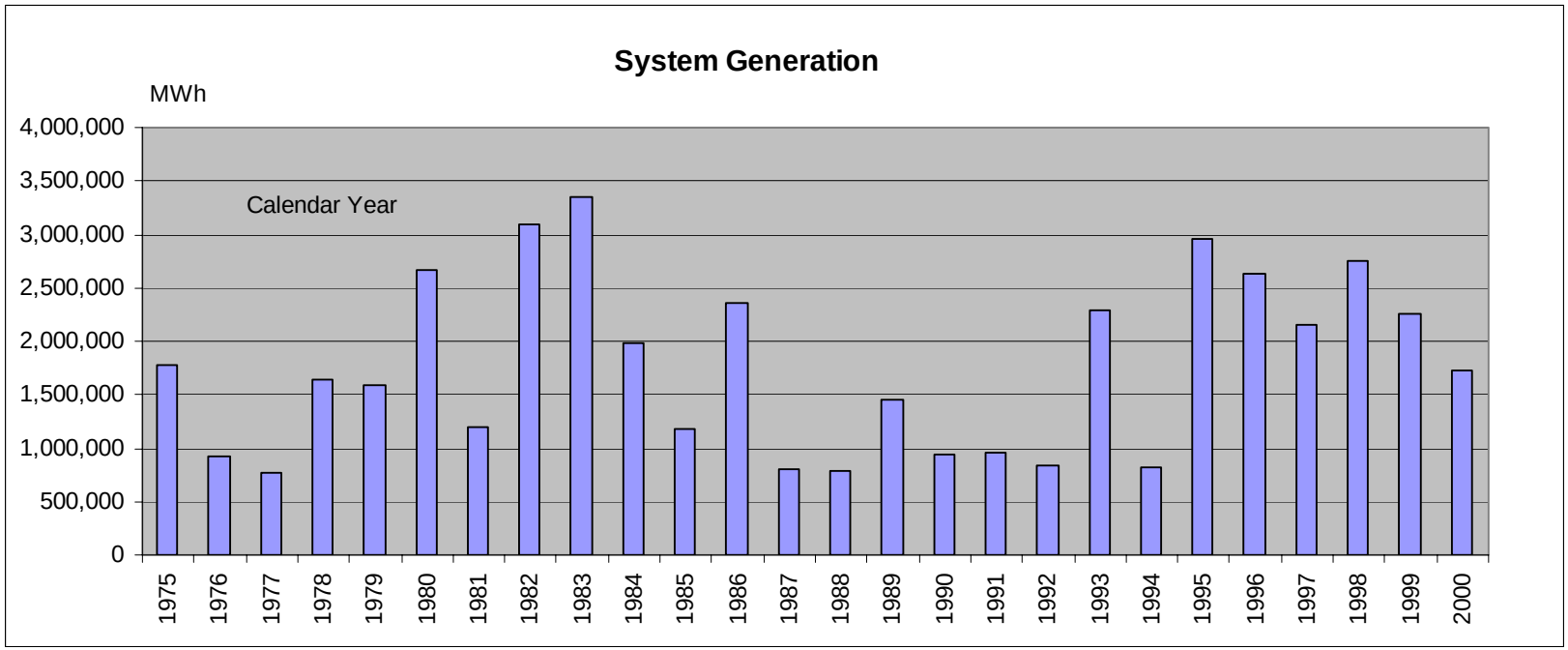
Base Case Assumptions
Overarching Planning and Operation Goals

- Operational Constraints / Objectives
  - Minimum stream flow requirements met
  - Generation is prioritized to peak-demand periods of a day
  - Operating reserve is incorporated into available generation capacity

Base Case Results

- Varying Annual Generation



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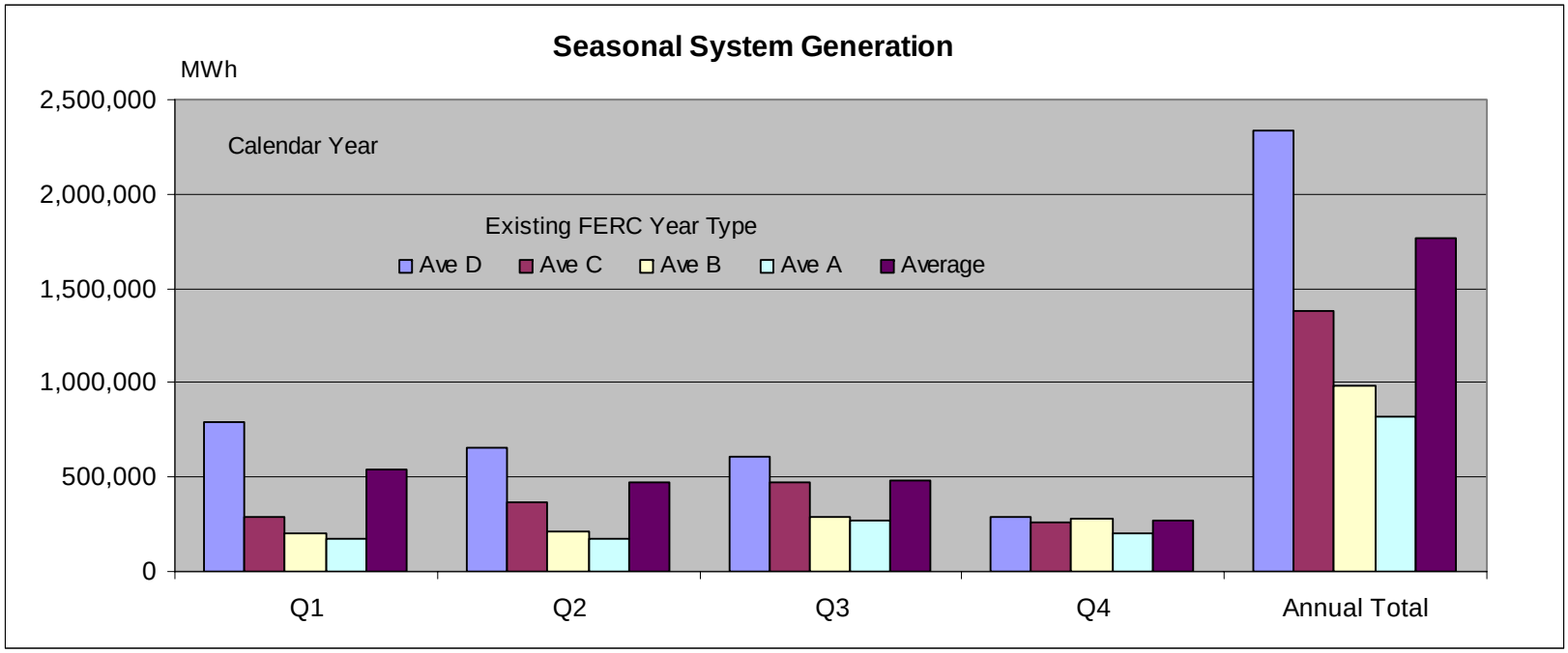
Base Case Results

- Seasonal Generation



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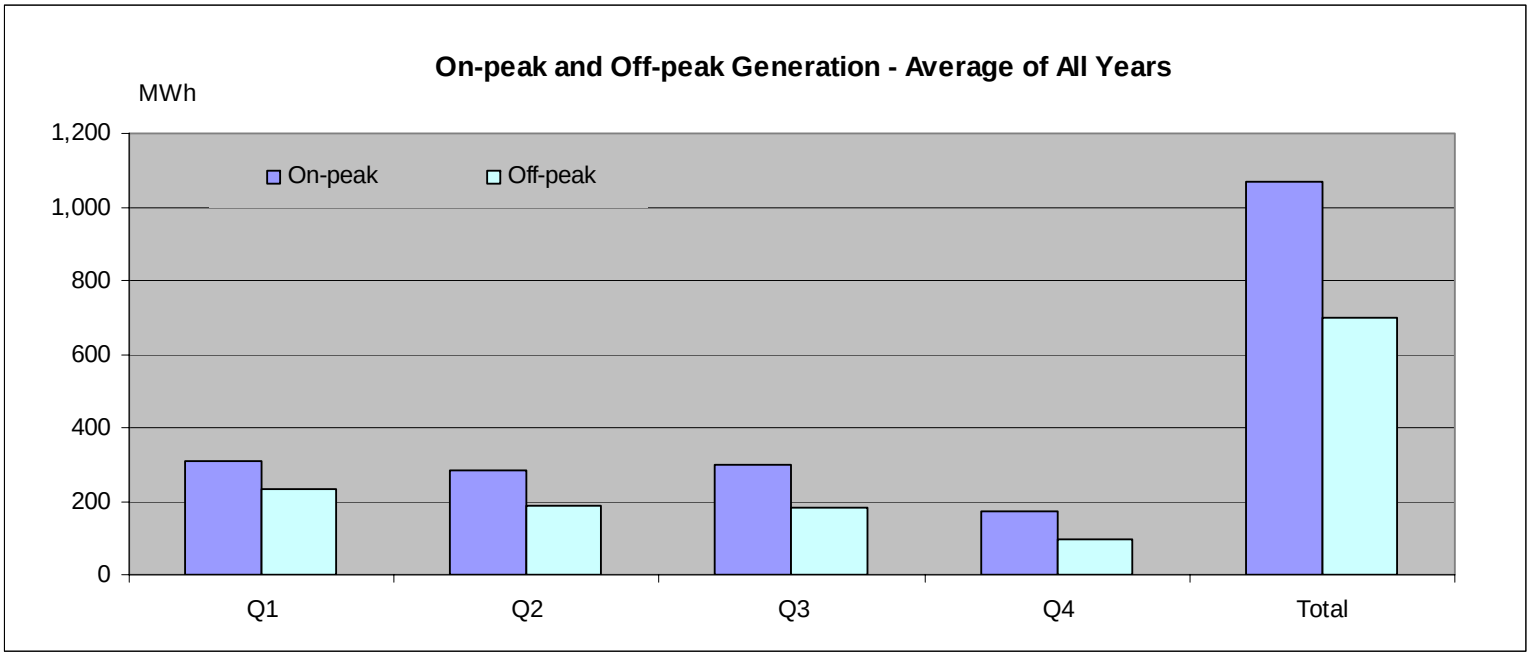
Base Case Results

- On-peak and Off-peak Generation – Average of All Years



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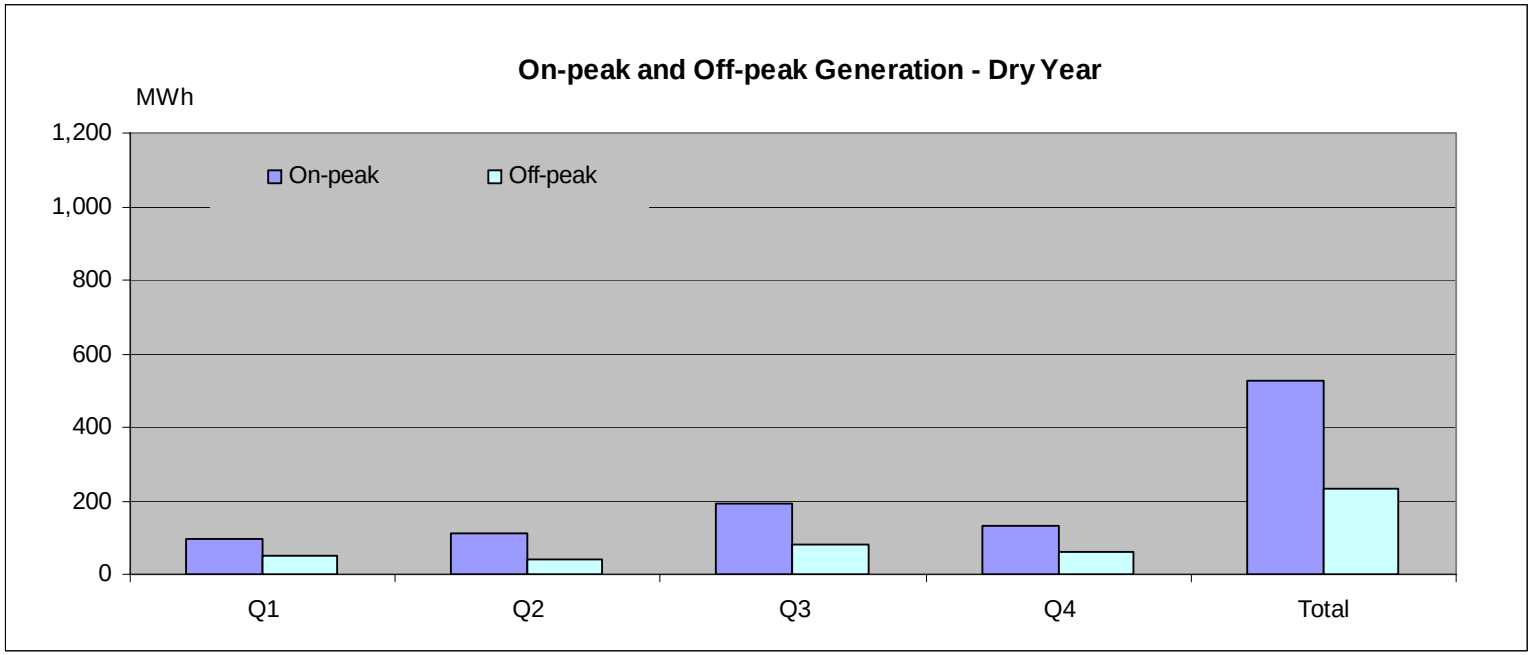
Base Case Results

- On-peak and Off-peak Generation – Dry Year



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Base Case Results

- Total Project Generation

Total UARP Generation - Base Case

Calendar	Q1		Q2		Q3		Q4		Annual		Total
Year	On	Off	On	Off	On	Off	On	Off	On	Off	Annual
1975	285,724	170,509	283,839	186,539	360,752	236,269	168,760	91,931	1,099,075	685,248	1,784,323
1976	141,817	58,149	136,609	53,181	242,434	95,855	128,512	58,999	649,372	266,183	915,555
1977	94,632	49,752	109,011	42,229	189,939	79,452	133,007	62,127	526,589	233,560	760,149
1978	247,551	118,615	302,413	161,254	355,307	240,138	147,520	71,572	1,052,791	591,579	1,644,371
1979	235,916	126,233	270,474	139,616	318,866	221,879	185,702	91,336	1,010,958	579,064	1,590,021
1980	531,409	510,297	356,107	268,587	465,468	309,890	143,874	79,982	1,496,859	1,168,756	2,665,615
1981	144,389	63,911	153,289	61,901	185,782	76,836	291,755	217,994	775,216	420,643	1,195,858
1982	546,165	513,643	506,099	427,633	369,230	233,535	300,522	198,834	1,722,016	1,373,645	3,095,661
1983	522,827	480,215	466,385	398,157	484,053	381,194	357,425	255,780	1,830,690	1,515,345	3,346,035
1984	462,369	342,273	260,350	112,741	331,177	226,217	173,706	80,232	1,227,602	761,463	1,989,065
1985	150,234	70,554	214,979	106,304	258,306	144,931	155,299	78,005	778,818	399,795	1,178,613
1986	491,224	443,259	399,832	297,958	321,941	202,901	143,063	66,058	1,356,060	1,010,176	2,366,236
1987	124,018	51,174	130,557	51,948	178,414	72,661	130,512	63,875	563,500	239,659	803,159
1988	112,099	55,205	115,383	44,418	174,858	70,774	140,583	66,892	542,923	237,290	780,212
1989	224,316	119,761	318,347	207,374	247,636	141,753	142,977	73,438	933,276	542,326	1,475,601
1990	138,868	63,173	147,127	63,075	217,186	118,149	134,240	57,857	637,421	302,253	939,674
1991	128,789	54,433	172,919	78,000	221,285	105,490	139,754	64,052	662,747	301,976	964,722
1992	136,829	57,760	124,264	54,491	177,642	71,718	139,010	63,779	577,745	247,747	825,492
1993	399,676	292,691	453,607	352,378	355,934	222,828	141,043	74,304	1,350,260	942,200	2,292,460
1994	113,419	53,073	128,099	50,893	178,717	76,775	145,117	71,016	565,352	251,756	817,108
1995	497,584	411,564	496,771	426,308	463,314	370,178	188,686	109,266	1,646,356	1,317,317	2,963,673
1996	514,601	451,317	445,180	333,423	298,322	175,929	240,977	172,546	1,499,081	1,133,215	2,632,296
1997	514,146	475,226	274,984	135,589	328,448	213,462	142,341	67,552	1,259,920	891,829	2,151,749
1998	467,535	387,358	469,750	379,662	443,682	321,881	187,185	99,303	1,568,151	1,188,204	2,756,355
1999	454,444	359,959	380,485	250,532	362,564	238,148	137,804	66,823	1,335,297	915,463	2,250,760
2000	404,434	270,061	289,614	149,504	255,088	151,463	132,768	68,292	1,081,905	639,320	1,721,224
Average	310,962	232,699	284,864	185,911	299,475	184,627	172,005	95,071	1,067,307	698,308	1,765,615
Median	266,638	148,371	279,412	144,560	308,594	189,415	143,468	72,505	1,067,348	615,450	1,682,797
Maximum	546,165	513,643	506,099	427,633	484,053	381,194	357,425	255,780	1,830,690	1,515,345	3,346,035
Minimum	94,632	49,752	109,011	42,229	174,858	70,774	128,512	57,857	526,589	233,560	760,149

Units: MWh

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Base Case Results

- Individual Plant Generation

Union Valley Generation
MWh

CY	Q1	Q2	Q3	Q4	Annual Total
1975	28,882	18,085	53,029	17,462	117,459
1976	9,045	10,728	19,829	13,567	53,168
1977	8,765	9,124	17,401	10,433	45,723
1978	6,513	14,186	51,238	17,523	89,459
1979	18,766	16,024	48,935	15,879	99,604
1980	72,091	24,275	58,953	16,610	171,929
1981	8,698	10,926	20,857	35,858	76,339
1982	89,362	70,542	50,791	30,508	241,202
1983	72,651	52,071	73,486	46,871	245,078
1984	53,282	14,148	49,605	15,940	132,975
1985	12,378	16,253	35,070	15,896	79,597
1986	68,889	47,641	46,004	16,000	178,534
1987	8,567	10,710	20,049	13,985	53,311
1988	8,284	10,237	18,468	12,950	49,940
1989	10,552	31,020	33,046	15,835	90,453
1990	8,947	10,906	29,347	15,440	64,640
1991	9,340	10,846	26,878	15,508	62,572
1992	8,683	10,770	20,066	13,916	53,435
1993	30,603	44,729	50,002	16,709	142,044
1994	8,478	10,646	19,878	13,959	52,962
1995	55,466	54,383	69,832	22,239	201,920
1996	69,736	47,317	39,787	25,093	181,932
1997	78,129	19,489	49,563	15,644	162,824
1998	53,199	44,046	64,147	20,714	182,107
1999	54,594	30,704	53,221	15,408	153,928
2000	37,236	22,522	35,422	15,156	110,337
Min	6,513	9,124	17,401	10,433	45,723
Med	23,824	17,169	42,895	15,888	104,970
Max	89,362	70,542	73,486	46,871	245,078
Ave	34,274	25,474	40,573	18,658	118,980

Base Case Results

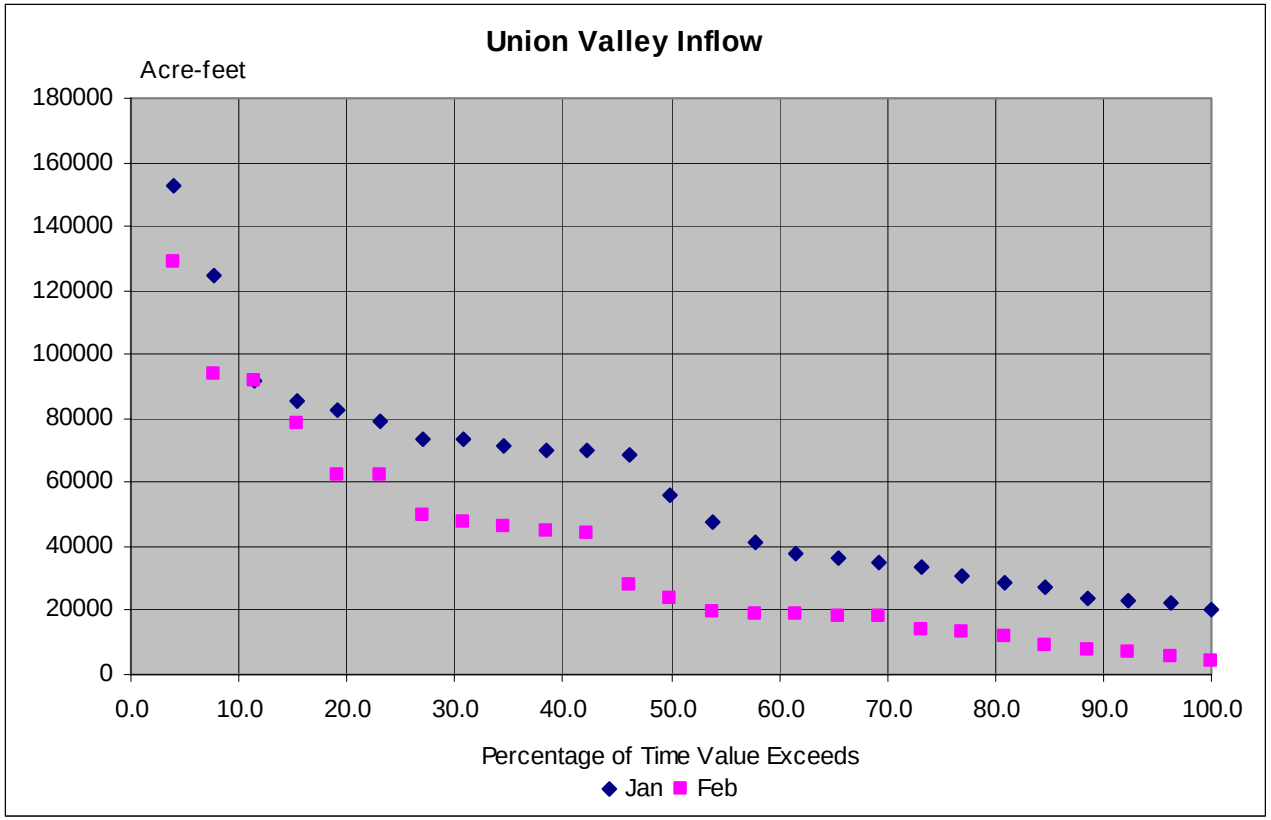
- Reservoir and Stream Hydrology Information

Union Valley Inflow
Acre-feet

CY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1975	36,518	18,787	29,193	24,672	88,661	85,006	28,241	17,937	14,513	15,776	15,005	15,324	389,631
1976	27,439	7,868	14,235	19,545	17,479	3,281	1,073	3,933	10,114	3,476	1,437	7,204	117,084
1977	20,258	5,785	6,677	11,945	15,073	21,685	25,245	16,988	6,605	350	1,608	20,090	152,310
1978	33,317	24,082	63,564	65,097	68,778	63,842	30,289	18,672	16,951	3,672	2,016	8,471	398,750
1979	55,883	17,972	31,144	54,662	78,602	30,133	12,782	15,808	13,442	7,135	13,077	19,302	349,942
1980	124,976	78,515	45,916	63,928	59,408	53,040	40,795	18,230	13,780	2,936	1,997	10,310	513,830
1981	37,639	19,624	19,500	40,267	27,793	4,547	2,802	12,407	13,804	5,832	74,752	90,462	349,429
1982	73,572	93,893	76,765	104,311	131,038	50,814	31,984	21,554	20,933	42,151	32,791	34,606	714,413
1983	68,303	44,819	77,573	57,111	104,036	171,328	111,447	39,158	18,407	9,115	99,830	75,714	876,840
1984	79,285	46,453	47,500	42,446	55,374	41,374	22,280	16,767	14,031	5,122	30,122	18,790	419,544
1985	41,158	11,932	18,803	60,019	36,860	10,083	5,580	13,826	14,166	4,374	7,308	29,855	253,962
1986	91,560	129,033	131,875	96,063	47,939	23,974	19,201	17,155	14,947	6,946	1,759	8,842	589,295
1987	22,535	14,172	20,482	40,361	18,528	3,548	1,461	11,046	13,241	3,605	2,287	17,497	168,762
1988	35,135	12,973	20,159	20,120	13,802	5,831	1,270	7,703	11,236	12,347	10,741	19,764	171,081
1989	28,990	18,887	93,491	99,164	41,099	18,990	9,172	13,316	13,845	7,816	6,494	13,153	364,416
1990	47,328	9,276	28,445	43,643	24,441	11,926	3,584	13,343	14,085	3,553	1,558	7,486	208,670
1991	30,526	4,449	26,502	33,065	45,311	24,318	11,033	16,721	13,964	4,597	6,105	9,971	226,562
1992	23,224	18,001	25,836	40,144	8,922	3,533	1,356	7,415	10,959	3,565	2,735	16,340	162,030
1993	69,710	27,710	78,670	88,516	96,636	50,000	28,788	19,354	14,312	3,539	1,483	9,994	488,712
1994	24,146	6,733	22,938	30,199	25,301	4,719	2,855	11,434	13,002	3,461	7,574	17,192	169,555
1995	85,620	62,232	97,139	93,300	104,787	78,387	85,172	33,645	16,970	4,207	1,930	38,033	701,423
1996	71,244	91,557	67,736	91,407	97,333	18,384	17,204	17,226	14,058	3,020	31,934	96,945	618,048
1997	152,595	62,610	49,783	55,604	43,947	36,137	14,142	16,327	13,409	3,772	4,791	13,803	466,921
1998	82,459	44,195	65,522	73,136	84,358	104,460	68,364	21,887	15,880	4,368	11,671	26,228	602,528
1999	73,416	50,073	43,714	62,079	84,534	67,619	25,235	17,575	14,084	3,924	4,169	9,454	455,877
2000	70,080	47,845	43,684	75,483	56,436	12,008	9,513	15,590	13,760	3,173	2,660	10,628	360,860
Min	20,258	4,449	6,677	11,945	8,922	3,281	1,073	3,933	6,605	350	1,437	7,204	117,084
Med	51,605	21,853	43,699	56,357	51,657	24,146	15,673	16,744	13,997	4,066	5,448	16,766	377,024
Max	152,595	129,033	131,875	104,311	131,038	171,328	111,447	39,158	20,933	42,151	99,830	96,945	876,840
Ave	57,958	37,288	47,956	57,165	56,788	38,422	23,495	16,731	14,019	6,609	14,532	24,825	395,787

Base Case Results

- Reservoir and Stream Hydrology Information



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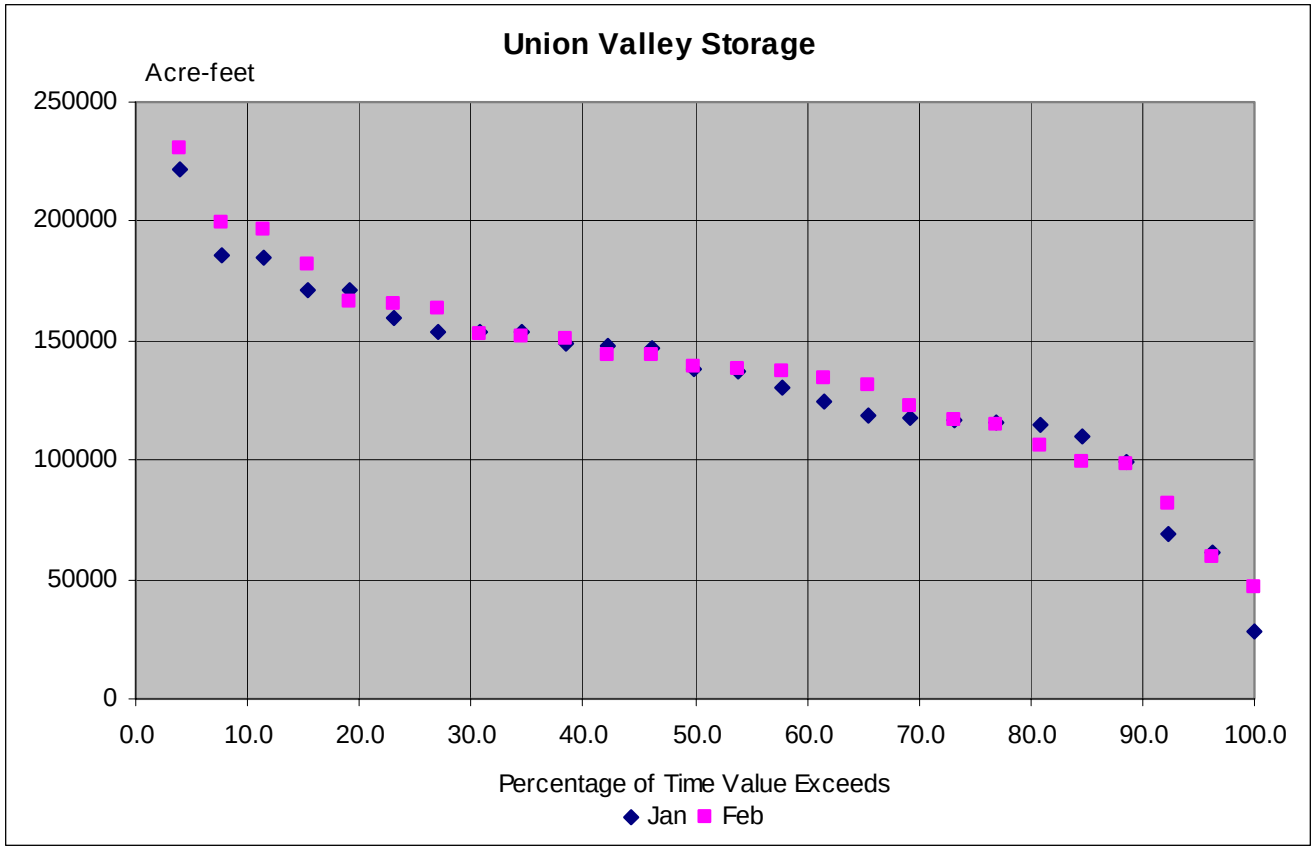
Base Case Results

- Reservoir and Stream Hydrology Information



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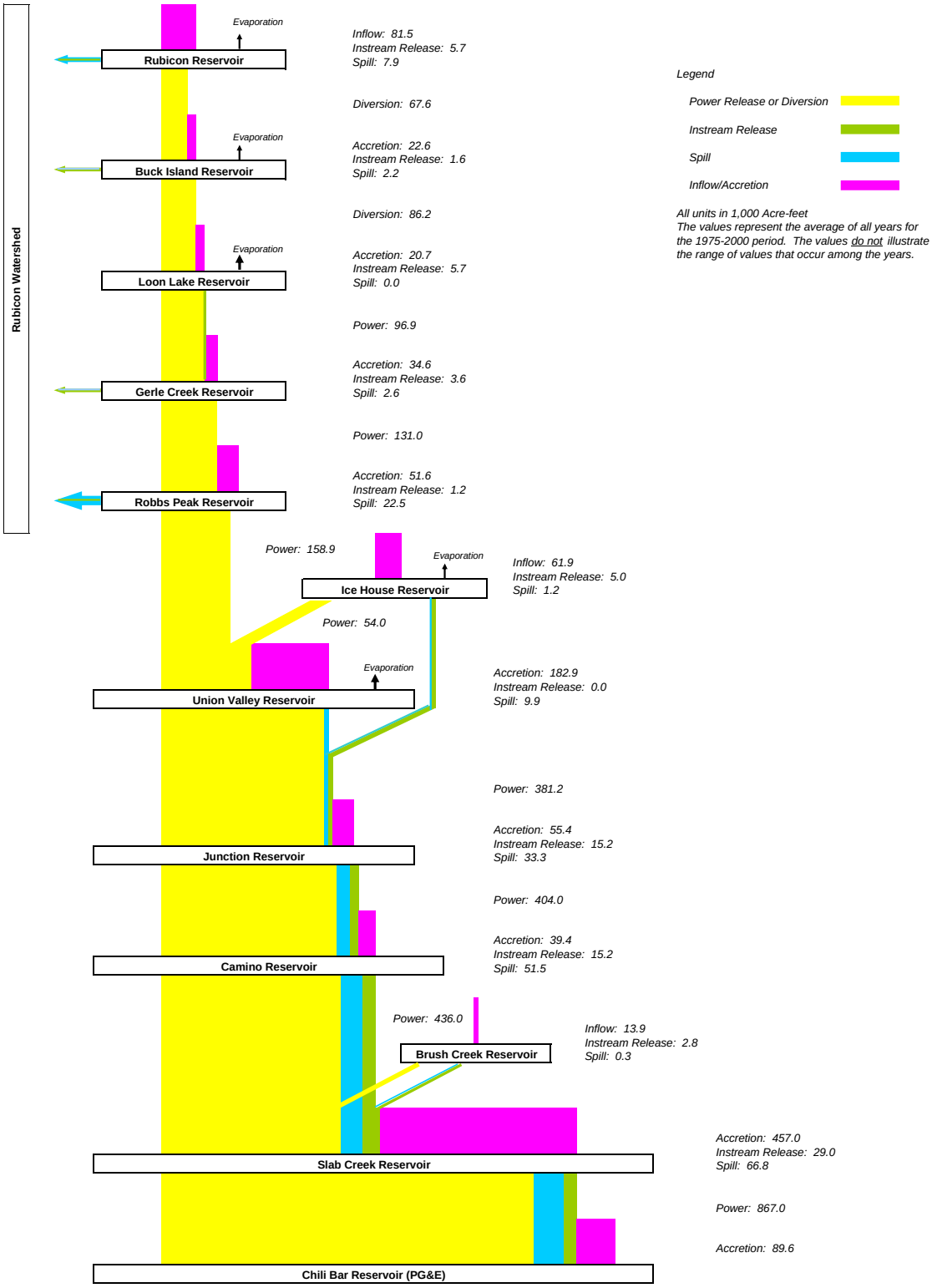
Sacramento Municipal Utility District
Upper American River Project
Underlying Hydrology and Base Case Routing



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