

Big Bear Watermaster

Forty-Second Annual Report

For Calendar Year 2018



Big Bear Municipal Water District vs. North Fork Water Company, et al.,
Case No. SCV 165493 – County of San Bernardino



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**BIG BEAR WATERMASTER
FOR
BIG BEAR MUNICIPAL WATER DISTRICT VS NORTH FORK WATER CO. ET. AL
CASE NO. 165493---COUNTY OF SAN BERNARDINO**

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March 29, 2019

To: Clerk of the Superior Court of San Bernardino County and All Parties

Subject: Watermaster Report for Calendar Year 2018

Gentlemen:

We have the honor of submitting the Forty-Second Annual Report of the Big Bear Watermaster for Calendar Year 2018.

Paragraph Twenty (20) of the Judgement requires that the Watermaster Report be submitted to the Court and the Parties before April 1 of each year on all significant Watermaster activities and provide an accounting of water deliveries for the proceeding calendar year as set forth in Section VI, Physical Solutions, of the Judgement.

We and each of us here by certify that this is a true and correct report of the Watermaster work performed by us and under our supervision during 2018 pursuant to the requirement of the Judgement.

Respectfully Submitted,

By: 
Donald E. Evenson

By: 
Daniel B. Cozad

By: 
Samuel H. Fuller

Big Bear
Municipal Water District

San Bernardino Valley
Water Conservation District

Bear Valley Mutual
Water Company

FORTY-SECOND ANNUAL REPORT BIG BEAR WATERMASTER CALENDAR YEAR 2018

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I. INTRODUCTION

The Big Bear Watermaster presents the Forty-Second Annual Report of its activities for calendar year 2018. The Watermaster's activities ensure that the rights of all parties subject to the Judgment rendered in Case No. 165493 are protected. The Watermaster generally oversees watershed conditions that may affect the Judgment and attempts to improve the conditions to the benefit of all parties.

This report describes the 2018 activities of the Watermaster including the status of accounts and various tabulations as required by the Judgment.

In 2018, the Big Bear Watermaster Committee was composed of Donald E. Evenson, President, representing Big Bear Municipal Water District; Samuel H. Fuller, representing Bear Valley Mutual Water Company; and Daniel B. Cozad, Secretary, representing San Bernardino Valley Water Conservation District.

The Watermaster Committee met four times during 2018. These meetings were held on the following dates:

January 22, 2018

March 9, 2018

July 10, 2018

October 23, 2018

Appendix A contains the minutes of these meetings. Minutes of the meetings are also on file at the office of each of the agencies.

II. SUMMARY

2018 WATERMASTER ACCOUNTS

2018 was a below average precipitation year. Annual precipitation at the two gages in the Big Bear Lake watershed averaged 20.29 inches, which is 83 percent of the 24.33 inches of average annual rainfall since 1977. Precipitation at Bear Valley Dam was 27.84 inches, which is 80 percent of the 109-year (1910-2018) average of 34.95 inches.

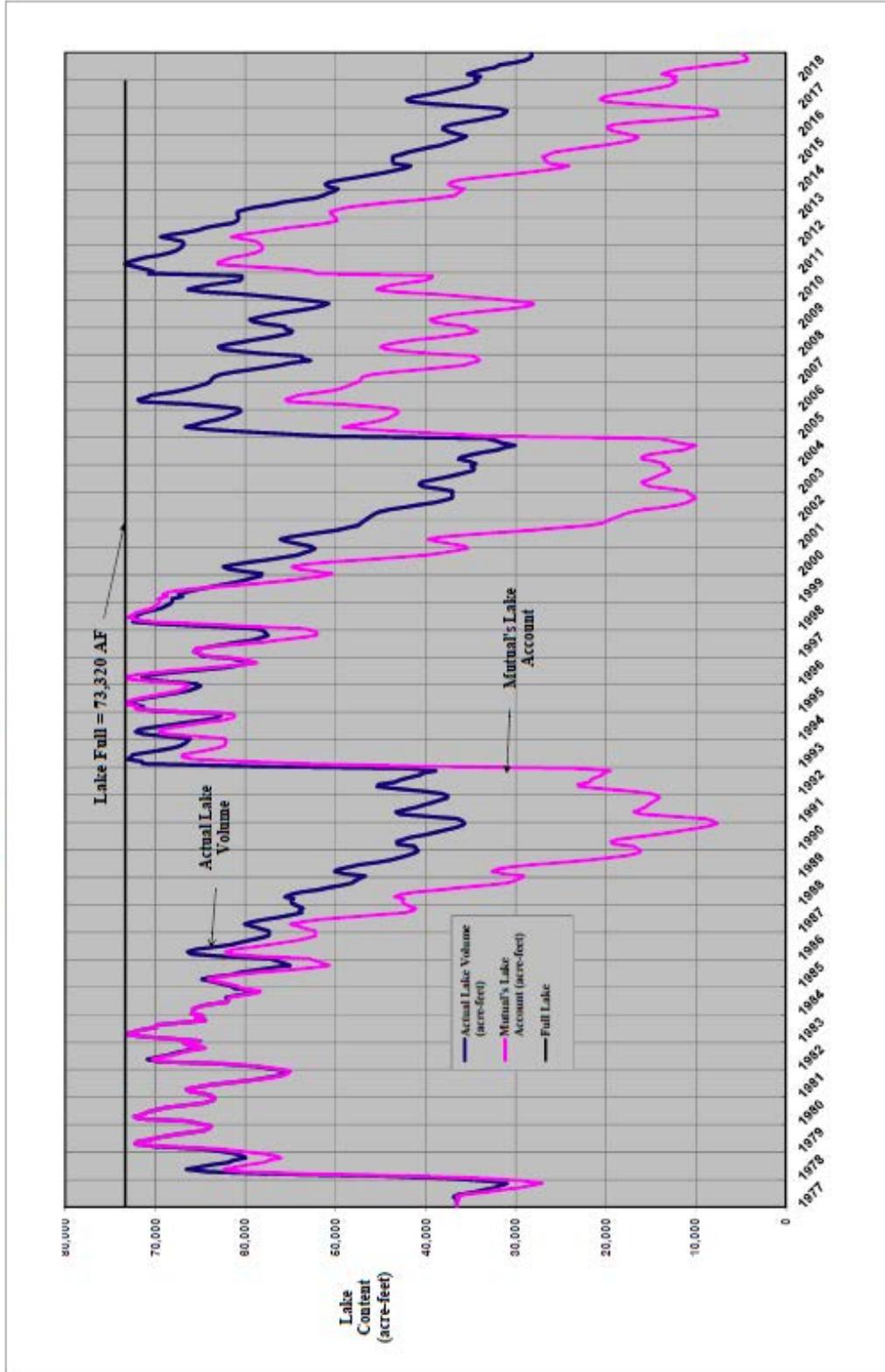
Inflow to Big Bear Lake in 2018 was also below average. The 2018 calculated lake inflow was 4,818 acre-feet, which is 32 percent of the average inflow since 1977. The average inflow for the 42 years since the Judgment was rendered is 15,010 acre-feet per year.

Actual lake levels dropped 3.00 feet in 2018 and ended the year 18.20 feet below the top of the dam. Accordingly, lake contents decreased by 5,964 acre-feet during the year. On December 31, 2018, the lake contained 28,242 acre-feet of water. When full, the lake level is 72.33 feet and it holds 73,320 acre-feet. **Figure 1** shows the history of the actual lake contents since the Judgment was rendered in 1977.

Mutual's lake account held 4,935 acre-feet at the end of 2018. Their lake account decreased by 7,187 acre-feet during the year. **Figure 1** also shows the history of Mutual's lake account since 1977. Under a "Mutual Operation", lake releases would be made to meet Mutual's water demands and their lake account is credited with the net wastewater exported from the Big Bear Lake watershed. Under these conditions, the lake level would have ended the year at 37.25 feet or 35.08 feet below the top of the dam and 16.88 feet lower than the actual year-end lake level of 54.13 feet. If Mutual had not been credited with the net wastewater exports, their lake account balance would have been 799 acre-feet and the lake level would have been 26.00 feet or 46.33 feet below the top of dam, and 28.13 feet lower than it actually was.

In 2018, Mutual received 7,890.9 acre-feet of water from Big Bear MWD. Big Bear MWD has the option to provide in-lieu supplies or to release water from the lake. In 2018, Mutual received 6,618 acre-feet of in-lieu State Water Project (SWP) water and 448 acre-feet of In Lieu well water from the San Bernardino Basin. Also, Mutual was able to use 825 acre-feet of water from Big Bear Lake that was required for fish protection purposes as required under SWRCB Order No. 95-4.

FIGURE 1
ACTUAL LAKE CONTENTS AND MUTUAL'S LAKE ACCOUNT 1977 - 2018
 Calendar Year 2018 - Big Bear Watermaster



At the beginning of the year, Big Bear MWD had 22,084 acre-feet in their lake account. By the end of the year, their lake account had increased by 1,223 acre-feet to 23,307 acre-feet. Big Bear MWD's lake account is the difference between the actual lake contents and Mutual's lake account as shown on **Figure 1**.

The Basin Make-up Account provides an estimate of the water supply impacts of the operation of Big Bear Lake under the Judgment on the San Bernardino Groundwater Basin. A positive account balance means there has been an increase in groundwater recharge as a result of the Big Bear MWD operation of the lake. If the account becomes negative, Big Bear MWD is required to correct the deficiency by providing additional water for groundwater recharge.

In 2018 the Basin Make-up Account balance decreased by 197 acre-feet. The Basin Make-up Account began the year with a balance of 27,170 acre-feet and ended the year with a balance of 26,973 acre-feet. The decrease resulted primarily as a result of the 448 acre-feet of In Lieu groundwater deliveries less some minor increases from higher basin additions from lake releases made to meet the requirements of SWRCB Order 95-4 under a Big Bear MWD lake operation as compared to a Mutual Operation.

OTHER WATERMASTER ACTIVITIES

The Watermaster has the responsibility to undertake studies and investigations, collect and maintain data and records, and monitor related activities necessary to implement the physical solution contained in the Judgment. In 2018, the Watermaster was involved in monitoring and discussing two issues. These issues are:

- Impacts of Seven Oaks Dam,
- Protecting Big Bear Lake from Quagga Mussels

These issues are discussed in Chapter V.

III. BASIC DATA

BIG BEAR LAKE

Summary

The Watermaster conducts a water balance of Big Bear Lake for each month. This water balance is based on measurements of lake levels, releases, leakages and air temperature, as well as calculated values of spills, evaporation and inflows. For 2018, the overall water balance for the lake was:

Initial Storage (1-01-18)	34,206 acre-feet
Inflows	4,818 acre-feet
Evaporation	9,391 acre-feet
Releases for Mutual	-0- acre-feet
Releases for Valley District	-0- acre-feet
Releases & Leakage for SWRCB Order 95-4	900 acre-feet
Spills & Flood Control Releases	-0- acre-feet
Net Snowmaking Withdrawal	491 acre-feet
Ending Storage (12-31-18)	28,242 acre-feet
Change-in-Storage	-5,964 acre-feet

In 2018, the volume of water in Big Bear Lake decreased by 5,964 acre-feet. The following subsections of this chapter describe each of the components in this water balance.

Lake Levels and Storage

Water levels in Big Bear Lake are measured continuously based on a reference mark located on the upstream side of the dam. In July 1998, Big Bear MWD completed installation of a continuous lake level recorder. The lake level recorder is a Global Water Model WL300 and is enclosed in a stilling well, which is attached to the upstream face of the dam. Lake level data is continuously transmitted by a remote telemetry unit (RTU) in the control building at the dam. From there, data

are transmitted via radio to a central computer in the administrative offices of Big Bear MWD. The automatically recorded values have been used since July 1998. The recorder can only record lake levels when the lake is within 15 feet of the top of the dam (i.e. above a gage height of 57.33 feet). In 2018, the lake was barely within the top 15 feet between March 2 and May 1. As a result, Big Bear MWD made manual measurements of the lake level at weekly intervals and at the end of every month throughout 2018.

The lake began the year at a gage height of 57.13 feet and ended the year at a gage height of 54.13 feet. Over the year, the lake level dropped 3.00 feet. The lowest recorded lake level was 53.87 feet or 18.46 feet below the top of the dam, and it occurred on November 28, 2018. The highest recorded lake level was 57.73 feet, which occurred on March 26, 2018. The lake is full at a gage height reading of 72.33 feet (6,743.20 feet above msl) and is empty at a gage height of zero.

The Watermaster uses an established gage height-lake capacity table to estimate the volume of water in the lake from the measured gage heights. At the beginning of the year, the lake contained 34,206 acre-feet of water. At the end of the year, there were 28,242 acre-feet of water in the lake. The lake content decreased by 5,964 acre-feet during 2018. When full, the lake contains 73,320 acre-feet of water.

Lake Evaporation

The Watermaster calculates evaporation from the lake surface using the Blaney Criddle formula to estimate monthly evaporation rates. The 1977 Annual Watermaster report describes the formula as follows:

“The Blaney Criddle empirical formula, utilizing average temperatures and daylight hours, has been used. The constant K for each month was calculated based on float pan empirical data at Long Valley Reservoir in Mono County, California, which is at elevation 6,796 feet, compared to the elevation of Big Bear Lake which is 6,743 feet.”

Monthly lake evaporation is calculated using the estimated evaporation rate and the average surface area of the lake during the month. If a negative value for lake inflow is calculated, the

monthly evaporation rate is increased to achieve a zero lake inflow. Calculated negative lake inflows occurred five times in 2018. They occurred in February, April, June, August, and September. The adjusted monthly evaporation rates totaled 4.673 feet (56.1 inches) for 2018. Total evaporation from the lake for 2018 was calculated to be 9,391 acre-feet.

Precipitation

Precipitation in the Big Bear Lake watershed varies significantly from Bear Valley Dam to Big Bear City at the east end of the watershed. **Table III-1** shows the monthly precipitation at Bear Valley Dam and the Big Bear City Community Services District for 2018. 2018 precipitation at the two stations was 27.84 and 12.74 inches, respectively. April, June, and September were the driest months with no precipitation. January and March were the wettest months with approximately 47 percent of the annual precipitation.

Table III-1 also compares the 2018 precipitation at the two stations with their corresponding averages for the forty-two years since the Judgment was rendered. At the Bear Valley Dam station, precipitation was 81 percent of its forty-two year average, and at the Big Bear Community Services District station, precipitation was 89 percent of its forty-two year average. For both stations, 2018 precipitation averaged 83 percent of their forty-two year combined average.

Table III-2 shows the annual precipitation for both stations for the forty-two years since the Judgment was rendered. As shown in **Table III-2**, 2018 was a below average year for precipitation. For the Bear Valley Dam station, precipitation was 80 percent of the 109-year (1910–2018) average of 34.95 inches.

Lake Inflow

Inflows to Big Bear Lake are not measured. Consequently, inflows naturally tributary to Big Bear Lake above Bear Valley Dam are calculated for each month using a water balance on the actual operation of the lake. This calculation, which utilizes observed basic data along with the calculated evaporation losses described previously, creates a water balance for each month to determine the amount of natural flow into the lake. The formula used is:

TABLE III - 1
MONTHLY PRECIPITATION FOR TWO STATIONS
IN BIG BEAR AREA (Inches)

Calendar Year 2018 - Big Bear Watermaster

Month	Bear Valley Dam*	Big Bear Community Services District**	Average	Percent of Annual Total
January	6.52	2.61	4.57	22.50%
February	1.26	0.41	0.84	4.12%
March	7.23	2.66	4.95	24.37%
April	0.00	0.00	0.00	0.00%
May	0.77	0.43	0.60	2.96%
June	0.00	0.00	0.00	0.00%
July	1.54	0.60	1.07	5.27%
August	1.36	1.07	1.22	5.99%
September	0.00	0.00	0.00	0.00%
October	1.35	1.49	1.42	7.00%
November	4.91	1.51	3.21	15.82%
December	2.90	1.96	2.43	11.98%
2018 Totals	27.84	12.74	20.29	100.00%
1977-2018 42-year Average	34.32	14.33	24.33	
2018 % of 42-year Average	81.1%	88.9%	83.4%	

Average of the 42-year Average for both stations	24.33
Average of the 2018 precipitation for both stations	20.29
2018 Average as a percent of the 42-year average	83.4%

Source:

* Big Bear MWD

** Big Bear Community Services District

Updated 2/23/19

D.Evenson

Table III-2

**FORTY-TWO YEARS OF PRECIPITATION DATA FOR
TWO STATIONS IN BIG BEAR AREA (Inches)**

Calendar Year 2018 - Big Bear Watermaster

Year	Bear Valley Dam*	Big Bear Community Services District**
1977	31.96	13.35
1978	68.43	26.09
1979	34.87	15.84
1980	63.00	29.86
1981	16.67	8.42
1982	49.14	26.53
1983	56.97	24.29
1984	20.19	16.66
1985	22.40	14.11
1986	35.16	15.26
1987	27.49	12.52
1988	24.18	8.15
1989	17.32	6.85
1990	22.20	11.02
1991	38.47	19.81
1992	44.03	16.64
1993	73.81	19.45
1994	31.78	12.24
1995	49.00	15.89
1996	41.04	15.47
1997	27.00	12.92
1998	50.40	12.07
1999	13.22	6.06
2000	24.82	5.21
2001	30.62	9.10
2002	15.02	3.82
2003	32.44	12.70
2004	39.50	13.51
2005	54.74	19.56
2006	37.96	9.98
2007	16.11	4.89
2008	37.87	8.58
2009	30.70	12.74
2010	64.14	33.23
2011	27.25	14.81
2012	23.70	16.41
2013	14.38	14.53
2014	29.61	12.23
2015	19.72	8.17
2016	31.93	15.42
2017	24.55	14.81
2018	27.84	12.74
42-Year Average	34.32	14.33
	81.1%	88.9%
109-Year Average	34.95	N/A
	79.7%	

Source:

* Big Bear MWD

** Big Bear City Community Services District

Updated 3/6/19 - D. Evenson

$$\text{Inflow} = \text{Evaporation} + \text{Releases} + \text{Spills} + \text{Leakage} + \\ \text{Net Withdrawals} - \text{Change in Storage}$$

If the calculated monthly inflow is a negative value, it is reset to zero, and the monthly evaporation rate is recalculated to achieve a lake water balance. Calculated negative lake inflows occurred five times in 2018. They occurred in February, April, June, August, and September.

Total annual inflow for 2018 into the lake was calculated to be 4,818 acre-feet. The largest monthly inflow was 1,986 acre-feet, and it occurred in March. The average annual lake inflow for the 42 years (1977-2018) since the Judgment was rendered is 15,010 acre-feet. The median annual inflow for this same period is 9,355 acre-feet.

Table III-3 lists the annual lake inflows for the period 1977–2018. This table also ranks the inflows from the lowest (1,717 acre-feet in 2002) to the highest (48,613 acre-feet in 1993). Inflow to the lake for 2018 was well below both the average inflow and the median inflow for the forty-two years since the judgment was rendered in 1977. Only six years had lower lake inflows, and thirty-five years had higher lake inflows.

SWRCB Order No. 95-4

On February 16, 1995, the State Water Resources Control Board (SWRCB) issued Order No. 95-4. This order directed the Big Bear MWD and Bear Valley Mutual Water Company to release enough water from the lake to maintain a minimum seven-day average flow of 1.2 cfs and a minimum average daily flow of 1.0 cfs in Bear Creek no more than 500 feet downstream of its confluence with West Cub Creek. This location is referred to as Station A. In 1998, Big Bear MWD completed construction of a continuous flow recording device at Station A to measure compliance with SWRCB Order No 95-4.

SWRCB Order No. 95-4 also required sufficient releases to maintain a minimum flow of 0.3 cfs at a location approximately 300 feet downstream from the toe of the dam. This location is referred to as Station B. In 1998, Big Bear MWD also completed construction of a continuous recording device at this location to measure compliance with SWRCB Order No. 95-4.

Table III - 3
Big Bear Lake Inflows 1977-2018
 (acre-feet / year)
 Calendar Year 2018 - Big Bear Watermaster

Year	Lake Inflows (AF/year)	Rank	Plotting Position	Year	Lake Inflow (AF/year)
1977	7,103	Min. 1	2.3%	2002	1,717
1978	40,743	2	4.7%	2007	2,841
1979	25,318	3	7.0%	2013	3,129
1980	42,336	4	9.3%	2015	3,677
1981	6,529	5	11.6%	1999	3,774
1982	25,310	6	14.0%	1988	4,551
1983	35,072	2018 7	16.3%	2018	4,818
1984	10,569	8	18.6%	1990	4,856
1985	9,497	9	20.9%	1989	4,967
1986	13,812	10	23.3%	2014	5,776
1987	8,005	11	25.6%	1981	6,529
1988	4,551	12	27.9%	2001	6,915
1989	4,967	13	30.2%	2000	6,930
1990	4,856	14	32.6%	2016	7,027
1991	11,658	15	34.9%	1977	7,103
1992	15,543	16	37.2%	1987	8,005
1993	48,613 Max.	17	39.5%	2012	8,175
1994	11,015	18	41.9%	2003	8,295
1995	33,340	19	44.2%	2004	8,404
1996	13,119	20	46.5%	1997	8,757
1997	8,757	Median 21	48.8%	2009	9,212
1998	34,600	Median 22	51.2%	1985	9,497
1999	3,774	23	53.5%	1984	10,569
2000	6,930	24	55.8%	1994	11,015
2001	6,915	25	58.1%	1991	11,658
2002	1,717 Min.	26	60.5%	1996	13,119
2003	8,295	27	62.8%	2017	13,213
2004	8,404	28	65.1%	1986	13,812
2005	39,600	29	67.4%	2008	14,182
2006	17,564	30	69.8%	1992	15,543
2007	2,841	31	72.1%	2011	16,908
2008	14,182	32	74.4%	2006	17,564
2009	9,212	33	76.7%	1982	25,310
2010	32,959	34	79.1%	1979	25,318
2011	16,908	35	81.4%	2010	32,959
2012	8,175	36	83.7%	1995	33,340
2013	3,129	37	86.0%	1998	34,600
2014	5,776	38	88.4%	1983	35,072
2015	3,677	39	90.7%	2005	39,600
2016	7,027	40	93.0%	1978	40,743
2017	13,213	41	95.3%	1980	42,336
2018	4,818	Max 42	97.7%	1993	48,613
1977 - 2018		42			
Maximum	48,613				
Average	15,010				
Median	9,355				
Minimum	1,717				

Flow at Station B has been measured by a compound weir with a v-notch section and a rectangular section. It was attached to a reinforced concrete structure in the riverbed. The v-notch section had a flow range of 0 to 0.44 cfs and the rectangular section had a flow range of 0.44 to 5.03 cfs. A water level transmitter is located in a stilling well just upstream of the weir structure. The water level data are transmitted to a remote telemetry unit (RTU) located in the control building at the dam. From there, data are transmitted to a central computer at the administrative offices of Big Bear MWD where average daily flow rates at Station B were calculated based on the rating curve of the weir plate.

In October 2016, the Station B weir plate was replaced to improve the accuracy of the water level measurements and the calculated flow values. The weir plate was changed from the compound weir to a 90-degree, 12-inch v-notch weir. Big Bear MWD reprogrammed the SCADA/PLC for the new weir and the flow values at Station B showed improved accuracy.

However, in 2017 measurement problems at Station B continued so Big Bear MWD continued to rely on using releases from the 6-inch Bypass Pipe Line to maintain flows at Station B. Big Bear MWD contracted with XiO, Inc. to install a new transducer probe and cloud SCADA system to record flows through the new weir plate at Station B. The new system was expected to be operational in early 2018 but due to unforeseen electrical issues, the system was installed and testing began in December 2018.

On December 29, 2004, data transmission from Station A ceased. In January of 2005, major storms hit the Bear Creek watershed with significant snowfall. Consequently, Big Bear MWD staff could not access Station A until May. On their first visit to the site, they found the data transmission facilities destroyed, the stilling basin filled with sediment and the weir plate damaged. The staff estimated the flow in Bear Creek at this time to be in the range of 10 to 15 cfs, well above the 1.20 cfs requirement.

Beginning in June 2005, the staff visited the site every two weeks and made velocity and water depth measurements. From these measurements, they used two methods to estimate the flow at Station A. Flow estimates ranged between 11.8 cfs and 2.3 cfs. Consequently, in 2005 Station A was well in compliance with the 1.20 cfs, seven-day flow requirement.

During the summer and fall of 2005, Big Bear MWD repaired the weir plate, cleaned out the stilling basin, and installed a battery operated, pressure transducer to record weir water depth information. Since 2005, when weather conditions permit, Big Bear MWD retrieves the recorded information and calculates the flows at Station A.

In December 2010, major storms again hit the Bear Creek watershed, destroyed the data recording equipment and filled the stilling basin with sediment and rock at Station A. In November 2011, Big Bear MWD cleaned out the stilling basin and downstream creek bed and installed a new battery operated, pressure transducer to record weir water depth information. However, there was some damage to the weir plate that could not be repaired.

When weather conditions permit, Big Bear MWD staff retrieves the recorded information, which again allows the flow at Station A to be calculated.

To determine if Station A was determining flows accurately, Big Bear MWD retained a consultant, Jericho Systems, Inc., to manually measure the Bear Creek flows above and below Station A on two occasions. The consultant found that the measured flows were 0.5 to 1.0 cfs higher than the flows calculated from water level data applied to the damaged weir plate. In 2017, Big Bear MWD began discussing options for Station A with the State Water Resources Control Board. These discussions will continue in 2019.

During 2005, Big Bear MWD, working with State Water Resources Control Board (SWRCB) and the State Department of Fish and Game, developed a proposed plan to keep Station A in compliance with both the 1.0 cfs average daily flow requirement and the 1.2 cfs seven-day average flow requirement. This proposed plan involved increasing the Station B flow requirements to insure the Station A requirements would be met. The new Station B requirements vary by month and hydrologic year type. The monthly hydrologic year type is based on water year-to-date precipitation at Bear Valley Dam. Water years (October 1 to September 30) are used to determine the hydrologic year type. The adopted plan is referred to as the “Exhibit A Flow Compliance Plan” and is presented in the following table.

Exhibit A Flow Compliance Plan
Table to Determine Minimum Daily Flows at Station B
Based Upon Water Year-to-Date Precipitation at Bear Valley Dam

Date	Dry Year		Below Normal Year		Above Normal Year		Wet Year	
	If year-to-date precipitation is less than (inches)	Station B Minimum Flow is (cfs)	If year-to-date precipitation is between (inches)	Station B Minimum Flow is (cfs)	If year-to-date precipitation is between (inches)	Station B Minimum Flow is (cfs)	If year-to-date precipitation is more than (inches)	Station B Minimum Flow is (cfs)
October 1	n.a.	0.95	n.a.	0.95	n.a.	0.95	n.a.	0.95
November 1	0.03	0.90	0.03 and 0.56	0.90	0.57 and 1.93	0.70	1.93	0.70
December 1	1.59	0.85	1.59 and 3.04	0.85	3.05 and 5.60	0.80	5.60	0.60
January 1	3.73	0.90	3.73 and 8.14	0.75	8.15 and 12.84	0.75	12.84	0.30
February 1	8.94	1.00	8.94 and 13.84	0.85	13.85 and 20.79	0.50	20.79	0.30
March 1	14.42	0.80	14.42 and 20.05	0.40	20.06 and 31.47	0.40	31.47	0.30
April 1	19.29	0.75	19.29 and 25.84	0.50	25.85 and 40.30	0.40	40.30	0.30
May 1	21.61	0.95	21.61 and 28.65	0.70	28.66 and 41.16	0.55	41.16	0.30
June 1	22.18	1.15	22.18 and 30.01	0.80	30.02 and 41.86	0.75	41.86	0.30
July 1	22.42	1.20	22.42 and 30.01	0.95	30.02 and 41.86	0.95	41.86	0.30
August 1	22.93	1.25	22.93 and 30.69	1.05	30.70 and 42.48	0.95	42.48	0.30
September 1	23.30	1.00	23.30 and 30.86	0.95	30.87 and 43.69	0.95	43.69	0.30

The plan was approved by the SWRCB on January 08, 2009. The amended order also required Big Bear MWD to monitor the flows at Station A for ten years to confirm that the Exhibit A Flow Compliance Plan would satisfy the minimum flow requirements at Station A. Starting in December of 2005, Big Bear MWD followed the Exhibit A Flow Compliance Plan for Station B.

Effective July 1, 2014, Big Bear MWD adopted a “Revised Flow Compliance Plan” that increased the minimum flow requirements at Station B in some months based on their experience over the six years since the SWRCB approved the Exhibit A Flow Compliance Plan. The Revised Flow Compliance Plan is shown on the following table. The Station B flow requirements for 2018 are highlighted in yellow.

2018 Revised Flow Compliance Plan
Table to Determine Minimum Flows at Station B
Based Upon Year-to-Date Precipitation at Bear Valley Dam

Date	Water Year-to-date Precipitation at Bear Valley Dam (inches)	Dry Year		Below Normal Year		Above Normal Year		Wet Year	
		If year-to-date precipitation is less than (inches)	Station B Minimum Flow is (cfs)	If year-to-date precipitation is between (inches)	Station B Minimum Flow is (cfs)	If year-to-date precipitation is between (inches)	Station B Minimum Flow is (cfs)	If year-to-date precipitation is more than (inches)	Station B Minimum Flow is (cfs)
October 1	0.00	n.a.	1.20	n.a.	1.20	n.a.	1.20	n.a.	1.20
November 1	0.00	0.03	1.10	0.03 and 0.56	1.00	0.57 and 1.93	0.95	1.93	0.90
December 1	0.00	1.59	0.90	1.59 and 3.04	0.85	3.05 and 5.60	0.85	5.60	0.85
2018									
January 1	0.00	3.73	0.90	3.73 and 8.14	0.85	8.15 and 12.84	0.85	12.84	0.85
February 1	6.52	8.94	1.00	8.94 and 13.84	0.85	13.85 and 20.79	0.50	20.79	0.30
March 1	7.78	14.42	0.95	14.42 and 20.05	0.85	20.06 and 31.47	0.40	31.47	0.30
April 1	15.01	19.29	0.75	19.29 and 25.84	0.50	25.85 and 40.30	0.40	40.30	0.30
May 1	15.01	21.61	0.95	21.61 and 28.65	0.70	28.66 and 41.16	0.55	41.16	0.30
June 1	15.78	22.18	1.15	22.18 and 30.01	1.00	30.02 and 41.86	0.75	41.86	0.30
July 1	15.78	22.42	1.50	22.42 and 30.01	1.30	30.02 and 41.86	0.95	41.86	0.55
August 1	17.32	22.93	1.50	22.93 and 30.69	1.50	30.70 and 42.48	1.25	42.48	0.55
September 1	18.68	23.30	1.35	23.30 and 30.86	1.20	30.87 and 43.69	1.20	43.69	1.15
October 1	0.00	n.a.	1.20	n.a.	1.20	n.a.	1.20	n.a.	1.20
November 1	1.35	0.03	1.10	0.03 and 0.56	1.00	0.57 and 1.93	0.95	1.93	0.90
December 1	6.26	1.59	0.90	1.59 and 3.04	0.85	3.05 and 5.60	0.85	5.60	0.85

Note 1
Note 2
Yellow highlighted values are the Flow Compliance values for CY 2018
Minimum flow values in blue are revised values used effective July 1, 2014

Based on Revised Flow Compliance Plan and the actual water year-to-date precipitation at Bear Valley Dam, the plan for minimum daily average flows at Station B in 2018 were as follows:

Month 2018	Hydrologic Condition WY To-Date	Minimum Daily Average Flow (cfs)
January	Dry	0.90
February	Dry	1.00
March	Dry	0.95
April	Dry	0.75
May	Dry	0.95
June	Dry	1.15
July	Dry	1.50
August	Dry	1.50
September	Dry	1.35
October	Start Water Year	1.20
November	Above Normal	0.95
December	Wet	0.85

Flows at Station B normally consist of leakage from the dam and spillway gates, releases and leakage from the outlet works, spills from the lake, and inflows and consumptive losses between the Dam and Station B.

In late 2015, vandalism at Station B impaired the reliability and accuracy of the flow measurements at Station B. To confirm compliance with the Revised Flow Compliance Plan requirements listed in the above table, Big Bear MWD used the measured flows from the 6-inch Bypass Pipeline plus the estimated leakage from the sluice gates.

In October 2016, Big Bear MWD replaced the weir at Station B with a 12-inch v-notch weir to improve the accuracy of the flow measurements in the range of flows covered in the Revised Flow Compliance Plan.

In 2018, measurement problems at Station B continued primarily due to data transmission issues and sedimentation clogs in the 6-inch bypass valve. A small fracture in the transmission cable was located in December 2018 and corrected. This fracture may have attributed to data loss

connectivity issues. Other issues experienced included times when the transducer probe at Station B fell out of calibration. There were instances when the flows at Station B appeared to fall below the combined 6-inch bypass valve release and sluice gate leakage. Station B was recalibrated based on manual measurements of water height against the weir.

In December 2018, the XiO cloud SCADA system was installed and began collecting data. There was a testing period between December 2018 and January 2019 to ensure data collection reliability and probe accuracy. For the annual 2019 year, the XiO data will be checked against the original transducer at Station B to ensure accuracy of measurement and system redundancy. Once the District is confident with the system, XiO will automatically actuate the 6-inch bypass valve based on flow conditions at Station B. If side flows are excessive, the XiO system will slow the flow of the 6-inch bypass valve. On the contrary, if side flows are non-existent, the XiO system will increase flows through the 6-inch bypass valve to ensure the desired downstream flow rate as stated in the Revised Flow Compliance Plan based on cumulative water year rainfall.

To handle the SWRCB Order No 95-4 lake release and in-lieu delivery conditions, the Watermaster Committee, in 2002, clarified the accounting procedures. In 2003, the Watermaster made further improvements to these procedures. In 2005, they made a further change to better reflect actual lake management. This change was to include leakage with the flows from the outlet works in the accounting for flows to meet SWRCB Order 95-4. For the lake accounts, the accounting procedures are:

1. The outlet works flows and dam leakage will be deducted from both Mutual's and BBMWD's lake accounts in proportion to the amount of water in their respective lake accounts on days when Mutual is not fully utilizing all the flow in the Santa Ana River at the point of diversion to the forebay of SCE Power Plant No. 1.
2. The outlet works flows and dam leakage releases will be deducted entirely from Mutual's lake account on days when:
 - a) Mutual is fully utilizing all the flow in the Santa Ana River at the point of diversion to the forebay of SCE Power Plant No. 1,
 - b) Mutual is requesting releases from the lake and BBMWD is releasing water from the lake or providing in-lieu supplies, or

c) Mutual is purchasing SW

Prior to 2012, the term “fully utilized” was defined as days when the “net amount” of water the SBVWCD diverted from the forebay of SCE Power Plant No. 3 was less than the amount of the fish release. The “net amount” of water diverted from the forebay was defined as the actual amount diverted by SBVWCD for groundwater recharge less the amount of water delivered to the forebay by the Bear Valley Pick-up on the Santa Ana River below Seven Oaks Dam. In prior years, the Committee noticed there were some operational conditions when this definition did not accurately depict if Mutual was “fully utilizing” all the flow in the Santa Ana River at the point of diversion to the forebay of SCE Power Plant No. 1. When this occurred, adjustments were made in the accounting to better reflect actual operating conditions.

In 2012, the Committee reviewed the conditions and adopted a revised definition of the term “fully utilized.” The revised definition of when Mutual is “fully utilizing” all the flow in the Santa Ana River is when:

- Mutual’s Deliveries of Santa Ana River water are greater than or equal to the SCE Santa Ana River Diversions, and
- The SCE Santa Ana River Diversions are greater than the Outlet Works Flows and Dam Leakage used to meet SWRCB Order No. 95-4.

The daily values of Mutual’s Deliveries and the SCE Santa Ana River Diversions will be made using the Daily Flow Reports prepared by the San Bernardino Valley Water Conservation District.

The daily SCE Santa Ana River Diversions will be determined as the sum of the following flows:

- PH#3 Penstock (CALC) (A1) flow,
- BVMWC Highline (B1) flow,
- Greenspot Spill (F1) to PH#3, and
- Deliveries to the Greenspot Pipeline (C1).

Beginning in 2018, the Watermaster Committee decided that Mutual’s Deliveries of Santa Ana River Water should be determined as the sum of the following three deliveries:

- BVMWC Highline (B1)* delivery,
- Northfork delivery: Northfork Canal Weir delivery (G2) plus Edwards Canal delivery (H2) plus Northfork Parshall Flume delivery to SBVWCD (K2), and
- Redlands delivery: Redlands Aqueduct Weir (W1) delivery less the Redlands Tunnel (I1) inflow plus the Redlands Sandbox Spills (YI).

The daily Outlet Works Flows and Dam Leakage from Big Bear Lake used to meet SWRCB Order No. 95-4 are determined by the Watermaster Committee using measured releases and leakage estimates provided by Big Bear MWD.

In 2018 the estimated Outlet Works Flows and Dam Leakage was 899.4 acre-feet and Mutual was determined to have “fully utilized” the SCE Santa Ana River Diversions, received in-lieu deliveries, or purchased SWP water on 330 days, which resulted in the following allocation:

1. 74.8 acre-feet was deducted from both Mutual’s and BBMWD’s lake accounts in proportion to the amount of water in their respective lake accounts on the 35 days when Mutual did not “fully utilize” the Santa Ana River Diversions and did not receive in-lieu deliveries or purchase SWP water, and
2. 824.6 acre-feet was deducted from Mutual’s lake account on the 330 days they “fully utilized” the Santa Ana River Diversions, received in-lieu water deliveries or purchased SWP water.

The Watermaster Committee will continue to review these accounting methods in 2019 to make sure the determinations of the allocation of the “outlet works flows and dam leakage” for fishery protection in Bear Creek accurately reflect actual operations.

The input data and allocation of releases under SWRCB Order No. 95-4 in **Table 2.C** of **Appendix B** reflect the above revised procedures.

For the Basin Make-up Account, the accounting procedures are:

1. Under a Big Bear MWD operation, the actual fish releases used by Mutual under Item 2 above will be considered a “release actually made under District Operation (R_d)” and the actual releases under Item 1 above will be treated as “spills which actually occurred under District Operation (S_d)”.
2. Under a Mutual operation, the fish releases used by Mutual under Item 2 above will be considered a “release which would have been made under a Mutual Operation (R_m)”, and the releases allocated to Mutual under Item 1 above will be considered a “spill which would have occurred under a Mutual Operation (S_m).”

*The term in parenthesis refers to the site location used in the Daily Flow Reports (DFR’s) of the San Bernardino Valley Water Conservation District.

Tables 4.A and 4.B of Appendix B reflect these accounting procedures.

The Watermaster Committee will continue to work on these accounting procedures in 2019 to make sure they will be accurate for all possible river flow and diversion conditions that could occur in future years.

Dam and Spillway Gate Leakage

Minor leakage through the spillway gates can occur in Bay 1 and Bay 10 if the lake level is above the spillway crest elevation. The structural reinforcement project completed in 2006 eliminated the dam leakage from cracks in the upper arches of Bays 5, 6 and 8. In 2018, the lake level was below the spillway crest (Elevation 6,731.00 feet which is 12.20 feet below a full lake) for all of the year. When the lake level is above the spillway crest elevation, Big Bear MWD estimates the leakage from Bays 1 and 10 by visual observations. The lake level was below the spillway elevation throughout 2018 and Big Bear MWD did not observe any leakage during this period. The 2018 estimated monthly leakages are shown in **Table III-4**. The estimated leakage through the spillway gates in Bays 1 and 10 for 2018 was zero acre-feet.

In late November 2009 during excavation of foundations for the new highway bridge below the dam, workers noticed water entering the excavation and seeping to the surface below. During meetings with Caltrans engineers and the District's engineer in January 2010, Caltrans indicated they were convinced the new seepage was not related to their blasting efforts but the result of the removal of overburden and bedrock resulting in the opening of new pathways for seepage water to move through the abutment rock. Caltrans promised to prepare a remedial grouting plan and submit it to the District for engineering review and approval.

TABLE III-4
ESTIMATES OF
MONTHLY DAM LEAKAGE
(acre-feet)
Calendar Year 2018
Big Bear Watermaster

Month	Bay 1 and Bay 10 Leakage Estimates (AF)	Additional Foundation Leakage (AF)	Total Estimated Leakage (AF)
January	-0-	-0-	-0-
February	-0-	-0-	-0-
March	-0-	-0-	-0-
April	-0-	-0-	-0-
May	-0-	-0-	-0-
June	-0-	-0-	-0-
July	-0-	-0-	-0-
August	-0-	-0-	-0-
September	-0-	-0-	-0-
October	-0-	-0-	-0-
November	-0-	-0-	-0-
December	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>
Annual Total	-0-	-0-	-0-

In late 2011, Caltrans prepared a remedial grouting program to control seepage at the left abutment of the dam. After review and approval by the Big Bear MWD, the program was submitted for technical review to the Division of Safety of Dams, and Caltrans received their approval in concept. The Caltrans proposal included four rows of grout holes. Two parallel rows parallel to the edge of the lake beginning at the left abutment and two rows perpendicular to the first rows beginning at the left abutment. While the intent of Caltrans is to protect their new highway bridge foundation, the project should dramatically reduce seepage at the left abutment of the dam. In mid-2012, Caltrans conducted the left abutment grouting on the roadbed approach (now the parking area) of the old highway bridge. Two rows of holes were drilled and grouted during the process along with three verification holes. After completion of this effort in August 2012 observed downstream seepage at the left dam abutment was significantly reduced. As a result of this observation Caltrans determined that the second set of grout holes would be unnecessary and Caltrans closed the project.

The additional foundation leakage cannot be directly measured and has been estimated from flow measurements at Station B that are in excess of the measured releases and estimated spillway gate leakage from the lake. Beginning in September 2013, no additional foundation leakage has been identified which indicates the grouting program may have reduced or perhaps eliminated the foundation leakage. The Committee will continue to monitor this source of leakage before drawing any conclusions concerning the effectiveness of the grouting program.

There was no estimated dam leakage in 2018 and it did not contribute to the outflows from the Lake to meet the requirements of SWRCB Order 95-4.

Outlet Works Releases

Water is released from the lake through the outlet works. These releases can be for flood control purposes, for Mutual, or for fishery protection in accordance with SWRCB Order No. 95-4.

Releases are made either through a 36-inch outlet works or a 6-inch bypass pipeline that is connected to the 36-inch outlet works. A 36-inch butterfly valve is the primary control mechanism on the outlet works. Flows in the outlet works are measured by an in-line 36-inch flow meter that

was installed on the outlet piping downstream of the butterfly valve in December 1993 to replace an older meter. The meter is an Electromatic Flow Meter Model 655 manufactured by Sparling Instruments, Inc. Downstream of the flow meter, the outlet works splits into a 24-inch pipeline and a 14-inch pipeline. Flows through these two pipelines are controlled by two motorized sluice gates. The two sluice gates are 24-inch by 24-inch and 14-inch by 14-inch. The 36-inch meter was calibrated with an accuracy of ± 0.5 percent between 7.07 and 212 cfs. When the sluice gates were fully opened and the lake was full, the meter measured a flow of 256 cfs, which is the maximum that can be discharged through the outlet works. When the lake is full and only the 14-inch sluice gate is open, the flow from the outlet works is estimated to be 68 cfs. When only the 24-inch sluice gate is open, the maximum discharge from the Outlet Works is estimated to be 195 cfs. The rate of flow and totalized flow are recorded at the flow meter and also at the control building. There is usually a small amount of leakage through the two sluice gates. In 2018, the leakage through the sluice gates was estimated to be 74.5 acre-feet.

There is also a 3-inch Relief Line, meter and valve on the 36-inch outlet pipeline. During the winter months this valve is usually opened to allow a small amount of flow (usually 4 to 6 gpm) to pass through the 36-inch pipeline and prevent water in the pipeline from freezing. The 3-inch Relief Line had been used to provide water for the construction of the new highway bridge downstream of the Dam that replaced the bridge that was on the top of Bear Valley Dam. The bridge construction was completed in November 2011, and Big Bear MWD is no longer releasing any water for the bridge construction project. The winter water releases through the 3-inch Relief Line were 1.4 acre-feet in 2018, and they flowed down Bear Creek and were measured as part of the flow at Station B. These releases are considered as part of the releases to comply with SWRCB Order NO. 95-4.

Flow through the 6-inch Bypass Pipeline was metered beginning in August 2006 when Big Bear MWD replaced a 4-inch Bypass Pipeline with a 6-inch Bypass Pipeline, valve and a Krohne IFS 400 flow meter. Releases to comply with SWCRB Order No. 95-4 are normally made through the 6-inch Bypass Pipeline. The total amount released through the 6-inch Bypass Pipeline in 2018 was 823.5 acre-feet.

In 2018, Big Bear MWD released water from the lake through the Outlet Works to comply with SWRCB Order No. 95-4. **Table III-5** summarizes the monthly amounts of water discharged from

the outlet works in 2018. The total from the Outlet Works in 2018 was estimated to be 899.4 acre-feet.

TABLE III-5
MONTHLY DISCHARGES FROM
THE OUTLET WORKS OF BEAR VALLEY DAM
 (acre-feet)
 Calendar Year 2018
 Big Bear Watermaster

Month	Flood Control Releases (AF)	Mutual Releases (AF)	SBVMWD Releases (AF)	SWRCB Discharges (AF)	Total Outlet Works Discharges (AF)
January	-0-	-0-	-0-	79.5*	79.5
February	-0-	-0-	-0-	72.2*	72.2
March	-0-	-0-	-0-	70.3*	70.3
April	-0-	-0-	-0-	64.6*	64.6
May	-0-	-0-	-0-	65.6*	65.6
June	-0-	-0-	-0-	68.5*	68.5
July	-0-	-0-	-0-	97.6*	97.6
August	-0-	-0-	-0-	93.9*	93.9
September	-0-	-0-	-0-	82.5*	82.5
October	-0-	-0-	-0-	77.9*	77.9
November	-0-	-0-	-0-	72.3*	72.3
December	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	<u>54.5*</u>	<u>54.5</u>
Total	-0-	-0-	-0-	899.4	899.4

* These releases were also used to partially or wholly meet Mutual's needs for lake water.

Mutual Releases

There were no lake releases for Mutual in 2018.

San Bernardino Valley MWD Releases

In 2018 San Bernardino Valley MWD did not request any lake releases from their storage account in Big Bear Lake for delivery of in-lieu lake water to Mutual.

Flood Control Releases

There were no flood control releases in 2018.

Spills

Spills are flows that leave the lake over the spillway of the dam. They are calculated from lake gage height readings and spillway gate settings at the dam during the time of the spill. In 2018, there were no spills from the lake

Station B Flows

Leakage estimates and outlet works flows are confirmed by comparing the sum of dam leakage plus the amount released from the lake through the outlet works with the flow measured at Station B, which is 300 feet downstream of the dam. The differences can be either gains or losses. Although small, these differences can illustrate the impacts of rainfall/snowfall and plant evapotranspiration between the dam and Station B. **Table III-6** shows this comparison.

TABLE III-6
COMPARISON OF FLOWS AT STATION B WITH
ESTIMATED LEAKAGE AND FLOWS FROM OUTLET WORKS
 Calendar Year 2018 - Big Bear Watermaster

Month	Flows from Outlet Works (AF)	Dam Leakage (AF)	Spillway Gate Release (AF)	Total Flows From Lake (AF)	Flow at Station B (AF)	Gains/ (Losses) (AF)
January	79.5	-	-	79.5	77.6	(1.9)
February	72.2	-	-	72.2	69.8	(2.4)
March	70.3	-	-	70.3	79.7	9.4
April	64.6	-	-	64.6	63.6	(1.0)
May	65.6	-	-	65.6	67.2	1.6
June	68.5	-	-	68.5	69.8	1.3
July	97.6	-	-	97.6	97.8	0.2
August	93.9	-	-	93.9	94.0	0.1
September	82.6	-	-	82.6	82.4	(0.1)
October	77.9	-	-	77.9	77.6	(0.3)
November	72.3	-	-	72.3	74.3	2.0
December	54.5	-	-	54.5	74.0	19.5
Total	899.4	-	-	899.4	927.7	28.3

In 2018, the measured and estimated flow at Station B was 28.3 acre-feet more than the estimated amount leaving Big Bear Lake from releases, leakage and spills. In 2018 these differences were small and reflect the improved measurements at Station B. In October 2016, Big Bear MWD replaced the weir plate at Station B with a 12-inch v-notch weir to improve the accuracy of the measurements and replaced the communication line between the transducer and the SCADA system. These changes improved the accuracy of the Station B measurements. Big Bear MWD is continuing their efforts to improve the reliability and accuracy of the Station B measurements by installing an additional transducer probe and XiO cloud SCADA system. The Watermaster Committee will continue to monitor this condition in 2019.

Lake Withdrawals for Snowmaking

Big Bear MWD sells water from Big Bear Lake for use in snowmaking, fire protection and re-vegetation for ski areas within the watershed. In 2018, 879.2 acre-feet of water was withdrawn from the lake for these purposes. The withdrawals for snowmaking occurred in seven winter months (January, February, March, April, October, November and December). The withdrawals for fire protection and re-vegetation occurred in five summer and fall months (May, June, July, August and September).

Big Bear MWD began selling water from the lake for snowmaking purposes in 1980 and the Watermaster accounting assumed 50 percent would return to the lake as snowmelt. In 1989, Big Bear MWD retained James M. Montgomery, Consulting Engineers to evaluate this assumption. Their report was completed in May 1989 and concluded the return flow factors would range between 0.48 and 0.52 depending on the air temperature during snowmaking. The report recommended the Watermaster continue using a return flow factor of 0.50. The Watermaster Committee adopted the recommendation in 1989.

Based on this report, Watermaster estimates that half of the monthly amount pumped from the lake for snowmaking in the winter months returns to the lake in the form of snowmelt during the same month. In 2018, the withdrawal from the lake for snowmaking was 775.8 acre-feet and 387.9 acre-feet returned to the lake. In the summer and fall months, 103.4 acre-feet of water was used and none was returned to the lake. The “net withdrawal” for all purposes was 491.3 acre-feet.

Net Wastewater Exports

The Watermaster Committee calculates “net” wastewater exports as the difference between the wastewater that leaves the Big Bear Lake Watershed and the water supply that is imported into the Big Bear Lake Watershed from the Baldwin Lake Watershed. The methodology used to make these calculations is documented in a report entitled “Development of a Methodology for Estimating Gross Sewage Export from Upper Bear Creek Watershed”, prepared by James M. Montgomery, Consulting Engineers, Inc., in September 1989 for Big Bear Municipal Water District.

Wastewater is exported from the Big Bear Lake watershed to the Baldwin Lake watershed from the following three areas:

- City of Big Bear Lake
- San Bernardino County Service Area 53B
- Airport area served by Big Bear City CSD

Wastewater flows from the first two areas are measured by the Big Bear Area Regional Wastewater Authority (BBARWA). Wastewater flows from the airport area within the Big Bear Lake watershed are estimated based upon the number of sewer connections in the area.

Water is imported into the Big Bear Lake watershed from the Baldwin Lake watershed by the following three activities:

- City of Big Bear Lake imports groundwater from the Baldwin Lake watershed.
- Big Bear City CSD provides water to the airport area from the Baldwin Lake watershed
- Big Bear City CSD occasionally provides emergency water to the City of Big Bear Lake

The City of Big Bear Lake imported supplies and emergency supplies are both metered, while the airport area supplies are estimated based on the number of water service connections.

In 2018, the "net" wastewater exported from the Big Bear Lake Watershed was 727 acre-feet.

Table III-7 contains the 2018 monthly net exports.

TABLE III-7
NET WASTEWATER EXPORTS
(acre-feet)
Calendar Year 2018
Big Bear Watermaster

Month	Net Wastewater Exports (acre-feet)
January	80.1
February	65.3
March	88.8
April	50.3
May	49.4
June	56.9
July	56.5
August	50.6
September	34.3
October	47.0
November	60.8
December	<u>87.3</u>
Total	727.3

SANTA ANA RIVER

Bear Valley Mutual Water Company Water Needs

Mutual meets the water needs of its shareholders primarily by diverting water from the Santa Ana River. When river flow is inadequate to meet their needs, Mutual can call upon water stored in Big Bear Lake, pump ground water from the San Bernardino ground water basin, buy State Water Project (SWP) water from San Bernardino Valley MWD, or reduce the delivery rate to its shareholders.

In 2018, Mutual reported they may need up to 6,500 acre-feet of water from Big Bear MWD including the portion of the SWRCB 95-4 outflows they could beneficially use. Mutual met their overall 2018 water needs by in-lieu supplies from Big Bear MWD, diversions from the Santa Ana River, and local groundwater. Mutual also got some water from the lake releases and dam leakage for fish protection in Bear Creek.

Summary of Flows and Diversions at Mouth of the Santa Ana River Canyon

Exhibit D, Section 1(f) of the Judgment calls for data to be included in each Watermaster annual report summarizing the river flows at the mouth of the Santa Ana River Canyon and diversions at the mouth of the Santa Ana River Canyon. Specifically, it requests quantities of water diverted into the following facilities:

1. Bear Valley High Line
2. Redlands Canal
3. North Fork Canal
4. Edwards Canal
5. San Bernardino Valley Water Conservation District Spreading Grounds

Exhibit D also requires the annual report to estimate the amount of Santa Ana River flow not diverted for beneficial use. **Table III-8** contains this information for 2018.

TABLE III-8

**SUMMARY OF DIVERTED FLOW AT MOUTH OF
SANTA ANA RIVER CANYON
(ACRE-FEET)**

Calendar Year 2018
Big Bear Watermaster

Flow Component	Amount (AF)
FLOW OF SANTA ANA RIVER AT MOUTH OF CANYON	
Flow Reported for U.S.G.S. Gage 11051501-provisional	14,314
less BVMWC Canyon Well No. 1 Production	<u>-0-</u>
Estimated Santa Ana River Flow Below Seven Oaks Dam	14,314
Annual Storage Change in Seven Oaks Reservoir	<u>+619</u>
Estimated Santa Ana River Flow at Mouth of Canyon	14,933
DIVERSIONS BY BEAR VALLEY MUTUAL WATER COMPANY	
Diversions: Greenspot Metering Station	-0-
Edwards Line	351
North Fork Canal	1,988
Bear Valley Highline	2,258
Redlands Aqueduct (includes Redlands Tunnel)	6,914
SBVMWD Morton Canyon Connector Deliveries	-0-
Redlands Sandbox Spreading (observed)	<u>97</u>
	11,608
Adjustments: Water pumped from BVMWC Canyon Well No. 1	-0-
Redlands Tunnel Diversion	<u>-282</u>
Total MUTUAL Diversions	11,326
DIVERSIONS BY SBVWCD	
Diversions: Diversion by San Bernardino Valley Water Conservation District	2,888
SBVMWD Morton Canyon Connector Deliveries to SBVWCD	<u>-0-</u>
Total SBVWCD Diversions	2,888
TOTAL DIVERSIONS FROM THE SANTA ANA RIVER	
Total Diversions by Mutual and SBVWCD	14,214
AMOUNT NOT DIVERTED	
Santa Ana River Flow at Mouth of Canyon	14,933
Mutual and SBVWCD Diversions	- 14,214
Amount Released from Storage Behind Seven Oaks Dam	<u>- 619</u>
Estimated Not Diverted	100
Estimated Flow Downstream of Diversions*	0
Estimated Losses and Measurement Errors **	+100 or 0.7%

* This value equals the amount observed at the Cuttle Weir (-0- AF) plus spills from PH #3 (-0- AF)

** See written text for explanation

Flow of Santa Ana River at Mouth of Canyon

The United States Geological Survey (USGS) reports flow in the Santa Ana River at the mouth of the Santa Ana Canyon under Station No. 11051501. This station is the combination of flow records from three gages (USGS Station No. 11049500, 11051499, and 11051502). Flow in the flume between the afterbay of SCE Power House No. 1 (SCE Power House No. 2 was removed due to the construction of Seven Oaks Dam) and the forebay of SCE Power House No. 3 is estimated by the USGS using a meter installed by SCE and reported as Station No.11049500. Note that this metered flow includes the overflow from the old SCE Powerhouse No.3 forebay as reported on the Daily Flow Report as the Greenspot Spill. In addition, the USGS maintains two gauging stations near the mouth of the Santa Ana River Canyon below Seven Oaks Dam. Station No. 11051499 measures the flow in the main river channel while Station No. 11051502 measures river flow diverted into the afterbay of SCE Power House No. 3 through the Bear Valley River Pick-up. The measured flows at this gage also includes the over-flow from the old SCE Powerhouse No. 3 forebay. The records from these three sources are summarized, adjusted for the overflow from the old SCE Powerhouse No. 3 forebay, and reported as the total flow in the Santa Ana River, USGS Station No. 11051501.

During 2018, the total river flow reported by the USGS, currently provisional, was 14,314 acre-feet. However, measurements at Station No. 11049500 include the amount of groundwater pumped by Mutual and discharged into the flume above the gage. Thus, to get the actual Santa Ana River Flow, the canyon well production must be deducted from the reported flows. In 2018, there was no canyon well production. Thus, the resulting estimated River flow was 14,314 acre-feet in 2018. However, this value does not reflect the storage change in the reservoir behind Seven Oaks Dam. In 2018, an estimated 619 acre-feet of water was stored behind the dam. Thus, the estimated flow of the Santa Ana River at the mouth of the canyon above Seven Oaks Dam was 14,933 acre-feet in 2018.

Diversions by Bear Valley Mutual Water Company

Amounts diverted by Mutual and associated prior right companies are reported to the State Water Resources Control Board under Recordation Numbers 36-00021, 36-00022 and 36-00028. In 2018, Mutual's diversions were estimated to be 11,608 acre-feet based on the Daily Flow Reports

prepared by the San Bernardino Valley Water Conservation District (SBVWCD). The vast majority, 11,326 acre-feet, was water diverted from the Santa Ana River. They did not pump any groundwater from their well located in the Santa Ana Canyon above the major points of diversion, but they did produce 282 acre-feet of water from the Redlands Tunnel.

Diversions by San Bernardino Valley Water Conservation District

Water diverted by the San Bernardino Valley Water Conservation District for groundwater recharge is by virtue of licenses, pre-1914 rights and diversion rights of San Bernardino Valley MWD and Western MWD; all diversions are reported to the State Water Resources Control Board. In 2018, the diversions were estimated to be 2,888 acre-feet of Santa Ana River water for ground water recharge based on the Daily Flow Reports prepared by the SBVWCD.

Amount Not Diverted

The sum of the diversions mentioned above are subtracted from the total river flow, as reported by USGS Gage 11051501 plus the annual storage change in Seven Oaks Reservoir to determine the "Amount Not Diverted". The "Amount Not Diverted" represents the amount of water that flows past the mouth of the Santa Ana River Canyon without being diverted for beneficial use.

Losses and Measurement Errors

During preparation of the 1996 report, the Watermaster Committee discovered significant discrepancies between the value for "Amount Not Diverted", as calculated by the method contained in previous Watermaster Reports, and observed flows in the Santa Ana River just downstream from the last diversion point. Since 1994, San Bernardino Valley Water Conservation District staff have been estimating the amount of water flowing past the Greenspot Road Bridge at the Cuttle Weir, which is just downstream from the mouth of the Santa Ana River Canyon, on a daily basis. In past years the difference between the estimated flows at the Greenspot Road Bridge and the "Amount Not Diverted" were significantly different. The Watermaster has conducted extensive research with regards to the discrepancy and provided the following eight explanations:

1. Leakage Losses between Inflows and Outflows. The first explanation was unmeasured losses between the points where inflows and outflows are measured. These include:
 1. Leakage in the tailrace from SCE Power House No. 3 afterbay,
 2. Leakage in the Redlands Aqueduct between SCE Power House No. 3 afterbay and the Redlands Sandbox, and
 3. Leakage around the Redlands Sandbox weir.

2. Unmeasured Diversions. The second explanation was that Mutual can divert water for spreading at the Redlands Sandbox without it being measured. San Bernardino Valley Water Conservation District staff now observes and reports this diversion on a daily basis. These estimates are based on known flows delivered to the Redlands Sandbox and are fairly accurate. This possible source of error has been corrected and the amount diverted for spreading is included in Table III-8.

3. USGS Gage Accuracy. The third possible explanation for the disparity is the accuracy of the USGS flow records. The USGS reports that this combined flow measurement of the three gaging stations is considered to have an accuracy rating of "fair". A "fair" rating means that 95 percent of the daily discharge measurements are within 15 percent of the true value. According to Jeffrey Agajianian of the USGS, this means the error band for the entire year should be within approximately 15 percent of the total measured flow. This value is a conservative estimate of the possible measurement errors and the flow is likely to be well within this error band, especially during the summer months when flows are generally constant and lower.

4. Water Delivery Flow Measuring Device Accuracy. A fourth reason for the difference could be inaccuracies in the diversion measuring devices, which should be less than +/- 10 percent at any given time. Most of these measurements are obtained through the use of stable, long-term weirs and parshall flumes, but small, though not insignificant, errors are possible. Some of the measurement devices provide daily readings and are equipped with totalizer equipment providing monthly data. The San Bernardino Valley Water Conservation District (SBVWCD) will continue to update totalizer equipment on any of the measurement devices that are not equipped with totalizer equipment.

5. Observed Flow at the Cuttle Weir. A fifth possible explanation was the accuracy of the flow estimates at the Cuttle Weir. These estimates are based on daily flow observations. Total flow quantities are difficult to determine because of the high degree of short-term variability in the river flows during storm events. For 2018, the flow over the Cuttle Weir was estimated to be zero acre-feet.

The construction of the Seven Oaks Dam required the reconstruction of the SCE flume between the old Power House No. 2 and No. 3. This eliminated any losses in the flume from the old Power House No. 2 and No. 3 and required the USGS to move Station No. 11049500 to the old forebay of Power House No. 3. Flow at this station was initially estimated by using the Daily Flow Report provided by the San Bernardino Valley Water Conservation District and is reported as Station No. 11049500. As of August 2001, SCE has installed a new meter in their aqueduct above the forebay of Power House No. 3 and data from this flow meter is provided to the USGS. In addition, improved efforts were taken to monitor diverted water at the Redlands Sandbox for ground water recharge and observed flows at the Cuttle Weir. The Watermaster has concluded that these efforts have reduced the losses and measurement inaccuracies such that the large errors that occurred in the past should no longer occur.

6. Storage behind Seven Oaks Dam. There is, however, an additional factor that must be considered when the Watermaster Committee estimates the “amount not diverted”. This factor is the amount of water that has been stored behind Seven Oaks Dam (SOD) and not released by year-end. This stored water is Santa Ana River flow that has not yet been measured by the two USGS stream gages below the dam. In addition, water stored behind the dam from inflow in the previous year and released in the current year must also be taken into account. The amount stored behind SOD at the end of 2017 was 139 acre-feet (water surface elevation of 2,135.9 feet). The amount stored behind SOD at the end of 2018 was 758 acre-feet (water surface elevation of 2,162.2 feet). In other words, water was stored behind the dam from inflow in 2018. This amount was 619 acre-feet and was not included in the USGS provisional value of 14,314 acre-feet. Adding the amount of SAR water stored behind SOD in 2018 to the USGS provisional value increases the estimate of Santa Ana River flow to 14,933 acre-feet for 2018.

7. Spills from SCE PH No. 3. In 2012, the Committee identified an additional location where Santa Ana River water that is not diverted is measured by the San Bernardino Valley Water Conservation District. This location is the afterbay of SCE Power House No. 3. On occasion, all of the water delivered to the afterbay is not diverted and some of it is spilled to a small channel that discharges to the Santa Ana River below Cuttle Weir. The Committee agreed that these spills should be added to the observed flows at Cuttle Weir to estimate the “Estimated Flow Downstream

of Diversions” as reported in **Table III-8**. In 2018, there were no estimated spills from SCE PH No. 3.

8. Differences in Measurements. The USGS estimates of the Santa Ana River flow are based on stream gauges that record data at 15 minute intervals throughout the day. The estimates of diversions are based on the Daily Flow Reports prepared by the SBVWCD and these reports contain only a single value (usually in the morning) for each working day for each diversion point. Thus the diversion estimates are not as accurate as the USGS flow estimates and this could lead to significant errors in the “Estimated Not Diverted” value (100 acre-feet) as shown in Table III-8. The Watermaster Committee will review this item in 2019 to determine if Table III-8 should be revised to provide a better estimate of the amount of Santa Ana River water that is not diverted.

2018 Estimate of Amount Not Diverted

In 2018, San Bernardino Valley Water Conservation District observed no river flow past the Cuttle Weir at the Greenspot Road Bridge and no spills from the Santa Ana River from the afterbay of SCE Power House No. 3. Their estimate of these flows, which represents the amount not diverted, was zero acre-feet. In other words, all the flow in the Santa Ana River was diverted in 2018.

In 2018, the estimated Santa Ana River flow at the mouth of the canyon was 14,933 acre-feet. Deducting the 619 acre-feet of flow that was stored behind Seven Oaks Dam in 2018. The total estimated diversions of Santa Ana River flow by Mutual and San Bernardino Valley Water Conservation District was 14,214 acre-feet. This left an estimated 14,314 acre-feet of Santa Ana River water available for diversions. The difference between the estimated inflow and the total diversions is 100 acre-feet. Comparing this difference with the observed flows past the Cuttle Weir at Greenspot Road Bridge and the spills from the afterbay of SCE PH No. 3 (zero acre-feet), results in unmeasured leakage losses and measurement errors of 100 acre-feet. These losses and errors represent only 0.7 percent of the estimated Santa Ana River flow (acre-feet).

Lake Releases/In-Lieu Water Deliveries

Santa Ana River flows are often insufficient to meet Mutual’s water needs; as a result, they frequently request lake releases from Big Bear MWD to meet their needs. Big Bear MWD has the choice of releasing water from the lake or providing an in-lieu supply. At their meeting on May 1,

1987, the Board of Directors of the Big Bear MWD voted unanimously to approve the following policy for providing in-lieu supplies.

1. *Adopt the following 1987 in-lieu policy:*
 - A. *When the lake is in the top 4 feet, the irrigation demands from the lake will be met by releasing water from Big Bear Lake.*
 - B. *When the lake is between 4 feet and 6 feet down, the District intends to purchase in-lieu water between the months of May 1st and October 31st from either wells or the State Water Project; between November 1st and April 30, water required would be released from Big Bear Lake.*
 - C. *When the lake is between 6 and 7 feet down, the Board shall determine whether to release from the lake.*
 - D. *In the unlikely event that the lake is more than 7 feet down, the District intends to buy in-lieu water throughout the year.*
 - E. *The General Manager shall inform the Board each time water is released.*

On November 16, 2006, the Board of Directors of Big Bear MWD modified their Lake Release Policy to eliminate items C, D and E and to use in-lieu water whenever the lake is more than 6 feet below full. The revised Lake Release Policy is:

1. *When the Lake is within the top 4 feet, the water demands from Bear Valley Mutual will be met with Lake releases;*
2. *When the Lake is between 4 and 6 feet below full, the District intends to obtain in-lieu water between the months of May 1 and October 31. Between November 1 and April 30, water required would be released from Big Bear Lake;*
3. *When the Lake is more than 6 feet below full, the District intends to obtain in-lieu water throughout the year.*

In 2018, the lake level was more than 6 feet below full for the entire year. The lake ended the year 18.20 feet below full.

2012 In Lieu Lake Release Agreement

In July 2012, Big Bear MWD and San Bernardino Valley MWD (Valley District) entered into a Memorandum of Understanding that allowed Valley District to deliver In Lieu Water to Mutual when the Lake Release Policy would normally call for lake releases, and, in return, Valley District would get credit for an equal amount of water stored in Big Bear Lake. The amount of water in their storage account would be reduced monthly by the amount of additional evaporation resulting from the increased surface area of the lake. This In Lieu Lake Release program began on July 1, 2012 and was scheduled to run through December 31, 2015. In 2015, the two agencies modified the existing In Lieu Agreement to extend the time Valley District could make In Lieu lake deliveries to Mutual and provide Valley District with the opportunity to reduce their In-Lieu SWP deliveries to Mutual during emergency years when their State Water Project (SWP) deliveries are significantly reduced. At the end of 2017, Valley District had stored 962 acre-feet of water in Big Bear Lake. In 2018, Valley District did not request any In Lieu Lake Releases. The additional evaporation losses in 2018 were 130 acre-feet. Valley District ended the year with 832 acre-feet in their sub-account and the Lake was 0.48 feet higher than it would have been without the Memorandum of Understanding. **Table III-9** shows the account details of Valley District's portion of Big Bear MWD's lake account.

TABLE III-9
ALLOCATION OF BIG BEAR MWD LAKE ACCOUNT
 Calendar Year 2018
 Big Bear Watermaster

LAKE ACCOUNTS (acre-feet)	Big Bear WM Account	Valley District Subaccount	Big Bear Subaccount
Initial Storage	22,084	962.2	21,121.8
Lake Inflows	-	-	-
In-Lieu Supplies to Mutual	7,066.3	-	7,066.3
Lake Releases (Mutual & BBMWD)	-	-	-
Releases & Leakage (SWRCB 95-4)	(52.3)	-	(52.3)
Net Snowmaking Withdrawals	(491.3)	-	(491.3)
Lake Spills & Flood Control Releases	-	-	-
Evaporation from Lake	(4,572.3)	(129.7)	(4,442.6)
Net Wastewater Exports	(727.3)	-	(727.3)
Advances and Repayment of Advances	-	-	-
Ending Storage	23,307.0	832.5	22,474.5

Water Deliveries to Mutual by Big Bear MWD

Mutual received 7,890.9 acre-feet of water from Big Bear MWD in 2018. This year Mutual's needs were met by in-lieu deliveries of SWP water, water pumped from SBVMWD's well, and water discharged from the lake for fishery protection under SWRCB Order No. 95-4. **Table III-10** shows Big Bear MWD monthly water deliveries to Mutual during 2018.

TABLE III-10
WATER DELIVERIES TO MUTUAL BY
BIG BEAR MUNICIPAL WATER DISTRICT
 (Acre-feet)
 Calendar Year 2018
 Big Bear Watermaster

Month	Releases from Big Bear Lake for Mutual	Mutual's Use of Fish Releases*	"In-Lieu" State Water Project	"In-Lieu" Lake Releases	"In-Lieu" Groundwater	Total Deliveries to Mutual
January	-0-	64.1	83.5	-0-	-0-	147.6
February	-0-	69.7	95.1	-0-	-0-	164.8
March	-0-	39.2	144.0	-0-	-0-	183.2
April	-0-	62.6	257.0	-0-	-0-	319.6
May	-0-	65.6	419.3	-0-	-0-	484.9
June	-0-	68.5	1,242.1	-0-	35.3	1,345.9
July	-0-	97.6	2,087.9	-0-	163.2	2,348.7
August	-0-	90.8	1,469.3	-0-	149.9	1,710.0
September	-0-	82.5	820.2	-0-	99.5	1,002.2
October	-0-	77.9	-0-	-0-	-0-	77.9
November	-0-	69.9	-0-	-0-	-0-	69.9
December	-0-	<u>36.2</u>	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	<u>36.2</u>
Total	-0-	824.6	6,618.4	-0-	447.9	7,890.9

* Also required to comply with SWRCB Order No. 95-4

The amount of water delivered to Mutual consisted of 6,618.4 acre-feet of in-lieu SWP water, 447.9 acre-feet of well water and 824.6 acre-feet of lake water they were able to use from the releases and leakage for fish protection. In 2018, Mutual delivered in-lieu water for groundwater recharge for the first time. These deliveries could have an impact on the Basin Make-Up Account. The Watermaster committee will look into this issue in 2019.

The amount of water Big Bear MWD is obligated to deliver to Mutual is limited by the Judgment. According to the Physical Solution Agreement, Article III.A.1.(b), Mutual has the right to:

“divert water, or cause water to be diverted, at such rate as may be reasonably necessary to meet the requirements of Mutual’s stockholders, not exceeding 65,000 acre-feet in any ten (10) year period, as determined by the Board of Directors of Mutual in its sole discretion.”

Table III-11 summarizes the deliveries to Mutual since the agreement went into effect. For the ten-year period ending with calendar year 2018, the amount of water delivered to Mutual by Big Bear MWD was 59,073 acre-feet. For the 42-year period the Judgment has been in effect, the average annual deliveries by Big Bear MWD to Mutual has been 4,636 acre-feet.

In 2019, Mutual can request up to 12,427 acre-feet of water from Big Bear MWD. This value is the amount that they are below the 65,000 acre-feet limitation at the end of 2018 (which is 5,927 acre-feet), plus the deliveries made in 2009 (which was 6,500 acre-feet), that will be dropped from the ten-year period ending in 2019. The 12,427 acre-feet total includes in-lieu deliveries, lake releases, and fishery outflows that Mutual is able to divert.

Draft TABLE III-11
SUMMARY OF WATER DELIVERIES TO MUTUAL 1977 - 2018
 (acre-feet)
 Calendar Year 2018 Big Bear Watermaster

Calendar Year	Mutual Lake Releases	SWRCB Outflows to Mutual	In-lieu Wells	In-lieu SWP	In-lieu EVWD or VD Lake Rel	In-lieu Stock	Total In-lieu & Releases	10-year Total
1977	868.0	-	4,412.0	-	-	-	5,280.0	n.a.
1978	-	-	-	-	-	-	-	n.a.
1979	-	-	-	-	-	-	-	n.a.
1980	-	-	-	-	-	-	-	n.a.
1981	2,250.0	-	-	672.0	-	-	2,922.0	n.a.
1982	657.0	-	-	56.0	-	-	713.0	n.a.
1983	-	-	-	-	-	-	-	n.a.
1984	1,700.0	-	-	993.0	-	-	2,693.0	n.a.
1985	2,463.0	-	842.0	2,994.0	-	-	6,299.0	n.a.
1986	1,358.0	-	1,139.0	190.0	-	-	2,687.0	20,594.0
1987	-	-	3,301.0	4,762.0	-	84.0	8,147.0	23,461.0
1988	-	-	1,864.0	5,432.0	-	63.0	7,359.0	30,820.0
1989	-	-	1,593.0	8,555.0	-	-	10,148.0	40,968.0
1990	-	-	562.0	7,722.0	-	-	8,284.0	49,252.0
1991	78.6	-	-	-	151.0	-	229.6	46,559.6
1992	-	-	-	-	-	-	-	45,846.6
1993	-	-	-	-	-	-	-	45,846.6
1994	1,140.8	-	-	-	-	-	1,140.8	44,294.4
1995	88.3	-	-	-	-	-	88.3	38,083.7
1996	3,460.7	-	-	4,027.5	-	-	7,488.2	42,884.9
1997	364.0	-	-	6,780.1	-	-	7,144.1	41,882.0
1998	-	-	-	-	-	-	-	34,523.0
1999	124.2	146.5	-	10,435.8	-	-	10,706.5	35,081.5
2000	-	510.4	-	12,877.5	-	-	13,387.9	40,185.4
2001	46.3	492.7	48.1	14,212.4	-	-	14,799.5	54,755.3
2002	-	614.1	-	5,000.0	-	-	5,614.1	60,369.4
2003	-	484.3	-	-	-	-	484.3	60,853.7
2004	-	512.3	-	2,500.0	-	-	3,012.3	62,725.2
2005	-	146.3	-	2,218.0	-	-	2,364.3	65,001.2
2006	-	467.2	-	2,070.3	-	-	2,537.5	60,050.5
2007	-	486.0	-	6,500.0	-	-	6,986.0	59,892.4
2008	-	474.6	-	4,633.6	-	-	5,108.2	65,000.7
2009	-	509.8	-	5,990.2	-	-	6,500.0	60,794.2
2010	123.1	276.2	-	2,478.8	-	-	2,878.1	50,284.3
2011	-	384.5	-	789.2	-	-	1,173.7	36,658.5
2012	-	640.8	-	4,695.9	-	-	5,336.7	36,381.1
2013	-	653.1	-	6,454.4	-	-	7,107.5	43,004.3
2014	-	892.9	4,691.9	1,716.0	-	-	7,300.8	47,292.8
2015	-	661.9	648.0	5,170.9	484.8	-	6,965.6	51,894.1
2016	-	766.5	-	8,500.0	-	-	9,266.5	58,623.1
2017	-	506.3	-	4,146.8	-	-	4,653.1	56,290.2
2018	-	824.6	447.9	6,618.4	-	-	7,890.9	59,072.9
1977-2018 Average	350.5	248.8	465.5	3,552.2	15.1	3.5	4,635.6	

Table III-11 was updated December 27, 2018 to correct minor rounding problems

Mutual's Equivalent Water Diversions

Table III-12 shows the amount of water that Mutual would have diverted from the Santa Ana River if the Judgment had not been rendered. This figure is determined by adding the in-lieu State Water Project water and in-lieu groundwater deliveries as reported in **Table III-10** to the river diversions by Mutual and Mutual's groundwater production from their Canyon Well No. 1, as shown in **Table III-8**. Mutual's Canyon Well No. 2 was destroyed as part of the construction of the Seven Oaks Dam between 1994 and 1998. The value for river diversions includes the supply from the Redlands Tunnel and the in-lieu lake release. This equivalent diversion is the amount of Santa Ana River water Mutual would have diverted if their demands for water from Big Bear MWD had been met by lake releases rather than in-lieu deliveries. In 2018, Mutual's equivalent diversions were 18,674 acre-feet.

TABLE III-12
EQUIVALENT WATER DIVERSIONS BY MUTUAL 1977-2018

(acre-feet)
 Calendar Year 2018
 Big Bear Watermaster

Calendar Year	Net Santa Ana River Diversion by BVMWC*	Groundwater Production From Wells No. 1 & 2	Big Bear MWD In-Lieu Deliveries	Equivalent Total Water Diversions
1977	14,420	1,546	4,412	20,378
1978	16,809	282	-	17,373
1979	19,470	114	-	19,584
1980	20,479	188	-	20,667
1981	20,449	1,130	672	22,251
1982	18,565	246	56	18,867
1983	19,209	53	-	19,262
1984	23,392	739	993	25,124
1985	19,837	872	3,836	24,545
1986	23,160	894	1,9	25,383
1987	16,373	947	8,147	25,467
1988	14,170	612	7,359	21,141
1989	11,449	672	10,148	22,269
1990	11,242	1,576	8,283	21,101
1991	13,715	368	151	14,234
1992	16,840	97	-	16,937
1993	26,591	-	-	26,591
1994	23,819	594	-	24,413
1995	30,794	60	-	30,853
1996	19,529	1,131	4,027	24,687
1997	19,490	1,559	6,780	27,829
1998	26,625	105	-	26,730
1999	21,336	484	10,436	32,256
2000	17,171	2	12,878	30,371
2001	12,355	140	14,260	26,755
2002	8,007	58	5,000	13,065
2003	13,301	114	-	13,415
2004	11,815	67	2,500	14,382
2005	13,615	-	2,218	15,833
2006	18,733	-	2,070	20,803
2007	12,445	182	6,500	19,127
2008	14,144	182	4,634	18,960
2009	11,022	-	5,990	17,012
2010	18,153	-	2,479	20,632.
2011	17,601	-	789	18,390
2012	15,560	-	4,696	20,250
2013	11,310	-	6,454	17,764
2014	9,572	-	6,408	15,980
2015	11,345	-	5,819	17,164
2016	9,453	-	8,500	17,953
2017	16,521	-	4,147	20,668
2018	11,608	-	7,066	18,674

* Includes 2013 Redlands Tunnel Diversions

IV. DETERMINATIONS AND ACCOUNTS

ACCOUNTING REQUIREMENTS

In accordance with Article 29 of the Judgment, "Watermaster shall maintain three basic accounts, in accordance with Watermaster Operating Criteria, as follows:

- (a) District's Lake Water Operation. A detailed account to reflect actual operation of the Lake by District shall be maintained.*
- (b) Mutual's Lake Water Operations. In addition, a corollary account shall be maintained to simulate the effect of Mutual's operations with regard to Lake water under the In-Lieu Water operations.*
- (c) Basin Make-up Account. An account of District's annual and cumulative obligation for Basin Make-up Water shall also be maintained."*

In 1986, the Watermaster Committee developed a computer program for keeping these accounts. This program was designed to operate on an IBM (or IBM compatible) personal computer using Lotus 1-2-3. To standardize all years of operations under the Judgment, all past accounts were recalculated using the program and were included in the 1986 Annual Report.

In 1990, the Watermaster Committee decided how to account for wastewater exports from the Big Bear Lake watershed and delivery of water on Mutual stock owned by Big Bear MWD. Only the Basin Make-up Account was affected by these decisions. Consequently, the 1990 Watermaster Report contained revised tables for the Basin Make-up Accounts for calendar years 1986, 1987, 1988 and 1989, as well as the status of all the 1990 accounts.

For the 1994 report, the Watermaster Committee updated the accounting procedures to reflect 1994 Watermaster decisions and to clarify the reports.

In 1995, the Watermaster made several additional revisions to the accounting procedures. However, in preparing the 1996 accounts, the Watermaster Committee discovered some errors in the changes made in 1995. These errors were corrected and, as a result, the 1995 accounts were recomputed and were included in the 1996 Annual Watermaster Report.

2018 ACCOUNT BALANCES

Appendix B contains the 2018 accounts. The first four pages of the appendix present the input data used to calculate the various accounts. The fifth page summarizes the status of the various accounts. The remaining pages of **Appendix B** are the detailed monthly tables of the accounts.

Actual Lake Account

Figure 2 illustrates the water balance for the actual operation of Big Bear Lake in 2018. **Table 1** of **Appendix B** provides additional detail. This information shows that:

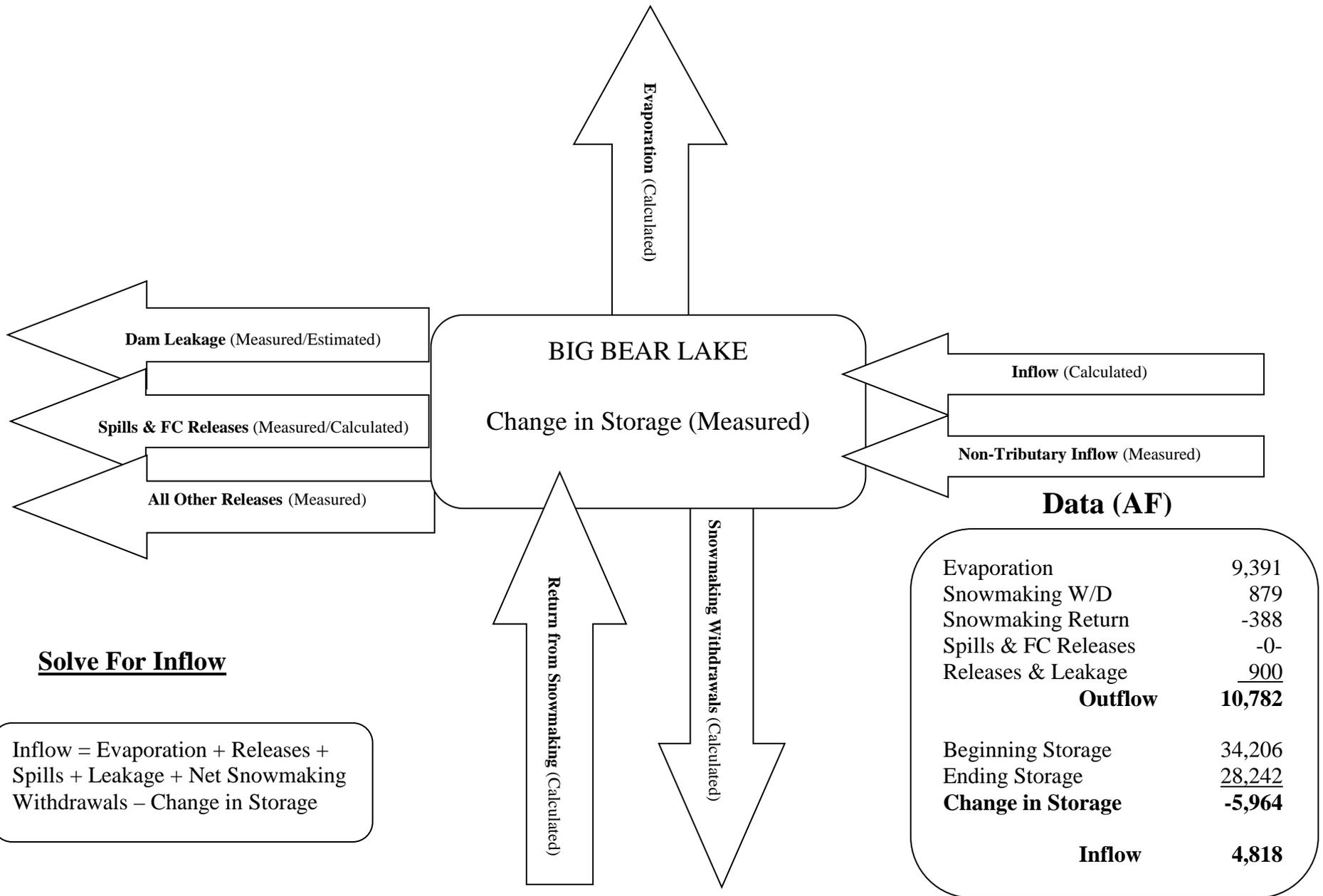
- 1) the lake level dropped 3.00 feet, from a gage height of 57.13 feet to 54.13 feet; 72.33 feet is full;
- 2) lake storage decreased by 5,964 acre-feet, it began the year with 34,206 acre-feet and ended the year with 28,242 acre-feet; when the lake is full, it contains 73,320 acre-feet of water;
- 3) lake surface area varied between 2,138 and 1,900 acres;
- 4) evaporation was 9,391 acre-feet;
- 5) lake inflow was 4,818 acre-feet,
- 6) the total of spills, releases, leakage and net lake withdrawals was 1,391 acre-feet.

Tables 1A through **1D** provide additional details to support **Table 1**.

Mutual's Lake Account

Figure 3 illustrates the water balance for Mutual's synthesized operation of Big Bear Lake in 2018. Mutual's operation shows what would have happened if:

Figure 2
Water Balance for 2018 Actual Lake Operations



Solve For Inflow

$$\text{Inflow} = \text{Evaporation} + \text{Releases} + \text{Spills} + \text{Leakage} + \text{Net Snowmaking Withdrawals} - \text{Change in Storage}$$

Data (AF)	
Evaporation	9,391
Snowmaking W/D	879
Snowmaking Return	-388
Spills & FC Releases	-0-
Releases & Leakage	<u>900</u>
Outflow	10,782
Beginning Storage	34,206
Ending Storage	<u>28,242</u>
Change in Storage	-5,964
Inflow	4,818

- 1) Mutual had owned the lake,
- 2) The in-lieu program was not in place, and
- 3) The net wastewater exported from Big Bear Lake watershed entered the lake as supplemental inflow.

In this synthesized case, Mutual's demands for lake water would have been met entirely from lake releases.

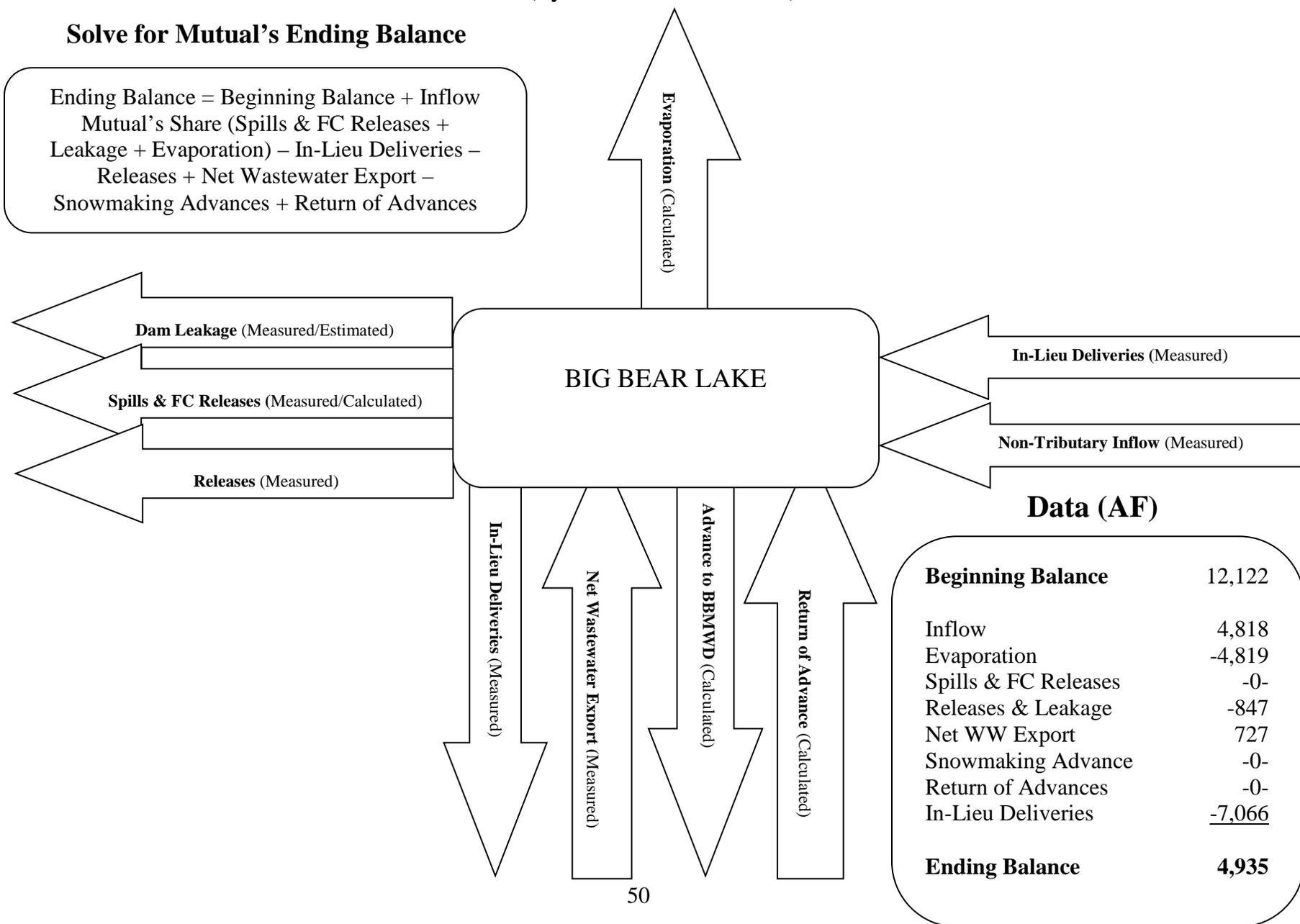
Figure 3 and **Table 2** of **Appendix B** show that Mutual had 4,935 acre-feet in its lake account at the end of 2018. This account balance is 7,187 acre-feet less than was in their lake account at the end of 2017. **Table 2** also shows that in 2018 Mutual's lake account was credited with all the lake inflow (4,818 acre-feet), the total of their releases, spills and leakage was 847 acre-feet and their in-lieu deliveries were 7,066 acre-feet. In 2018, supplemental inflow of 727 acre-feet was added to Mutual's Lake Account for net wastewater exported from the basin. In 2018, there were no advances to Big Bear MWD for snowmaking within the watershed. Evaporation that would have taken place under a Mutual operation was 4,819 acre-feet.

The cumulative effect of changes in lake releases and supplemental inflows that would have taken place since 1977 under a "Mutual Operation" would be a lake level that would have been 37.25 feet at the end of 2018 or 35.08 feet below the top of the dam. This synthesized lake level is 16.88 feet lower than it actually was. This lower lake level reflects the impact of what Mutual's lake withdrawals would have been without the in-lieu program and with the credits they receive from the net wastewater exports. **Tables 2A** through **2C** of **Appendix B** provide additional details to support **Table 2**.

Article 4.(b) of the Watermaster Operating Criteria (Exhibit "D" of the Judgment discusses how to handle the export of wastewater from and the import of water to the Upper Bear Creek Watershed. Specifically, it says:

In the event gross export from Upper Bear Creek Watershed to any area not tributary to the Santa Ana River Watershed within Upper Bear Creek Watershed, calculated inflow to the Lake shall be increased each year, beginning with the calendar year 1986 by the amount by which such gross export exceeds imports. If gross import exceeds gross export, said excess shall be credited against District's Basin Make-up Water obligation.

Figure 3
Water Balance for 2018 Mutual's Lake Operation
 (Synthesized Conditions)



In 1986, the Watermaster Committee decided to handle the net wastewater exports (gross exports-gross imports) entirely in the District's Basin Make-up water obligations. This decision was contingent upon implementation of a wastewater reclamation project in the Upper Bear Creek Watershed by December 31, 1994. A reclamation project was not implemented by that date so the Watermaster Committee, in 1994, decided to add the net wastewater credits to the calculated lake inflows effective January 1990. This decision adds the net wastewater credits to Mutual's lake account. Essentially, it transfers the amount of the credit from Big Bear MWD's lake account to Mutual's lake account.

Table IV-1 shows the impacts of crediting Mutual's lake account (and debiting Big Bear MWD's lake account) with the net wastewater exports. Since 1990, Mutual has been credited with 36,972 acre-feet of net wastewater exports. After 29 years of getting these credits, Mutual's lake account has 4,162 acre-feet more water than it would have had if it hadn't received the credits. This additional increase raised their simulated lake level by 11.30 feet. In other words, without the credits, Mutual's lake account would have been 799 acre-feet and their lake level would have ended the year at 26.00 or 46.33 feet down. In other words, it would have been 28.13 feet below the actual lake level of 54.13 feet and 11.30 feet lower than reported in Mutual's lake account tables (37.30 feet).

There are two primary reasons why the increase in their lake account (4,162 acre-feet) is less than the cumulative credits they have received (36,972 acre-feet). The first reason is spills. When the lake fills, Big Bear MWD's water spills first, and then Mutual's water spills. The Wastewater export credits they receive will spill during very wet years, like 1998. The second reason is evaporation. Mutual's lake level increases with the credits. With higher lake levels, their share of the evaporation losses increases. The end result is that at the end of 2018 Mutual's lake account had 4,162 acre-feet more and Big Bear MWD's lake account had 4,162 acre-feet less as a consequence of the net wastewater export credits.

TABLE IV-1
EFFECT OF WASTEWATER EXPORT CREDITS
ON MUTUAL'S LAKE ACCOUNT
 Calendar Year 2018
 Big Bear Watermaster

End of Calendar Year	Net Wastewater Export Credit (AF)	w/Wastewater Credits		w/o Wastewater Credits		Differences	
		Storage Account (AF)	Lake Level (Feet)	Storage Account (AF)	Lake Level (Feet)	Storage Account (AF)	Lake Level (Feet)
1989	-	16,905	47.00	16,905	47.00	-	-
1990	857	7,627	40.30	6,864	39.50	763	
1991	940	14,226	45.75	12,772	44.65	1,454	1.10
1992	723	22,787	51.15	20,886	50.05	1,901	1.10
1993	2,223	62,165	68.40	58,271	67.00	3,894	1.40
1994	1,397	61,407	68.15	56,451	66.35	4,956	1.80
1995	2,012	66,308	69.90	65,019	69.45	1,289	0.45
1996	1,540	60,875	67.95	58,229	67.00	2,646	0.95
1997	1,427	52,407	64.80	48,663	63.35	3,744	1.45
1998	2,427	69,566	71.00	68,282	70.60	1,284	0.40
1999	1,339	51,390	64.40	48,922	63.45	2,468	0.95
2000	1,337	35,335	57.65	31,900	56.00	3,435	1.65
2001	1,317	19,898	49.45	15,732	46.75	4,166	2.70
2002	889	10,856	43.15	6,897	39.55	3,959	3.60
2003	1,044	13,718	45.35	9,695	42.20	4,023	3.15
2004	1,024	14,200	45.70	10,233	42.65	3,967	3.05
2005	1,750	43,041	61.05	37,900	58.85	5,141	2.20
2006	1,462	48,034	63.10	42,067	60.65	5,967	2.46
2007	997	34,655	57.35	28,588	54.30	6,067	3.05
2008	1,207	35,251	57.60	28,855	54.45	6,396	3.15
2009	1,074	30,034	55.05	23,496	51.55	6,538	3.50
2010	1,715	52,208	64.75	44,898	61.85	7,310	2.90
2011	1,781	58,121	66.95	49,683	63.75	8,438	3.20
2012	1,175	49,881	63.85	41,167	60.25	8,714	3.60
2013	883	36,058	58.00	27,657	53.80	8,402	4.20
2014	732	26,252	53.05	18,292	48.45	7,960	4.60
2015	846	16,437	47.25	8,968	41.55	7,469	5.70
2016	848	8,977	41.55	3,021	33.65	5,956	7.90
2017	1,279	12,122	44.20	6,290	38.90	5,832	5.30
2018	<u>727</u>	4,961	37.30	799	26.00	4,162	11.30
TOTAL	36,972						

*The lake is empty at a gage height of 23.0

In the analysis of Mutual's lake account without the wastewater export credits, their lake account would have emptied in September 2018. To prevent Mutual's lake account from becoming negative, 120 acre-feet of SWP In Lieu deliveries were shifted from September to October, which would also require 120 acre-feet of SWP purchases to be shifted from October to September. The result was Mutual's lake account would have ended September with 31 acre-feet and ended 2018 with 799 acre-feet.

Big Bear MWD's Lake Account

Section 3(b), District's Water in Storage, of the Watermaster Operating Criteria of the Judgment describes the procedure to determine Big Bear MWD's storage account as follows:

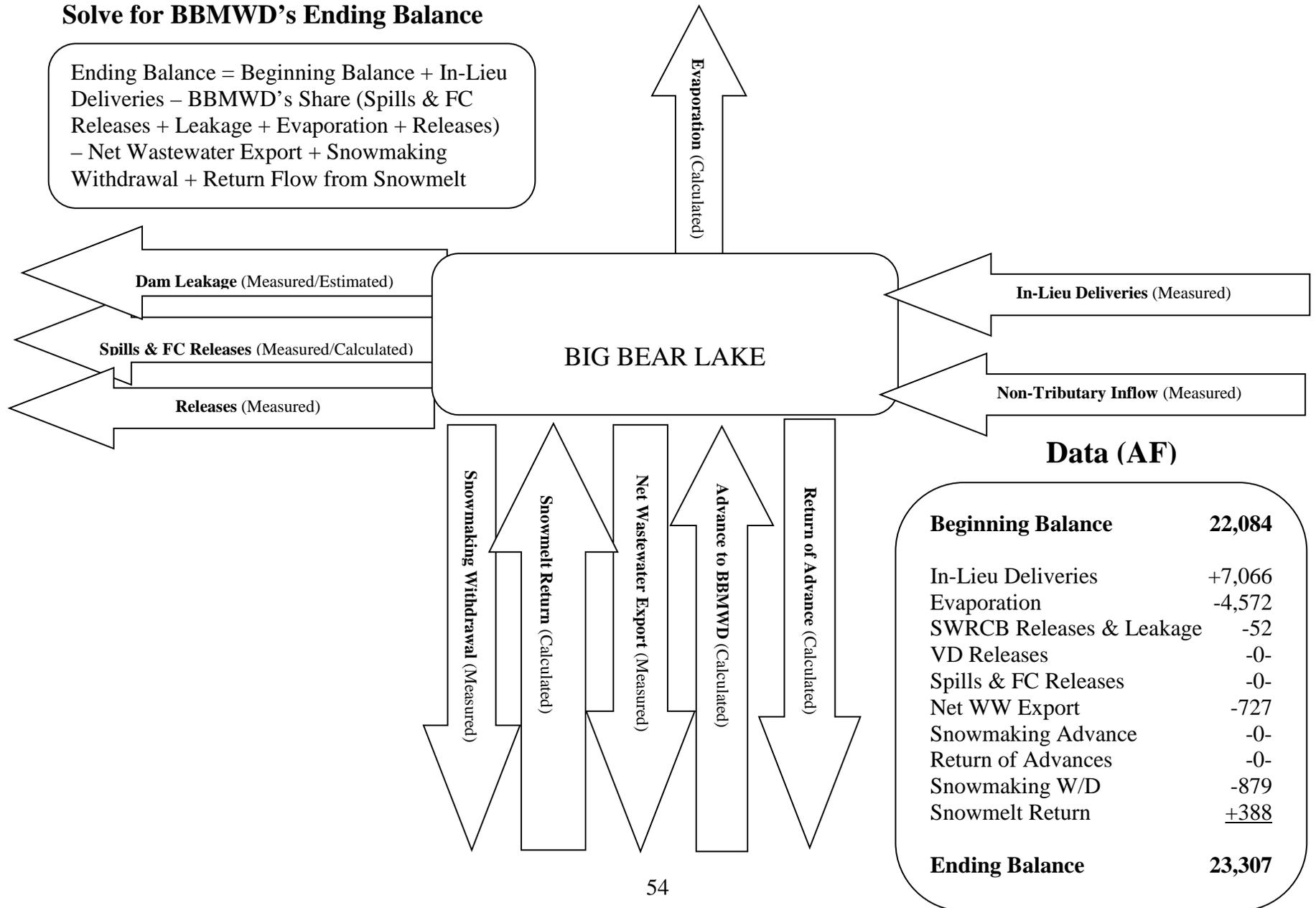
“Any water actually in storage in excess of Mutual's water in Storage, as calculated above, shall be for the account of District. So long as District has water in storage, all spills from the Lake shall be deemed District Water.”

Figure 4 illustrates the water balance for Big Bear MWD's lake account in 2018. Table 3 of **Appendix B** summarizes the results. This information shows the water actually in storage (from **Table 1** of **Appendix B**), Mutual's water in storage (from **Table 2** of **Appendix B**), and the difference between the two, which is the amount in Big Bear MWD's account. In 2018, Big Bear MWD's account balance began with 22,084 acre-feet and ended the year with 23,307 acre-feet. The increase in their account was 1,223 acre-feet. This increase was because the in-lieu deliveries to Mutual during the year were more than the evaporation losses, SWRCB releases, net snowmaking withdrawals and net wastewater exports.

Table 3 of **Appendix B** also shows the status of Big Bear MWD's "Advance Account". This account represents the net amount of water Big Bear MWD has "borrowed" from Mutual for snowmaking in the Big Bear Lake watershed. In 2018, Big Bear MWD's advance account was zero throughout the year.

Tables 3.A and **3.B** of **Appendix B** provide supporting information to Table 3.

Figure 4
Water Balance for 2018 BBMWD's Lake Operation
 (Synthesized Conditions)



Basin Make-up Account

Exhibit D of the Judgment contains a formula to be used for determination of the amount of Basin Make-up Water, if any, that is needed to offset deficiencies in the recharge supply to the San Bernardino Groundwater Basin. **Tables 4, 4A, 4B** and **4C** in **Appendix B** follow the formula presented in the Judgment for calculating the credit or deficiency in the Basin Compensation Account. The formula contained in the Judgment is:

Deficiency or Credit =

$$[(.50) (R_d) + (.51) (S_d) + (.50) (P_d)] - [(.50) (R_m) + (.51) (S_m)]$$

wherein:

R_d = Releases actually made under District Operation.

S_d = Spills which actually occurred under District Operation.

P_d = In lieu water purchased by District from San Bernardino Valley MWD or the Management Committee of the Mill Creek Exchange and delivered under District Operation to Mutual for service area requirements.

R_m = Releases which would have been made under a Mutual Operation.

S_m = Spills which would have occurred under a Mutual Operation.

The first three terms in the equation represent the recharge that occurs under Big Bear MWD's lake operation. These are referred to as the "Big Bear's Basin Additions" in **Table 4**. **Table 4.A** shows the details of the calculations for these three terms.

The last two terms in the equation represent the recharge that would have occurred if Mutual had owned and operated the lake and met its supplemental water needs from lake releases. Collectively these terms are referred to as "Mutual's Basin Additions" in **Table 4**. **Table 4.B** shows the detailed calculations for these two terms.

The monthly net credit or deficiency in recharge to the San Bernardino Basin is shown in Column 5 of **Table 4**. These calculations are in accordance with the formula in the Judgment.

The Judgment also requires Big Bear MWD to make-up for deficiencies in recharge that would occur as a result of their lake operations. Column 7 of **Table 4** shows the amount of water recharged by Big Bear MWD in the San Bernardino Basin to correct (or prevent) deficiencies in recharge. **Table 4.C** presents details of the sources of water used to replenish the Basin Compensation Account.

Table 4 of **Appendix B** presents the status of the Basin Make-up Account for 2018. The account balance began the year with a balance of 27,170 acre-feet and ended the year with 26,973 acre-feet. There was a 197 acre-foot decrease in the Basin Make-Up Account in 2018. The reason for the decrease was the use of local groundwater for in-lieu deliveries less a small recharge credit for the additional fish releases under a District operation.

In 2018, Mutual delivered In-Lieu water for groundwater recharge for the first time. The Watermaster Committee has agreed to review the impact of this new use of in-lieu water on the Basin Make-Up Account. The 1977 Judgment did not anticipate this use of in-lieu water and the formulas used to determine the Basin Make-Up Account balances may have to be revised to reflect this new use. The Watermaster Committee will address this issue in 2019.

V. OTHER WATERMASTER ACTIVITIES

IMPACTS OF SEVEN OAKS DAM

Previous Activities

Construction of Seven Oaks Dam by the U.S. Army Corps of Engineers (Corps) has been underway since 1990. The construction contract for the 550-foot high dam embankment was issued in 1994 and was completed in December 1998. Various clean-up and other miscellaneous contracts were completed in late 1999.

The plunge pool by-pass pipeline, which routes low flows through the dam, around the plunge pool and back to the river channel was completed in 2001. The low flows will be diverted for beneficial use by either Mutual through its “River Pick-up” or by SBVWCD at its main river diversion.

Subsequent to authorizing the project and beginning construction, the U.S. Fish and Wildlife Service (Service) listed the Slender Horned Spine Flower and the San Bernardino Merriam’s kangaroo rat as endangered species. This action generated new official biological mitigation consultations with the Service, as required by Section 7 of the Federal Endangered Species Act.

There are two features of Seven Oaks Dam that could affect future Watermaster activities. The first is that Seven Oaks Dam will prevent natural, subsurface flow of groundwater from leaving the Santa Ana River Canyon and will cause all groundwater coming from upstream of the dam to rise to the surface. This subsurface flow will then pass through the dam outlet structure. The plunge pool by-pass line will help to overcome the loss of these subsurface flows.

The second feature is related to impounding storm flows behind the dam. The San Bernardino Valley MWD and Western Municipal Water District of Riverside County provided funding to the Corps for a water conservation study, which began in November 1993, to evaluate Seven Oaks Dam as a dual use structure for flood control and water conservation which continued through late 2013

In 1995, the San Bernardino Valley MWD and Western Municipal Water District of Riverside County filed a petition to revise the Declaration that the Santa Ana River Stream System is Fully Appropriated and an application to Appropriate Water by Permit with the State Water Resources Control Board. The petition and application is to give the two local agencies the right to impound water behind Seven Oaks Dam, subject to the operational directions of the dam for flood control.

The possible impoundment of waters of the Santa Ana River for other than flood control raises a number of water rights issues that are yet to be resolved. Several diversion points for SBVWCD, North Fork Water Company, Mutual, and Redlands Water Company (“Below the Dam Diverters”) are downstream of Seven Oaks Dam, and the operation of these historical diversion points will be altered by the dam. During 1998 and 1999, discussions between the water rights holders and the San Bernardino Valley MWD began with an attempt to understand what and how much water would be impounded at various times of the year, along with the manner in which releases of storm flows from Seven Oaks Dam would be made.

It was the intent of the “below the dam diverters” to have releases from Seven Oaks Dam approximate average annual natural flows, recognizing that flood control release flows are expected to have less silt at low release rates than previous flows and may be more evenly distributed. Their request is to have the amount of water to be impounded behind Seven Oaks Dam for other than flood control determined after the combined needs have been met for (1) the water supply agencies to provide direct delivery water and (2) the integrity of the groundwater basin is stabilized by assuring groundwater levels are maintained within an appropriate operating range. These are the primary elements of discussion between the agencies. These discussions did not result in any agreement prior to the State Water Resources Control Board public hearing on the petition on December 7 and 8, 1999.

A Biological Assessment (BA) by the Corps was submitted to the Service in June 2000; however, in a November 2000 letter, the Service rejected the BA, and requested additional information, with particular emphasis on the Corps’ position related to the future water conservation element that had not been addressed by the Service. It is the apparent position of the Service that the biological mitigation requirements for operating the dam as a flood control facility must be negotiated before

any attempt to address the biological impacts of the water conservation element of Seven Oaks Dam.

On September 21, 2000, the State Water Resources Control Board (SWRCB) adopted Order WR2000-12 to allow for processing the application filed by the San Bernardino Valley MWD and Western Municipal Water District of Riverside County. SWRCB Order WR2000-12 also allowed for processing a water right application filed by Orange County Water District. The Chino Basin Water Conservation District filed a petition requesting the SWRCB to reconsider its decision, but in November 2000 the State Board denied the petition and upheld its September order. This decision meant that the applications for appropriation of the right to use water that will be impounded behind Seven Oaks Dam could be processed.

2001 Activities

The U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service continued meeting during 2001, but most of their discussions were focused on flood control issues at Prado Dam. Neither the flood control nor biological issues related to Seven Oaks Dam had been resolved.

On March 21, 2001, the water rights application (A031165) filed by San Bernardino Valley MWD and Western Municipal Water District of Riverside County was accepted for processing by the State Water Resources Control Board. On April 20, 2001, the water rights application (A031174) filed by Orange County Water District was accepted.

In May and June 2001, respectively, the San Bernardino Valley MWD filed a second application, and the San Bernardino Valley Water Conservation District (SBVWCD) filed an application for the right to use Santa Ana River water that would initially be impounded behind Seven Oaks Dam, then released for downstream use. As with the prior applications, accompanying each of the new applications was a petition requesting the fully appropriated steam designation for the Santa Ana River be overturned. Combined with the petition and application received in September 2000 from the Chino Basin Watermaster, there were three additional petitions pending. The State Board indicated a preference to hold hearings on all of the water rights applications together.

2002 Activities

On January 11, 2002, the SWRCB noticed the water rights applications filed by San Bernardino Valley MWD - Western Municipal Water District of Riverside County and Orange County Water District (Applications 31165 and 31174, respectively), which triggered a 60-day protest period. However, on March 4 the SWRCB extended the protest period until a hearing was conducted on additional filings for water rights and accompanying petitions to revise the fully appropriated stream designation for the Santa Ana River.

On March 19, 2002, a Pre-Hearing Conference and Public Hearing was noticed for the water rights applications filed by the Chino Basin Watermaster, San Bernardino Valley MWD - Western Municipal Water District of Riverside County (second application), San Bernardino Valley Water Conservation District, and the City of Riverside. During the Pre-Hearing Conference on April 16, 2002, all parties agreed to accept the evidence, which resulted in Order WR 2000-12 revising the fully appropriated stream designation for the Santa Ana River, as evidence that they would have presented again in their petitions. Consequently, the SWRCB adopted WR 2002-6 during its Public Hearing on July 2, 2002. Following the hearing on July 2, the protest period for Applications 31165 and 31174 was closed on July 17. Several protests were submitted and responses provided, but no further action occurred.

Also on July 2, 2002, the SWRCB staff notified all parties (all 6 applications) by letter that it was the SWRCB's intent to process all the applications in a similar time frame and requested each party to provide a schedule for completing its environmental documents for its respective application. A hearing on all the applications will be scheduled when the environmental analyses are completed.

The Corps and Service continued meeting during 2002. On December 19, 2002, a Biological Opinion outlining the mitigation requirements for Seven Oaks Dam was finalized and accepted. Various agencies in the San Bernardino Valley were given an opportunity to review the final draft and submit comments before it was finalized. With the Biological Opinion finalized, the Corps could complete any required environmental analyses for operating Seven Oaks Dam as a flood control facility. When that work is completed, the issue of a conservation pool of water detained

behind Seven Oaks Dam can be reviewed, and any needed biological consultations can be initiated. The impacts that a conservation pool may have on water rights remain unknown.

2003 Activities

In 2003 the Corps and the Local Sponsors, (San Bernardino and Orange County Flood Control Districts) continued to operate the dam under the Interim Water Control Plan. When a storm event occurred, the gates were closed until the water behind the dam stabilized at which time large volumes of water were released until the water level behind the dam reached the dead pool elevation. There were four events when large amounts of water were accumulated and released from the dam, one in February, two in March and one in April. All but 616 acre-feet of Santa Ana River water was diverted for beneficial use by Bear Valley Mutual Water Company and SBVWCD in 2003. The Corps and the Local Sponsors continued to operate the dam under the Interim Water Control Plan until December 30th, at which time they adopted the final plan and began to develop a debris pool. The dam will be operated in 2004 under the Water Control Manual for the Seven Oaks Dam & Reservoir.

The dam has been in operation for several years, and the Watermaster has identified an issue with regards to the river flow data collection. All of the USGS gages are located downstream of the dam. The dam prevents the gages from recording the actual stream flow during a storm event. The Watermaster Committee has found it important enough to investigate the location of a stream flow gage upstream of the dam. This location will allow the Watermaster to correlate precipitation data with stream flow data and to estimate inflow to the reservoir. The gages downstream of the dam will provide the amount of water released from the dam. Watermaster Committee members have conducted a field trip to locate a gage upstream of the inundation pool and have initiated discussion with the USGS and the Corps for assistance.

The review of the water rights applications proceeded in 2003. As of the end of 2003, a hearing date had not been set and no environmental documents had been distributed for review. Parties continue to negotiate to find common ground and interest.

2004 Activities

2004 started with the Army Corps of Engineers (ACOE) and the Local Sponsors releasing a base flow of approximately 3 cfs. The Water Control Manual required that during the storm season (October to May) a debris pool (water surface elevation of 2,200 feet) be formed for the purposes of protecting the intake tower from sediment intrusion. As of the beginning of May, the debris pool elevation had reached 2,180 feet and contained approximately 1,700 acre-feet of water. At this time, the ACOE began releasing water from the debris pool so they could begin their maintenance activities. As raw water was released, two water treatment plants, one owned by East Valley Water District (EVWD) and the other owned by the City of Redlands (COR), began to receive water from the debris pool. It was quickly noted that the raw water discharged from Seven Oaks Dam (SOD) was of poor quality and adversely impacted the ability of EVWD and the COR to successfully treat this water at their respective plants. This poor quality water is related to releases of water from the debris pool. If the upstream flow is diverted around the debris pool, such as when the Edison Facility is operational, there are no adverse impacts at their respective plants.

Because of this difficulty to treat water from SOD, EVWD hired a consultant, Camp Dresser & McKee, to perform a study on the treatability of the SOD discharges at their Plant 134. The report looked at two periods when water was released from SOD, May and November of 2004. The report concluded that local source water quality in November of 2004 showed significant degradation when it passed through the debris pool as compared to historical water quality. The results showed turbidity increasing from 2 NTU to between 5 to 80 NTU. Similar affects were noted with an increase in color units, iron, manganese, and TOC. All of these are indicative of poorer quality water than historical Santa Ana River water quality conditions. Limited source water quality sampling by the COR confirmed some of these adverse water quality trends during a period in May 2004 when discharges were also made from the debris pool. The water agencies impacted by the degradation of the water quality of the debris pool are meeting and working closely with the ACOE and the Local Sponsors to find a solution to the problem.

At the end of November 2004, the ACOE and the Local Sponsors completed their maintenance activities and began building the debris pool for the upcoming storm season. By the end of

December 2004, the debris pool was at a water surface elevation of 2,165 and contained approximately 900 acre-feet.

2005 Activities

The 2005 year began with abnormal rainfall. Late rains in 2004 had begun to fill the debris pool behind the dam. By the first of the year, the debris pool had reached elevation 2,165. Heavy rains in January and February more than filled the debris pool and by the end of March there was approximately 40,000 acre-feet of water stored behind the dam. The flood pool was at an elevation of approximately 2,390. In accord with operational guidelines, the Corps and local sponsors began to make releases at a rate of approximately 500 cfs. As happened in 2004, the water quality was unsuitable for surface diversion to the two local water treatment facilities. The NTU's were in excess of 400 and the water had the look of liquid milk chocolate. The Edison facilities were off line due to the storms. Surface water diverters were again faced with unusable water for domestic treatment purposes. The Conservation District initially diverted some of the degraded water for groundwater percolation but ultimately had to greatly reduce diversions due to the excessive turbidity and poor water quality.

A group was formed by the Upper Santa Ana River Water Resources Association to take another look at the water quality situation. East Valley Water District engaged the services of Camp Dresser & McKee (CDM) to prepare a detailed report addressing the problem as well as identifying potential solutions. Representatives from the Basin met with Congressman Jerry Lewis to describe the situation and seek Federal assistance to solve the problem. Congress appropriated \$1,000,000 to study the issue. By the end of 2005, CDM and the working committee from the Upper Santa Ana River Basin had completed their study. The study was been distributed to the Corps, Local Sponsors and to Congressman Lewis' office.

Because of the large body of water contained behind the SOD, the Corps decided to test the operating valves for flood releases in mid-spring. During the test period when high velocity releases were taking place, a portion of the outlet tunnel failed and the tests were terminated. For the balance of the spring, summer and fall seasons the releases from the SOD were minimal and averaged between 3 and 80 cfs, until the debris pool was emptied. The repairs to the tunnel were

completed in November and it was anticipated that in early 2006, testing would again be resumed. However, rainfall after March 2005 was inadequate to retest the tunnel for several years.

Water quality remains a priority concern. While 2005 was one of the wettest years on record, local diverters, who normally rely on the flows from the Santa Ana River for their source of treatable water for domestic purposes, had to purchase State Water Project water. The saving grace for the local water users is that Edison was able to repair all their upstream facilities by early fall. Their diversions by-pass SOD and they were able to deliver good quality water to the two local water treatment facilities. However, by the end of 2005 the debris pool was non-existent and slowly beginning to rise. Water quality again became poor.

2006 Activities

At their January 17, 2006 meeting, the Watermaster Committee received a copy of the “Seven Oaks Dam Water Impact Study” report prepared by Camp, Dresser & McKee, Inc. (CDM). This report identified the water quality and water supply impacts of Seven Oaks Dam on downstream water users, and recommended comprehensive alternatives to mitigate these impacts. Water quality impacts included longer durations and elevated levels of turbidity, total organic carbon, color, iron, manganese, algae, and taste and odor causing compounds. Water supply impacts included less supply in dry hydrologic years, reduced supplies in Fall through Winter as the Debris Pool behind the Dam is filled, and extended periods of time the SCE facilities are out of service after flood events. During these extended periods, the SCE facilities cannot be used to divert high quality Santa Ana River (and Bear Creek) water around Seven Oaks Dam.

The CDM report recommended long-term comprehensive alternatives and an interim solution. The long-term comprehensive alternatives included pretreatment of the water delivered from Seven Oaks Dam to achieve the water quality levels that existed before the Dam was constructed, and hardening of the SCE facilities so they would be more reliable and remain in-service for longer periods of time. The recommended interim solution is to purchase imported SWP water from San Bernardino Valley MWD to replace the water that could not be used because of water quality problems or that was not available due to dam operations and unavailability of SCE facilities.

At the May 16, 2006 meeting, the Watermaster Committee was advised that the ACOE was going to undertake a two-year \$3.5 million study of these issues. At the October 10, 2006 meeting, the Watermaster Committee was further notified that the ACOE staff had initiated their study, and they were in the data gathering phase.

The Watermaster Committee was concerned that the current operations of Seven Oaks Dam could restrict the operations of Big Bear Dam and the in-lieu program as described in the 1977 Judgment. These restrictions could include, at a minimum, reduced releases and increased in-lieu requirements when:

- SCE facilities are out of service and the quality of water behind Seven Oaks Dam is unacceptable to Mutual.
- SCE facilities are operating at capacity and the quality of water behind Seven Oaks Dam is unacceptable to Mutual.
- SCE facilities are out of service or operating at capacity in the fall and winter months when the Debris Pool is being filled and there are no releases from Seven Oaks Dam.

In addition, any reduction in releases from the Lake would increase lake evaporation and decrease the long-term average deliveries to Mutual. These restrictions could also constrain Big Bear MWD's opportunities to beneficially use the flood control releases they would make from Big Bear Lake in the late fall and winter months.

2007 Activities

2007 began with a release of approximately 3 cfs from Seven Oaks Dam. USACOE slowly raised the reservoir elevation. As of January 9, 2007 the elevation was 2,157.25 feet. The debris pool's desired elevation is 2,200.00 feet. Due to the abnormally dry weather conditions in January and February, SBVWCD began spreading State Project Water in the Santa Ana River spreading basins. By the end of February, the debris pool elevation was 2,175.20 feet and rising.

During the last two weeks in April, USACOE and local sponsors had hoped to accumulate enough water to test the Seven Oaks Dam tunnel repairs which were completed in early 2006, but never

subjected to test flows. Unfortunately there was insufficient water behind the Dam and the “high flow” testing lasted only approximately six (6) hours.

Very little to no water was released from Seven Oaks Dam from summer through November 2007. Southern California Edison was offline due to repairs on their facilities and on the intake.

In the spring of 2007, the capacity of the Foothill Feeder was tested. San Bernardino Valley Municipal Water District (Valley) was building a pump station on the Foothill Pipeline at the interconnect between Valley’s and Metropolitan Water District’s (MWD) pipeline to help improve the water pressure towards the east end of the valley when making large deliveries to MWD. It would also be used by MWD until their Inland Feeder Project tunnels are completed. In the future, the pumping station will help increase the flow capacity to the east end of the valley and the San Gorgonio Pass Water Agency. The results of the capacity testing are unknown.

In late November and early December 2007, the Upper Santa Ana Integrated Regional Water Management Plan (IRWMP) was approved. A press release in October 2007 by San Bernardino Valley Municipal Water District (Valley) summarized the main goal of the IRWMP is to improve water supply reliability in the region. To improve water supply reliability, the region must reduce demands as much as possible and capture and store wet year supplies for use during drought periods and other emergencies. The Plan is designed to meet this objective, and it addresses the following topics: water conservation and recycling, surface water management, groundwater management, diversification of water supplies, disaster preparedness, protection of water quality, ecosystem restoration and environmental improvement, and climate change.

2008 Activities

In 2008, the San Bernardino Valley Water Conservation District partnered with the San Bernardino Valley Municipal Water District in conducting a study of the capacity of the water spreading facilities downstream of the Seven Oaks Dam. The field work was conducted during March through December, collected and analyzed samples, performed flow testing of structures and assessed percolation capability and installed wells to identify enhancements to the facilities.

- Major conclusions of the study were that the area is ideal for recharge and not inhibited by clay or silt, faulting may interfere with recharge in the eastern end and very high flow years will saturate the spreading grounds. Additionally structure capacities limit regular use to 300cfs and further to the west the regular flows are limited to about 150CFS. This study would give rise to the Enhanced Recharge Project.

The missing upstream gaging station has not been replaced yet by the USACE. This is having a negative effect on the water flow monitoring capabilities of the Seven Oaks Dam as well as the downstream watershed.

The U.S. Army Corps of Engineers (USACE) has completed its draft study of the steps taken to address the degradation of the Santa Ana River water quality resulting from the construction of Seven Oaks Dam. That study has been reviewed by CDM, a consultant engineering firm hired by Bear Valley Mutual Water Company, Lugonia Water Company, Redlands Water Company, North Fork Water Company, San Bernardino Valley Conservation District, and the San Bernardino Valley Municipal Water District, and other interested water purveyors. The USACE report verifies original methodology used in calculating the effects of placing a dam interrupting the natural flow of the Santa Ana River for purposes of flood control and water retention to maintain a predictable daily controlled water flow for downstream users. The USACE report notes through modeling techniques based on field records data, that there appears to be no negative effect on the Santa Ana River water quality. The downstream users contend otherwise, that the very nature of the water being retained behind the dam for lengthy periods of time causes algae and bacterial growth, causes water to become stale and stagnant, and tends to plug up the pervious rock and soil layers of the downstream spreading basins. Several of the downstream water purveyors with water treatment facilities have difficulty, or cannot treat the stagnant water at all since the treatment facilities were not designed to treat water of this poor quality. The debate continues.

2009 Activities

In May, the Seven Oaks Dam Orange County Flood Control district operators emptied the reservoir behind the dam. With the advent of a drought breaking rainy season that began in October, the dam is now about 30 percent full. To view a daily activities record of the SOD, as

well as information about other area dams, use the web address of:

<http://www.spl.usace.army.mil/cgi-bin/cgiwrap/zinger/slProjReport.cgi?allRes.in>.

The Corps continued to address degraded water quality of river runoff retained for long time periods behind the dam. At Congressman Lewis's urging, the US Army Corps of Engineers (USACE) resumed bi-monthly talks with interested downstream prior rights and permitted water users to reach a conclusion about the change in operation of the SOD to decrease the impact of dam retention on degradation of good quality stream water. A final study report was to be issued in April 2010. Two general conclusions have been offered on how to deal with the water quality problem: (1) do not fill the debris pool with runoff that is high in organic materials; with less organic material contained in the stored water, less contamination of the water will result, and (2) use the volume for long term water storage to form a lake, thereby reducing the impact of plant life on pooled water (weeds, bushes, other plants that have grown since the last reservoir filling) and there will be no dry land for the plants to regenerate on when the reservoir is drained each spring. The USACE was willing to change its method of operations if the downstream users agree to accept responsibility for downstream water quality.

Another issue of importance to Bear Valley Mutual Water Company and downstream water users, and to the water volume calculations of the Big Bear Watermaster Report is the upstream bypass of high quality water that is collected upstream of the SOD and conveyed past the dam in Southern California Edison Electric Company pipelines to the SCE Power Plant No. 3. There the water is used to power a 3 MW generator. This better quality water is then distributed to Redlands Water Company, East Valley Water District, and Bear Valley Mutual Water Company for their usage. The water is clean and easily treatable by the respective water purveyors' treatment plants. When the reservoir level surpasses the access road to the upstream valves controlling the SCE Highline, water cannot be directed to the downstream SCE Power Plant No. 3. Then the high quality upstream water flows into the SOD reservoir and the water stored behind the SOD is distributed to the above entities. Most of the time that water is not usable. The access to the upstream valves when the reservoir levels are higher than the access road is now an issue that has to be resolved. Although the debate continues, at least there is the beginning of a consensus of how the water above the SOD can best be utilized by the water users downstream of the dam.

2010 Activities

For most of 2010 Seven Oaks Dam's reservoir was operated for flood control by the operators on behalf of Orange Flood Control District. The calendar year began with levels below the Debris pool level of 2200 based on telemetry data. Inflow was stored until high flow testing in April. This test flow and subsequent flows were discharged from the dam. A minimum flow of 3 CFS was discharged when significant rainfall and the reservoir level rose to approximately elevation 2,279 feet with 13,177 acre-feet in storage (based on telemetry) with 3 CFS outflow.

USACOE Reservoir Regulation branch maintains the referenced website as a public record or reservoir status: <http://www.spl.usace.army.mil/cgi-bin/cgiwrap/zinger/slProjReport.cgi?allRes.in>

The quality of the water impounded behind the dam was visually degraded but generally better quality when compared to 2005 conditions. The USACOE is still studying the quality of the water and changes that may make better quality water available in the future. Some participants feel this study should be combined with the reoperation of the reservoir for water conservation. The general result of the latter will be the discharge of 250-500 CFS average when water is impounded and there is room available in Prado Reservoir.

2011 Activities

In December 2010 heavy rains began and the increased Santa Ana River flows were stored in the reservoir behind Seven Oaks Dam. In mid-February 2011 the USACOE and Orange County Flood Control District operators utilized the stored flows to complete testing of the high flow capability of the Dam, ultimately releasing approximately 7,000 cfs in March 2011 from the dual gates at the outlet works. The flow was reduced shortly thereafter and a flow of 1,000 cfs was maintained for several days, almost emptying the reservoir. At this time the flows were reduced further to facilitate water conservation and Santa Ana Sucker spawning. At the conclusion of successful testing, the facility was considered complete and operation was further transferred to the local sponsors. To view a daily activities record of the SOD, as well as information about other area dams, use the web address of:

<http://www.spl.usace.army.mil/cgi-bin/cgiwrap/zinger/slProjReport.cgi?allRes.in>.

A final study report on the degraded water quality was projected to be completed in 2012. Based on the draft report Orange County Flood Control District asked the USACOE to design a drained debris basin to reduce water held by the dam in low water conditions. This would improve water quality but slightly reduce the water conserved. Other conclusions could be rolled into the Water Conservation Study by the USACOE. No final project management plan schedule is available for this study. The USACOE was still conducting a study for water conservation, which may provide additional basin benefits and provide guidance on how the supplemental water supply can be best utilized.

2012 Activities

In contrast to 2011, precipitation in 2012 was about 50% of normal and this reduction in rainfall was seen in the watershed for Seven Oaks Dam. Little water was stored behind SOD, and most outflow was clean and useable by surface diverters. Most water entering the dam was allowed to flow out at the same rate for use by surface diverters and for conservation.

Despite continued work, the US Army Corps of Engineers and the local sponsors of the SOD Project were not able to complete the documentation and environmental clearance for water quality improvements to the reservoir. While there was very little water, there was no issue of degraded water quality behind the dam as in earlier years. The final study report is now expected in late 2013 or 2014. As noted in 2010 the USACOE and Orange County Flood Control District continued design efforts for a drained debris basin to reduce water held by the dam in low water conditions. Environmental clearance for water conservation is expected to be separated from the study and provided by the local agencies through a river wide HCP.

2013 Activities

Precipitation in 2013 was about 50% of a normal year, and the low precipitation had impacts throughout the watershed and impacted flows into Seven Oaks Dam. Little water was stored behind SOD in 2013, and the outflow has been clean and almost exclusively used by surface

diverters. Most water entering the dam was allowed to flow out at the same rate for use by surface diverters and conservation.

Scheduled water quality improvement work by the US Army Corps of Engineers and the local sponsors of the SOD Project was not completed due to environmental clearances being delayed. Very little water was stored in the reservoir and there were no issues with degraded water quality behind the dam as there had been in earlier years.

The final water quality study report on this important topic is expected in 2014. Based on the draft report, Orange County Flood Control District and the USACOE are designing a drained debris basin to reduce the amount of water held by the dam in low water conditions. This change would improve water quality but slightly reduce the water conserved. The USACOE put the water conservation study on hold based on a request from San Bernardino Valley Municipal Water District, due to difficulties with the environmental planning related to the project. The environmental clearance for this project will be included in the Santa Ana River HCP by the local water agencies.

2014 Activities

2014 Precipitation was very similar to 2013 and the region struggled with drought and the limitations caused by loss of State Project Water. The effect of the drought on the SOD and Operations was similar to that of 2013. Very little water was stored behind SOD during the year and almost all water was clean and mostly used by surface diverters, further reducing recharge and groundwater levels. Virtually all water entering the dam was allowed to flow out at the same rate for use by surface diverters. With significant delays in the work on conservation storage the local sponsors determined to stop work on the study and develop a River Habitat Conservation Plan to ensure the Santa Ana Sucker can be protected while water management and flood control is operated.

Despite work on the effort, water quality improvement work by the US Army Corps of Engineers and the local sponsors of the SOD Project was not completed due to environmental clearances being delayed and limited water flows. Very little water was stored in the reservoir and there were no issues with degraded water quality behind the dam as there had been in earlier years.

2015 Activities

The long drought continued and worsened in 2015. The precipitation levels were around 50% of the average in much of the watershed. Again in 2015 imported water was very limited and significant basin groundwater had to be used to make up water needed or guaranteed to local uses. April provided several days of significant flows from Seven Oaks Dam which was recharged into the groundwater basin. In the watershed of Seven Oaks Dam, the historic lake fire raged for several weeks and burned a significant portion of the easterly SOD drainage. With limited rain and slowly melting snow, most of the sediment that is expected to run off the mountain has not been seen. Some water with black charred wood and ash was recharged with limited impact. In general the impacts of the fire are yet to be felt in the lower watershed.



The water flows that were impacted by the fire have not moved significantly and not yet impacted water coming to SOD significantly. Water levels behind SOD have been near historic lows due to the drought. Surface water diverters were able to use the water most all the time through the year with little disruption. For the vast majority of the year water was at a free flow through the dam.

The work on the River Habitat Conservation Plan, which would address the impacts of water operations on the Santa Sucker and other habitat impacts continued. This effort will allow consideration of additional storage by the dam in the future for water conservation. No water quality improvements were made at the dam and little water was stored more than a few weeks so no water quality issues were experienced. Should the sediment laden water from the fire have flows high enough to push it toward the dam decreased water quality will likely be seen again. In 2015 no significant water quality issues were seen. All focus was on having adequate water for basin users, due to the drought.

2016 Activities

As 2016 began it appeared that most needed relief from drought would not come. The only significant outflow from Seven Oaks Dam came in April when, as in previous years, the debris pool level was lowered and this water was recharged into the groundwater basin. Flow rates remained at historic lows for most of the year with on average 10 cubic feet per second or less from the Santa Ana River for the period of May through October. Fortunately the availability of imported water had greatly improved from 2015 and was used not only to make up for lack of local surface water supply, but was also recharged into the groundwater basin. Seven Oaks Dam remained 50 feet below the debris pool elevation for much of the year, which meant surface water users were able to use the water for most of the year with little disruptions. As with the previous two years virtually all water was at a free flow through the dam so water quality was not an issue.

Ultimately precipitation for the year was approximately 60% of normal. 2016 experienced some relief from the drought with larger storms in the end of November and continuing through December. The elevation for Seven Oaks Dam increased by 25 feet from the end of November to the end of December for a total increase of 1,094 acre-feet in that period. The Edison facilities were able to remain operational for most of November and December so users had access to the higher quality upstream water during this time period.

Work on the River Habitat Conservation Plan, which would address the impacts of water operation on the Santa Ana Sucker and other habitat impacts continued. This effort may allow consideration of additional water storage by the dam in the future for water conservation. No water quality improvements were made at the dam and little water was stored more than a few weeks so no water quality issues were experienced for most of the year. A lawsuit was filed by Endangered Habitats League and the Center for Biological Diversity related to the construction and operation of Seven Oaks Dam effects on the San Bernardino Kangaroo Rat and Santa Ana Sucker. No projection of changes in water supply or quality can be made at this stage of the lawsuit.

2017 Activities

The beginning of 2017 finally brought near normal rainfall with moderate and sustained outflows from the Seven Oaks dam between 50-250 cfs through April. Dam operators worked with the spreading operators to keep outflows from the dam from exceeding 250 cfs. This prevented water from passing the diversion points for users and spreading and ensured that little to no water passed users. Water quality was not an issue in 2017 as water did not sit behind the dam for extended periods of time. Edison was also able to generate electricity for the entirety of the summer which allowed for higher quality water. Spreading operations began to tail off in June; however total river flows remained at or above 15 cfs for the rest of the year, which was a significant improvement over 2015 and 2016.

The second half of 2017 brought disappointing rainfall with little or no monsoonal storms as well as almost no rainfall between October and December. Thankfully, the availability of imported water increased greatly as Northern California had historic rainfall levels. These flows helped to relieve some pressure in the groundwater basin that has been caused by several years of drought, but by no means reversed the affects.

Construction of Phase 1A of the Enhanced Recharge Project began in September. This portion of the project includes construction of a sedimentation basin to help improve the water quality of spreading flows. It also includes a portion of the plunge pool pipeline which will increase the spreading flows from 300 cfs to 500 cfs. Construction for this phase of construction is anticipated to be completed by July 2019.

Work on the River Habitat Conservation Plan, which would address the impacts of water operation on the Santa Ana Sucker and other habitat impacts continued. This effort may allow consideration of additional water storage by the dam in the future for water conservation. No water quality improvements were made at the dam. A lawsuit was filed by Endangered Habitats League and the Center for Biological Diversity related to the construction and operation of Seven Oaks Dam and its effects on the San Bernardino Kangaroo Rat and Santa Ana Sucker. The parties and intervenors are pursuing settlement discussions. No projection of changes in water supply or quality can be made at this stage of the lawsuit.

2018 Activities

2018 was a return to below average rainfall. There were only 16 days in April where greater than 10 cubic feet per second was released from the dam for downstream users. Flow rates remained low for most of the year with on average 13 cfs from Santa Ana River for the period of May through December. After the limited release of water in April, Seven Oaks Dam remained below the debris pool elevation for much of the year, which meant surface water users were able to use the water for most of the year with little disruptions. Virtually all water was at a free flow through the dam, so water quality was not an issue. Southern California Edison had to cease generating operations in mid-August due to limited flow rates and was only able to begin generating again in December.

Construction of Phase 1A of the Enhanced Recharge Project continued throughout 2018. This portion of the project includes a sedimentation basin to help improve the water quality of spreading flows. It also includes a portion of the plunge pool pipeline which will increase the spreading flows from 300 cfs to 500 cfs. Construction for this phase of construction is almost completed, and the sedimentation basin is anticipated to be in service in early 2019.

The San Bernardino Basin Groundwater Council was formed in 2018. The goals of the Groundwater Council are to prepare for and coordinate the increase and management of groundwater supply resources throughout the Basin and to coordinate maintenance of conveyance and recharge facilities to expedite such management. Groundwater Council Member Agencies made their first Groundwater Council payments in July and purchased all available State Water Project water for recharge this year. Due to the limited availability of imported water in 2018, excess funds will carry over for future imported water purchases.

QUAGGA MUSSEL PROTECTION PROGRAM

The invasive Quagga Mussel became a significant threat to Big Bear Lake in 2008. Big Bear Municipal Water District launched a ground breaking program at the beginning of the boating season to prevent the mussel from getting into the lake. While once only a problem east of the 100th meridian, the mussel reached western lakes, and most significantly Lake Mead in January

2007. By the fall of 2008 the mussel was pervasive in Lake Mojave, Lake Havasu, and boaters traveling to and from the lake were transporting the microscopic larvae in bilges and out drives creating a threat to Big Bear Lake. The California mussel population expanded via the Colorado River aqueduct turnout at Parker Dam into receiving reservoirs in San Diego County. Other southern California lakes became infested when infected boats transported the microscopic mussel larvae.

The Quagga mussel is a prolific reproducer and colonizes on every solid object it encounters. Fouled boat hulls, sinking buoys, clogged water pipes and screens are just some of the problems caused by the Quagga mussel. Also, because each mature mussel can filter feed about one liter of water daily, huge mussel masses significantly reduce concentrations of plankton that are an essential food supply for fisheries.

In our situation the potential impact of an infestation is great because Big Bear Lake is at the top of the Santa Ana River watershed. Every water body and stream below the lake could become infected, and the resulting impacts to Bear Creek fisheries, the pool behind Seven Oaks Dam, the Edison generating station, and the Santa Ana River could be disastrous.

In response to the threat the District imposed new rules on launching, installed traffic control structures to prevent unauthorized launching, and strictly regulated the launch ramp hours to provide constant staffing at the start of the boating season in 2008. All boats entering the lake at public launch ramps were required to complete a questionnaire to determine if and when they might have been in an infected lake. They were also checked for standing water in bilges, lockers, bait live wells, etc. All vessels deemed suspicious by District inspectors were decontaminated at no charge to the boat owner with pressurized hot (140 degree) water. Some limited training was also provided to commercial ramp operators who were responsible for sending suspicious vessels to a District facility for decontamination.

Both the City of Big Bear Lake and Snow Summit Resort contributed funds to help defray the costs associated with unexpected burden on the financial resources of the District. Nearly \$100,000 was spent during the summer of 2008 for educational materials, signs, additional summer staffing and capital improvements to fund the Quagga Prevention Program.

Sampling at the end of the 2008 boating season revealed that Big Bear Lake was free of visible mussels. Beginning in 2009 sampling for the microscopic mussel larvae will begin as soon as the lake warms to 45 degrees, the minimum temperature at which the mussels can reproduce.

In 2009 a Quagga Prevention Program surcharge will be added to boat permits to defray the costs associated with the program. The surcharge will remain in place as long as a threat exists or as grant money becomes available from the State. With the number of Quagga mussel infested lakes in southern California increasing, and the proximity of recreational boating opportunities at the Colorado River, the threat of infestation becomes greater. New, more stringent protective measures will be instituted at the start of the 2009 boating season. These will include training the entire public and private marina work force operating on the lake, requirements for commercial marinas to staff launch ramps with certified Quagga mussel inspectors, significant limitations on the use of private launch ramps and an expanded program of boat decontamination with pressurized hot water at both public launch ramps and the District office.

2009 Activities

Several new initiatives were launched in 2009 intended to keep Big Bear Lake Quagga Mussel free. Before the start of the boating season the BBMWD hosted a Level 1 Quagga Inspection training for all District and private marina workers. The 8 hour course was completed by nearly 50 workers who were then authorized by the District to perform boat inspections at all boat launching sites. The District also began collecting a boat permit surcharge of five dollars to help defray the costs associated with the Quagga Prevention Program. In an attempt to gain control of risks posed by privately owned launch ramps on single family properties, the District adopted strict standards for their use. District regulation required each of these individual ramps to be secured from unauthorized use with a chain and lock attached to steel posts set in concrete footings. The owners were also required to meet personally with District personnel to educate them regarding Quagga mussel risks and transport mechanisms. At the two public launch ramps District ramp personnel used hot water to decontaminate more than 1,200 boats and sealed more than 10,000 boats to their trailers as they left the lake. Sealing boats to trailers allows the boater to return to the launch ramp at a later date without having to be inspected.

Static sample media suspended in the lake at each marina and the launch ramps were free of Quagga Mussels in November for the second full year of monitoring. Also lake water sampling conducted during the entire boating season did not find any Quagga larvae. Big Bear Lake continues to be Quagga Mussel free.

2010 Activities

Lake water samples as well as inspection of static sample media suspended in the Lake at the conclusion of the 2010 boating season indicate Big Bear Lake remains Quagga Mussel free. The Big Bear Municipal Water District in conjunction with District trained private marina owners, continued to enforce pre-launch inspection of all registered vessels entering the Lake. Permits sold to non-registered vessels capable of being hand launched obligated the owners to assure the District that their vessels, mostly kayaks and canoes, were clean, drained and absolutely dry before entering the Lake. District personnel controlled the two public launch ramps and only fully inspected and/or decontaminated vessels were permitted to launch. Over the course of the 2010 summer, 6,504 vessel inspections were performed and 1,251 were decontaminated with hot water. Roughly another 10,000 boats were sealed to their trailers after recovery allowing them to launch without inspection at a later date.

2011 Activities

In 2011 Big Bear MWD sent 3 employees to obtain their Level II Quagga Mussel training certification. This certification is to “train the trainer”. The entire United States only has 200 level 2 certified trainers. Currently, Big Bear MWD has 4 staff members trained to this level.

In the spring of each year, the Level II Quagga Mussel trainers conducted a Level 1 Quagga Mussel class to certify new and returning inspectors. The class was an all-day course taught by the Big Bear MWD Level II trained staff. The class was offered to marina employees and Big Bear MWD employees.

In 2011 Big Bear MWD employed 7 seasonal launch ramp attendants whose job was to inspect and decontaminate vessels as they arrive at the public launch ramps. In total, Big Bear MWD

inspected 4,613 boats at the public launch ramps. Of this number 2,696 vessels were clean and no decontamination was necessary (58%), and about 1,917 vessels were decontaminated.

At the end of the season, Big Bear Lake remained Quagga Mussel free. The program of vessel inspection before launching on the Lake was continued in 2012.

2012 Activities

Starting with the boating season of 2008, the Big Bear MWD has implemented a Quagga Mussel prevention program aimed at preventing the spread of Quagga Mussels in Big Bear Lake. The general policy is clean, drained and dry before a vessel can launch. If a vessel does not meet these criteria, the vessel will be decontaminated at one of the three public launch ramps. Private marinas along the lake are required to have a Level I certified Quagga Mussel inspector available to inspect boats prior to launch. If they encounter a vessel that does not meet the policy, the vessel is sent to one of the public launch ramps for decontamination.

Big Bear MWD has 3 decontamination stations. The East Ramp and West Ramp handle the bulk of the decontaminations. The third station is located at the District's main office and is only run on holidays or special events. The decontamination is conducted by flushing suspect areas of the vessel with hot water. The entire process can take 5 to 45 minutes depending on the size of the vessel and level of decontamination.

In the spring of 2012, Big Bear MWD's Level II Quagga Mussel inspection trainers conducted a Level I Quagga Mussel training class to certify new and returning inspectors. The class was free-of-charge and was an all-day course for both private marina employees and Big Bear MWD staff.

In 2012 Big Bear MWD employed 7 seasonal ramp attendants whose job was to inspect and decontaminate vessels as they arrived at the public launch ramps. In total, the Big Bear MWD inspected 5,018 boats at the public launch ramps. Of this number 2,672 vessels were clean and no decontamination was necessary, and 2,346 vessels were decontaminated.

At the end of the season, Big Bear Lake remained Quagga Mussel free. The program of vessel inspection before launching on Big Bear Lake was continued in 2013.

2013 Activities

During the 2013 boating season the District employed 9 seasonal ramp attendants whose job was to inspect and decontaminate vessels as they arrive at the District's two public launch ramps. In total, the District inspected 4,843 boats at the public launch ramps. Of this number 2,482 vessels were clean and no decontamination was necessary and 2,278 vessels were decontaminated.

In addition to training new and returning District seasonal personnel the District conducted a Level 1 Quagga Mussel training class to certify new and returning inspectors for private marina employees. The training was provided free of charge by District Level II Certified Quagga Mussel inspection instructors.

2014 Activities

During the 2014 boating season, the District employed 10 seasonal ramp attendants in addition to a Launch Ramp Supervisor. These ramp personnel inspected and decontaminated vessels as they arrived at the District's two public launch ramps. In total, the District inspected 4,834 vessels at the public launch ramps. Of this number, 2,503 were clean and no decontamination was necessary. 2,270 vessels were decontaminated.

In 2014, the District had ten Quagga related incidents where mussels were found on inspected vessels prior to launch. In four of those incidents, what appeared to be live or viable mussels were discovered on the vessels. These vessels were impounded, stored at the District's main office and decontaminated prior to the vessels being allowed to launch. The remaining six vessels contained shells or dead mussels and were decontaminated at the east launch ramp.

In addition to training new and returning District seasonal personnel, the District conducted two Level One Quagga Mussel Inspection training classes to certify new and returning inspectors for private marina employees. This training, conducted by District employees who are Level Two certified Quagga Inspectors, was provided free of charge.

2015 Activities

During the 2015 boating season, the District employed 9 seasonal ramp attendants plus one Launch Ramp Supervisor. These ramp personnel inspected all vessels which entered District ramp facilities. Boats returning with intact “bands” were allowed to launch without further inspection. A total of 9,772 boats were launched at District launch facilities between April 1 and September 30, 2015. Of the 9,772 launched, 5,332 arrived with their bands intact and were allowed to launch. Inspections were required on 4,440 boats. Of the 4,440 boats requiring inspections, 2,194 were decontaminated; 22% of the boats launched on Big Bear Lake required decontamination.

The District continued to provide free Level I training to its staff, marina employees, and other interested lake management agencies. The District conducted two Level I Quagga Mussel Inspection training classes to certify new and returning inspectors. During the summer 2015 boating season, two employees were sent to receive a California State re-certification for Quagga Mussel Inspector Level I and II.

2016 Activities

Starting with the boating season of 2008, the District implemented a quagga mussel prevention program aimed at preventing the spread of quagga mussels in Big Bear Lake. The general policy is clean, drained and dry before a vessel can launch. If a vessel does not meet these criteria, the vessel will be decontaminated at one of our public launch ramps. Private marinas along the lake are required to have a level 1 certified quagga mussel inspector available to inspect boats prior to launch. If they encounter a vessel that does not meet the policy, they are sent to one of the public launch ramps for decontamination.

The District has 3 decontamination stations. The East Ramp and West Ramp handle the bulk of the decontaminations. The third station is located at the District’s main office and is only run on holidays or special events. The decontamination is conducted by flushing suspect areas of the vessel with hot water. The entire process can take 5 minutes up to 45 minutes depending on the size of the vessel and level of decontamination.

In the spring of each year, the District's Level III quagga mussel inspection trainers conduct a Level I quagga mussel training class to certify new and returning inspectors. The class is a free-of-charge all-day course for both private marina employees and District staff.

The District was awarded \$400,000 in grant money for a Quagga/Zebra Mussel Prevention grant through the Department of Boating and Waterways. This money will fund projects and costs for 2017 seasonal ramp personnel salaries, adding an additional decontamination pad at the East Public Launch Ramp, purchasing efficient and safer operating decontamination units, implementing a more robust and secure reciprocal banding program, upgrading the District's phone system to include a quagga hotline for the public, and training our inspection staff to be Level II quagga inspectors with the new training material and protocol.

The District applied for another two year rolling \$400,000 Quagga/Zebra Mussel Prevention grant through the Department of Boating and Waterways to continue our prevention efforts. Application approval will be determined in the spring of 2017.

The District employs 10 seasonal ramp attendants whose job is to inspect and decontaminate vessels as they arrive at the public launch ramps. In total, the District launched 10,825 boats in the 2016 boating season. Of these, 5,444 were inspected at the public launch ramps. Of this number 3,043 vessels were clean and no decontamination was necessary and 2,401 vessels were decontaminated. A total of 7,832 boats were banded.

2017 Activities

The District was awarded \$345,000 in grant money for a Quagga/Zebra Mussel Prevention grant through the Department of Boating and Waterways. This money funded projects and operational costs for 2017 seasonal ramp personnel, purchases of replacement parts and equipment for decon units, updating and enhancing training and educational materials/ supplies, implementing a more robust and secure reciprocal banding program, and purchase of a Flow-Cam for improved early detection.

The District applied for another two year rolling \$400,000 Quagga/Zebra Mussel Prevention grant through the Department of Boating and Waterways to continue our prevention efforts and was awarded \$385,000 in the fall of 2017.

The District employs 10 seasonal ramp attendants whose job is to inspect and decontaminate vessels as they arrive at the public launch ramps. In total, the District launched 7,845 boats in the 2017 boating season. Of these, 5,175 were inspected at the public launch ramps. Of this number 3,049 vessels were clean and no decontamination was necessary and 2,426 vessels were decontaminated. A total of 2,369 boats were banded.

2018 Activities

As described above, in late 2017, the District was awarded an additional \$385,000 to cover seasonal ramp personnel and operational costs, constructing a new enclosure at the East Ramp to house the new decontamination units, and purchase more banding supplies. This grant funding covered the 2018 annual year.

The District consistently monitored water for the presence of quagga mussels in Big Bear Lake. If quaggas were found in Big Bear Lake early enough, the District could do its part to contain the quagga or zebra mussels so they would not contaminate any other neighboring body of water. The District sent water samples to the California Department of Fish and Wildlife Bodega Bay Shellfish Laboratory for analysis and samples were proven negative by the State. Furthermore, the District monitored for quagga mussels using cross-polarized light microscopy with the District's flow cam. **Table V-I** shows samples were collected and tested on the following dates (all results were **negative**):

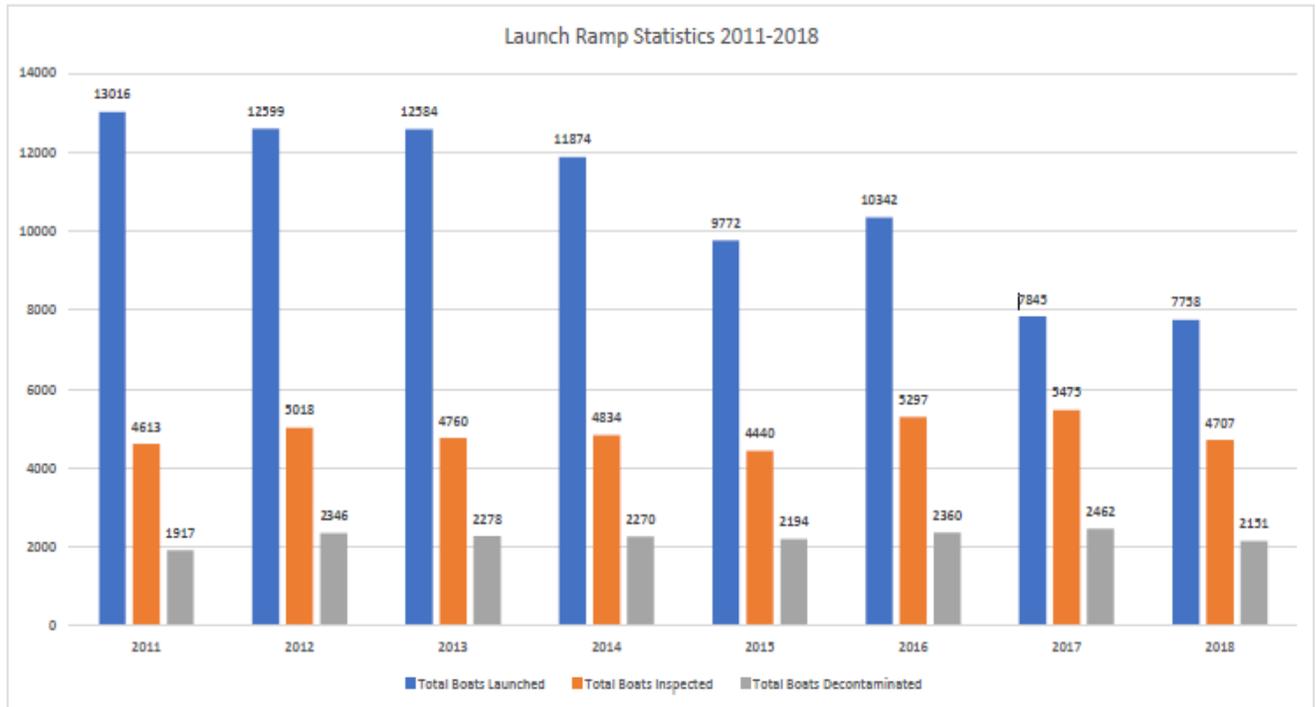
**Table V-I
PLANKTON TOW SAMPLE SHEET
Calendar Year 2018
Big Bear Watermaster**

2018 Quagga Plankton Tow Sample Sheet for FlowCam Cross-Polarized Microscopy					
Date	Location	Sample Runs	Positive/Negative	Sampled By	Analyzed By
7/9/2018	TMDL 1 (Dam)	5	Negative	James Bellis	James Bellis
7/13/2018	Big Bear Marina	4	Negative	James Bellis	James Bellis
7/25/2018	West Ramp	1	Negative	James Bellis	James Bellis
7/26/2018	East Ramp	4	Negative	James Bellis	James Bellis
8/20/2018	TMDL 1 (Dam)	3	Negative	James Bellis	James Bellis
9/19/2018	Big Bear Marina	3	Negative	James Bellis	James Bellis
10/3/2018	Big Bear Marina	11	Negative	James Bellis	James Bellis
10/25/2018	TMDL 6 (Mid Lake)	4	Negative	James Bellis	James Bellis
10/26/2018	TMDL 6 (Mid Lake)	3	Negative	James Bellis	James Bellis

Also, the District monitored multiple substrate locations weekly in 2018. Other locations were checked for presence of quagga mussels throughout 2018. These areas include boats exiting the launch ramp, District vessels during maintenance, District docks, the face of the Bear Valley Dam, and random shoreline areas during dock inspections. All instances of substrate and other inspections came back **negative** in 2018. Because Big Bear Lake is still quagga/zebra free, the District is eligible to apply for further quagga/zebra prevention grant funding. The District intends to apply for more funding through the Department of Boating and Waterways Quagga/Zebra Mussel Prevention program as opportunities become available.

The District employs 11 seasonal ramp attendants whose job is to inspect and decontaminate vessels as they arrive at the public launch ramps. In total, the District launched 7,758 boats in the 2018 boating season. Of these, 4,707 were inspected at the public launch ramps. Of this number 2,556 vessels were clean and no decontamination was necessary and 2,151 vessels were decontaminated. A total of 3,051 boats were banded. **Figure 5** below depicts the lake ramp statistics for 2011-2018.

Figure 5



APPENDIX A

MINUTES OF WATERMASTER MEETINGS

Dates

January 22, 2018

March 9, 2018

July 10, 2018

October 23, 2018

BIG BEAR WATERMASTER
MINUTES OF THE MEETING OF JANUARY 22, 2018

PLACE: San Bernardino Valley Water Conservation District
1630 W. Redlands Blvd., Ste. A
Redlands, California

PRESENT:	<u>Watermaster Committee</u>	<u>Representing</u>
	Don Evenson	Big Bear MWD, Chair
	Daniel Cozad	SBV Water Conservation District
	Sam Fuller	Bear Valley Mutual Water Company
	<u>Others</u>	
	Mike Stephenson	Big Bear MWD
	Bob Ludecke	Big Bear MWD
	James Bellis	Big Bear MWD
	John Erminger	Big Bear MWD
	Charlotte Van Eck	Bear Valley Mutual Water Company
	Bob Martin	Bear Valley Mutual Water Company
	David E. Raley	SBV Water Conservation District
	Athena Monge	SBV Water Conservation District
	Katelyn Scholte	SBV Water Conservation District

1. WELCOME AND CALL TO ORDER

The Big Bear Watermaster meeting was called to order by Don Evenson at 2:00 p.m.

2. APPROVAL OF MINUTES

The minutes of the October 10, 2017, meeting were approved with revisions.

3. LAKE AND BEAR CREEK STATUS

Mike Stephenson reported that the current lake level is 15.24 feet below full as of January 6th. BBMWD measured 14.96 inches of precipitation at the dam. The overall lake level increase was 4 ¾ inches. The release at Bear Creek is 1.27 CFS.

4. SANTA ANA RIVER STATUS AND FLOW REPORT/EDISON FACILITIES

Daniel Cozad reported that the Conservation has recharged 8,932 AF of SWP water. The City of Redlands water treatment plant is currently down so the District is receiving and recharging that water. In SAR, the water is building up behind debris pool at Seven Oaks Dam. Edison has been operational except for half a day when they were out. This has been a dry year so far. Mr. Cozad indicated that if the Committee wanted to go on a tour that it should schedule it today. Mr. Stephenson stated that BBMWD is interested in a tour.

5. MUTUAL'S PROJECTION OF NEEDS FOR LAKE RELEASES/IN-LIEU WATER

Sam Fuller said that Mutual's projection of need is at 6,500 AF.

6. ANNUAL WATERMASTER ACCOUNTING, REPORT, TASKS AND DEADLINES

Mr. Evenson provided handouts to Committee and reviewed in detail. He reviewed the 2017 Annual Report Schedule and Assignments. Mr. Evenson reviewed preliminary data, the 2017 Lake Level is at -15.20 feet below full which is a gain over the year of 1.10 feet. He reviewed the summary of the preliminary lake accounts for 2017. The lake account ending balance for 2017 is 27,167 AF. The Summary of Water Deliveries to Mutual 1977-2017 ending balance for 2017 is 56,298 AF.

Mr. Fuller asked if the history from 2000 to current is essential to be included in the Watermaster Report. Mr. Evenson said that once an issue is resolved we typically take that information out of the Watermaster Report. He said he will review the history and see what can be pulled out. Mr. Cozad said that the SOD information can be consolidated down. Mr. Evenson asked Mr. Cozad to review and see what can be consolidated.

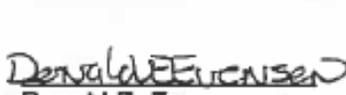
7. DATE FOR NEXT MEETING

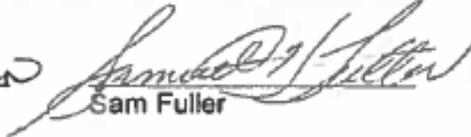
The next meeting will be on Friday, March 9, 2018 at 9:00 a.m. at the Water Conservation District. The tour was proposed for the July meeting.

There was a moment of silence in remembrance of the passing of Mike Huffstutler and his significant contributions to the Watermaster Committee. Mr. Cozad suggested that a memorial be included in this report to pay tribute to Mike Huffstutler.

8. ADJOURN

There being no further business, the meeting was adjourned by acclamation.


Donald E. Evenson


Sam Fuller


Daniel B. Cozad

**BIG BEAR WATERMASTER
MINUTES OF THE MEETING OF MARCH 09, 2018**

PLACE: San Bernardino Valley Water Conservation District
1630 W. Redlands Blvd., Ste. A
Redlands, California

PRESENT:	<u>Watermaster Committee</u> Don Evenson Daniel Cozad Sam Fuller	<u>Representing</u> Big Bear MWD, Chair SBV Water Conservation District Bear Valley Mutual Water Company
	<u>Others</u> Mike Stephenson James Bellis John Eminger Brittany Dupriest Frank Howes Bob Martin David E. Raley Athena Monge	Big Bear MWD Big Bear MWD Big Bear MWD Big Bear MWD Big Bear MWD Bear Valley Mutual Water Company SBV Water Conservation District SBV Water Conservation District

1. WELCOME AND CALL TO ORDER

The Big Bear Watermaster meeting was called to order by Don Evenson at 9:00 a.m.

2. APPROVAL OF MINUTES

The minutes of the January 22, 2018 meeting were approved.

3. LAKE AND BEAR CREEK STATUS

Mike Stephenson reported that the current lake level is 15.3 feet below full. He reported that the current water volume is 32,686. The water quality report from the Regional Board and BBMWD reports the lake at half full. The current flow at Station B is 1.33 CFS.

4. SANTA ANA RIVER STATUS AND FLOW REPORT/EDISON FACILITIES

Daniel Cozad reported that the Edison was down for maintenance for a couple of weeks. The Conservation District has sunk approximately 700 AF of river water and about 6500 AF of SWP. In Mill Creek, 1000 AF of native water has been recharged and 1600 AF of State Water Project water.

5. MUTUAL'S PROJECTION OF NEEDS FOR LAKE RELEASES/IN-LIEU WATER

Sam Fuller said that Mutual's projection of need is at 6,500 AF.

6. ANNUAL WATERMASTER ACCOUNTING, REPORT, TASKS AND DEADLINES

Mr. Fuller said that it would be helpful to add the history of the litigation and a summary of the judgment to the introductory section. He provided a handout of suggested verbiage. Mr. Evenson said that he will have legal counsel review proposed changes but that the proposed

changes will not be included in this version of the draft Watermaster Report. Mr. Fuller indicated that he would draft verbiage and submit to Mr. Evenson for review. Mr. Evenson said that the memoriam for Mike Huffstutler was not included in the Watermaster Report; he proposed that it be included in the Transmittal Letter. Mr. Evenson asked that any edits be provided to him as soon as possible for inclusion in the report.

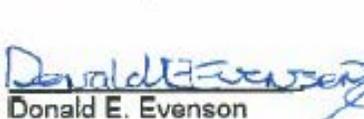
Mr. Evenson provided handouts to Committee and reviewed them in detail. He reviewed the procedure for allocating fishery releases. Table 1-2017 Daily Releases and Leakage for Fish handout indicates that the year ended at 663.97 AF. The day's Mutual fully utilized flow from Santa Ana indicates 192 days total for 2017. Mr. Evenson suggested that the Committee hold a workshop with Valley Municipal sometime this summer to discuss allocations and in-lieu calculations. Table 2 – 2017 - Days When Mutual Used Releases and Leakage for Fish in 2017 indicates 222 days utilized. Table 3-2017 - Allocation of Releases and Leakages for Fish to Mutual indicates the year ended with Mutual utilizing 506.30 AF and Shared indicates 157.66 AF with a total of 663.97 AF for 2017.

7. DATE FOR NEXT MEETING

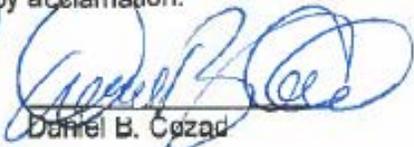
The next meeting will be on Tuesday, July 10, 2018, at 2:00 p.m. at the Water Conservation District. The tour was proposed for June separate from the next Committee meeting.

8. ADJOURN

There being no further business, the meeting was adjourned by acclamation.


Donald E. Evenson


Sam Fuller


Darrel B. Cozad

BIG BEAR WATERMASTER
MINUTES OF THE MEETING OF JULY 10, 2018

PLACE: San Bernardino Valley Water Conservation District
1630 W. Redlands Blvd., Ste. A
Redlands, California

PRESENT:	<u>Watermaster Committee</u> Don Evenson Daniel Cozad Sam Fuller	<u>Representing</u> Big Bear MWD, Chair SBV Water Conservation District Bear Valley Mutual Water Company
	<u>Others</u> Mike Stephenson James Bellis John Eminger Bob Ludecke Bob Martin Charlotte Van Eck David E. Raley Athena Monge Katelyn Scholte	Big Bear MWD Big Bear MWD Big Bear MWD Big Bear MWD Bear Valley Mutual Water Company Bear Valley Mutual Water Company SBV Water Conservation District SBV Water Conservation District SBV Water Conservation District

1. WELCOME AND CALL TO ORDER

The Big Bear Watermaster meeting was called to order by Don Evenson at 2:00 p.m.

2. APPROVAL OF MINUTES

The minutes of the March 9, 2018 meeting were approved with one minor revision.

3. LAKE AND BEAR CREEK STATUS

Mike Stephenson reported that the current lake level is 16.31 feet below full. Don Evenson provided handouts noting that there is a graph of lake levels for this year. Mr. Stephenson pointed out that the Station B release is 1.19 CFS; Station B is recording 1.57 CFS. He said that Big Bear MWD had exercised sluice gates and there may have been leakage at the gates.

A. UPDATE ON THE RECYCLED WATER PROJECT

Mr. Stephenson provided an update on the Recycled Water project. He said that the project is a \$43 million project that stemmed from the Big Bear MWD being required to have a Groundwater Sustainability Agency (GSA). The project would treat wastewater and store it in the lake. Mr. Stephenson gave a brief overview of the project and estimates three years for project implementation.

B. SAWPA LAKE DATA REQUEST

Mr. Evenson said that Big Bear MWD was requested to provide data to SAWPA to determine what the increase in Big Bear Lake is related to climate change. Mr. Cozad noted that SAWPA is redoing their study from several years ago with the Bureau of Reclamation and are looking for data on the overall impacts.

SAWPA took climate studies and subsampled models to see what would happen in the watershed.

Mr. Evenson provided preliminary status reports of the lake accounts. At the end of June, the lake level was 32,255 AF; which is approaching the lowest on record. Mutuals' lake account had an estimated 10,446 AF, Big Bear had 21,809 AF and the Inflow at the lake for the first six months of the year was 2,720 AF. Mr. Evenson noted that Station A is in full compliance.

4. SANTA ANA RIVER STATUS AND FLOW REPORT/EDISON FACILITIES

Daniel Cozad reported that the Conservation District is receiving small flows in Santa Ana and Mill Creek. Katelyn Scholle said that currently Powerhouse #3 is "in" and Powerhouse #1 is "out" and has been out for about a month now.

A. UPDATE ON GROUNDWATER COUNCIL AND PROJECTS

Mr. Cozad provided an update on the Groundwater Council (GC). It had its first meeting in April 2018. Mr. Cozad noted that all of the potential participants had finalized their agreements except for the City of Redlands and Fontana Water Company. Tom Crowley was asked to be the chair of the GC. There will be a Budget Committee and Governance Committee. The goal of the GC is to purchase the water necessary and available from the state and have money set aside for that purpose to recharge the basin.

5. MUTUAL'S PROJECTION OF NEEDS FOR LAKE RELEASES/IN-LIEU WATER

Sam Fuller provided a handout on SWP Deliveries to BVMWC. He said that Mutual's projection of need is at 8,500 AF to finish out the year based on estimates.

6. TOUR DATE AND DATE FOR NEXT MEETING

The meeting will be on Tuesday, October 23, 2018, at 9:00 a.m. and the tour will be the same day at 11:00 a.m. at the Water Conservation District. Mr. Fuller said that the Committee should tour the improvements on the spreading basins, new diversion structure, dam, delivery points, turnouts, and Tres Lagos.

A. NEXT MEETING – HISTORICAL SUMMARY OF WATERMASTER ACCOUNTING

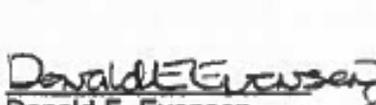
Mr. Evenson created a historical summary data sheet of Watermaster accounting; including the operational history of the lake, leakage, releases etc. Mr. Ludecke requested that a total per year be included within the spreadsheet.

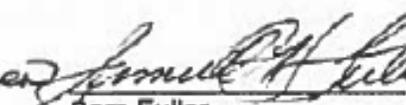
B. OTHER ITEMS

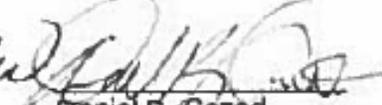
Mr. Evenson reviewed the handout of the presentation he will be presenting to the Conservation District at its July 11 Board meeting on the Annual Watermaster report. Minor revisions were noted and will be included in tomorrow's PowerPoint presentation.

7. ADJOURN

There being no further business, the meeting was adjourned by acclamation.


Donald E. Evenson


Sam Fuller


Daniel B. Cozad

BIG BEAR WATERMASTER
MINUTES OF THE MEETING OF OCTOBER 23, 2018

PLACE: San Bernardino Valley Water Conservation District
1630 W. Redlands Blvd., Ste. A
Redlands, California

PRESENT: <u>Watermaster Committee</u>	<u>Representing</u>
Don Evenson	Big Bear MWD, Chair
Daniel Cozad	SBV Water Conservation District
Sam Fuller	Bear Valley Mutual Water Company
<u>Others</u>	
Mike Stephenson	Big Bear MWD
James Bellis	Big Bear MWD
Bob Ludecke	Big Bear MWD
Bob Martin	Bear Valley Mutual Water Company
Gary Stebbins	Bear Valley Mutual Water Company
David E. Raley	SBV Water Conservation District
Athena Monge	SBV Water Conservation District
Katelyn Scholte	SBV Water Conservation District

1. WELCOME AND CALL TO ORDER

The Big Bear Watermaster meeting was called to order by Don Evenson at 2:00 p.m.

2. APPROVAL OF MINUTES

The minutes of the July 10, 2018 meeting were approved.

3. LAKE AND BEAR CREEK STATUS

Mike Stephenson reported that the current lake level is 18.01 feet below full. The dam releases are measuring at 1.20 CFS and meeting requirements at Station A. Mr. Stephenson said that he and Mr. Evenson will be meeting with officials in Sacramento to discuss the possibility of abandoning Station A; obtaining readings at this station has proved to be problematic for staff. Mr. Stephenson noted that they received 1.22 inches of precipitation at the Dam and 1.4 inches at the office from the Saturday storm and the lake level increased by $\frac{3}{4}$ of an inch.

A. UPDATE ON THE RECYCLED WATER PROJECT

Mr. Stephenson provided an update on the Recycled Water project. BBMWD met with partners and discussed performing a preliminary study and piloting that will be done within the next sixteen months. USDA will be carrying loan and BBMWD will be applying for grants to offset capital costs. Mr. Stephenson stated that the project is receiving a lot of support from those involved. He estimated that the project would cost around \$44 million to meet the basin objectives.

Mr. Stephenson said that New Zealand Mud Snails have been found in the Santa Ana River bed beyond the confluence and a half mile up Bear Creek. A survey has been done around Big Bear Lake, and none have been seen. The Forest Service has a consultant named Aspen Group performing a survey and the consultant located them.

Mr. Evenson reviewed handouts on the lake level, preliminary lake account status and summary of water deliveries to Mutual. The lake level as of September 30, 2018, was at 17.8 feet below full which is the lowest level since the 1977 Judgment has been in effect and the lowest since 1967. The beginning lake account storage began at 34,206 AF in the Lake Account, 12,122 AF in Mutual's Lake Account and 22,084 AF in BBMWD's Lake Account. The ending storage as of September 30, 2018, was 29,010 AF in the Actual Lake Account, 3,993 AF in Mutual's Lake Account and 25,017 AF in BBMWD's Lake Account. The September 30, 2018 estimated ten-year total for water deliveries to Mutual is 61,996.5 AF; the ten-year total will be adjusted at year end for 2018.

4. SANTA ANA RIVER STATUS AND FLOW REPORT/EDISON FACILITIES

Daniel Cozad reported that the Santa Ana River status is similar to what has already been reported by others. Katelyn Scholte reported that Santa Ana remained pretty much the same after the storm. She said that SCE turned out and had 9 CFS until last Friday that the District was recharging. Ms. Scholte said that Crafton Water is taking about 1.5 CFS in Mill Creek and the rest is going to the City of Redlands. She stated that on the Santa Ana side there is 13 CFS and SCE is not generating. All of the Santa Ana water went to the City of Redlands today and yesterday. There have been no significant recharges this month. Ms. Scholte reported that the water year ended at 15,000 AF of water recharged; most being imported water.

Mr. Cozad provided an update on the Groundwater Council (GC). The GC will be meeting bi-monthly. Mr. Cozad noted that so far everyone has paid their contribution to operations and maintenance.

5. MUTUAL'S PROJECTION OF NEEDS FOR LAKE RELEASES/IN-LIEU WATER

Sam Fuller provided a handout on SWP Deliveries to BVMWC. He said that Mutual's projection of need is at 9,502 AF to finish out the year based on estimates. BVMWC has been running wells all October; they may look into purchasing water from SBVMWD.

6. GROUNDWATER SUSTAINABILITY PROJECT UPDATE DISCUSSION

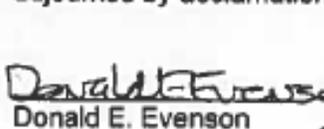
Mr. Stephenson discussed in brief the origins of the project.

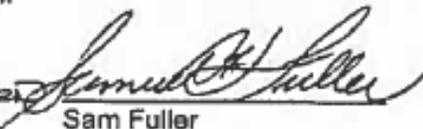
7. DATE FOR NEXT MEETING

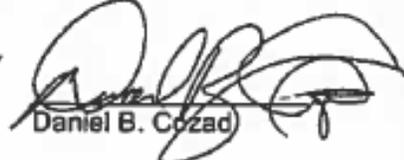
The meeting will be on Tuesday, January 22, 2019, at 2:00 p.m. at the Water Conservation District.

8. ADJOURN TO FIELD TOUR

Mr. Fuller reviewed tour map and schedule. There being no further business, the meeting was adjourned by acclamation.


Donald E. Evenson


Sam Fuller


Daniel B. Cozad

APPENDIX B

TABLE OF

ACCOUNTS OF OPERATION OF BIG BEAR LAKE

ACCOUNTS FOR

CALENDAR YEAR 2018

INPUT DATA	B-1 thru B-4
SUMMARY OF RESULTS	B-5
1. ACTUAL OPERATION OF BIG BEAR LAKE	B-6
1.A Summary Details	B-7
1.B Release Details	B-8
1.C Lake Withdrawal Details	B-9
1.D Evaporation Details	B-10
2. SYNTHESIZED MUTUAL OPERATION OF BIG BEAR LAKE	B-11
2.A Lake Outflow Details	B-12
2.B Synthesized Evaporation Calculation	B-13
2.C Mutual's Leakage and Adjusted Spills	B-14
3. DETERMINATION OF BIG BEAR'S LAKE ACCOUNT STATUS	B-15
3.A Lake Inflow Details	B-16
3.B Lake Outflow Details	B-17
4. BASIN MAKE-UP ACCOUNT	B-18
4.A Big Bear's Basin Additions	B-19
4.B Mutual's Basin Additions	B-20
4.C Basin Replenishments	B-21

**INPUT DATA
BIG BEAR WATERMASTER REPORT
CALENDAR YEAR
2018**

Sheet 1 of 4

Calendar Year	=	2018		
Mutual's Lake Account Balance on Jan.1	=	12,122	acre-feet	
Basin Make-Up Account Balance on Jan. 1	=	27,170	acre-feet	See Note 1
Account Balance for Mutual's Advances to BBMWD	=	-	acre-feet	
Repayment Premium for Mutual's Advances to BBMWD	=	0%		
Recharge Factor for Lake Deliveries to Mutual	=	0.500		
Recharge Factor for Imported Water Deliveries to Mutual	=	0.500		
Recharge Factor for Lake Spills	=	0.510		
Snowmelt Return Factor	=	0.500	Jan, Feb, Mar, Apr, Oct, Nov, Dec	
Snowmelt Return Factor	=	0.000	May, June, July, Aug, Sept	
<u>Monthly Evaporation Rate Calculation Factors</u>		<u>C1</u>	<u>C2</u>	<u>C3</u>
January		7.09	0.42	1,200
February		6.90	0.50	1,200
March		8.36	0.74	1,200
April		8.82	0.87	1,200
May		9.73	1.02	1,200
June		9.72	1.10	1,200
July		9.90	1.13	1,200
August		9.34	1.22	1,200
September		8.36	1.25	1,200
October		7.89	1.22	1,200
November		7.01	1.07	1,200
December		6.91	0.50	1,200
Evaporation rate (feet/month)	=	Average air temperature x C1 x C2 / C3		

**INPUT DATA
BIG BEAR WATERMASTER REPORT
CALENDAR YEAR
2018
(continued)**

Month	Gage* Height 1st of Month (feet)	Actual Mutual Shareholder Releases (acre-feet)	Mutual Other Releases (acre-feet)	Actual Spillway Flood Control Releases (acre-feet)	Actual Outlet Works & Flood Control Releases (acre-feet)	Big Bear's Spreading Releases (acre-feet)	Big Bear's Other Releases (acre-feet)	Leakage (Not used, included in Fish Releases) (acre-feet)
January	57.13	-	-	-	-	-	-	-
February	57.29	-	-	-	-	-	-	-
March	57.01	-	-	-	-	-	-	-
April	57.70	-	-	-	-	-	-	-
May	57.35	-	-	-	-	-	-	-
June	56.88	-	-	-	-	-	-	-
July	56.22	-	-	-	-	-	-	-
August	56.00	-	-	-	-	-	-	-
September	55.19	-	-	-	-	-	-	-
October	54.53	-	-	-	-	-	-	-
November	54.23	-	-	-	-	-	-	-
December	54.15	-	-	-	-	-	-	-
	54.13							
Change	-3.00						0.00	

* Gage at Bear Valley Dam

INPUT DATA
BIG BEAR WATERMASTER REPORT
CALENDAR YEAR
2018
 (continued)

Month	Big Bear's Withdrawals for Snowmaking (acre-feet)	Big Bear's Releases for SBVMWD (acre-feet)	Mutual Spills of Wastewater Exports (acre-feet)	In-Lieu Imported Supplies (SBVMWD) (acre-feet)	In Lieu Supplies from SBVMWD's Contract Wells (acre-feet)	In Lieu Supplies from Mutual's Wells (acre-feet)	VD In Lieu Supplies (BB Lake) (acre-feet)
January	168.74	-	-	83.5	-	-	-
February	153.68	-	-	95.1	-	-	-
March	13.69	-	-	144.0	-	-	-
April	5.32	-	-	257.0	-	-	-
May	18.34	-	-	419.3	-	-	-
June	22.17	-	-	1,242.1	35.3	-	-
July	23.40	-	-	2,087.9	163.2	-	-
August	20.04	-	-	1,469.3	149.9	-	-
September	19.48	-	-	820.2	99.5	-	-
October	22.33	-	-	-	-	-	-
November	138.68	-	-	-	-	-	-
December	273.33	-	-	-	-	-	-
	879.20	-		6,618.4	447.9		-

INPUT DATA
BIG BEAR WATERMASTER REPORT
CALENDAR YEAR
2018
 (continued)

Month	SWRCB Order 95-4 Releases & Leakage (acre-feet)	Mutual's Direct Use of Order 95-4 Releases (acre-feet)	Basin Replenishment from SBVMWD (acre-feet)	Basin Replenishment from Others (acre-feet)	2018 Net Wastewater Exports (acre-feet)	Average Air Temperature (degrees F)
January	79.50	64.12	-	-	80.13	40.8
February	72.19	69.74	-	-	65.28	35.5
March	70.33	39.21	-	-	88.78	39.0
April	64.58	62.58	-	-	50.29	48.0
May	65.56	65.56	-	-	49.38	52.1
June	68.52	68.52	-	-	56.88	61.1
July	97.56	97.56	-	-	56.55	67.9
August	93.90	90.80	-	-	50.59	66.1
September	82.55	82.55	-	-	34.28	60.7
October	77.87	77.87	-	-	46.97	48.2
November	72.31	69.93	-	-	60.86	43.4
December	54.53	36.18	-	-	87.31	37.3
	899.40	824.62			727.30	

**SUMMARY RESULTS
CALENDAR YEAR
2018**

LAKE ACCOUNTS (acre-feet)	Big Bear	Mutual	Actual
Initial Storage	22,084.0	12,122.0	34,206.0
Lake Inflows	0.0	4,817.8	4,817.8
In-Lieu Supplies to Mutual	7,066.3	(7,066.3)	0.0
Lake Releases (Mutual & BBMWD)	0.0	0.0	0.0
Releases & Leakage (SWRCB 95-4)	(52.3)	(847.1)	(899.4)
Net Snowmaking Withdrawals from Lake	(491.3)	0.0	(491.3)
Lake Spills & Flood Control Releases	0.0	0.0	0.0
Leakage from Dam	0.0	0.0	0.0
Evaporation from Lake	(4,572.3)	(4,818.8)	(9,391.1)
Net Wastewater Exports	(727.3)	727.3	0.0
Advances & Repayment of Advances	0.0	0.0	0.0
Ending Storage	23,307.0	4,935.0	28,242.0
BASIN MAKE UP ACCOUNT (acre-feet)			
Beginning Balance	n.a.	n.a.	27,170
Recharge From Releases of Lake Water Used I	412	3,945	(3,533)
Recharge From In-lieu SWP Water Delivered to	3,309	n.a.	3,309
Recharge from Spills & Other Lake Releases	38	11	27
Account Credit (Debit)	3,760	3,957	(197)
Amount Replenished	0	n.a.	0
Ending Balance			26,973

**CALENDAR YEAR
2018
BIG BEAR WATERMASTER**

**TABLE 1
ACTUAL OPERATION OF BIG BEAR LAKE**

Month	1 Gage Height 1st of Month (Input Data) (feet)	2 Volume in Storage (ac-ft)	3 Change in Storage (ac-ft)	4 Lake Surface Area (acres)	5 Spills Releases Leakage Withdrawals (see Table 1.A) (feet)	6 Estimated Lake Evaporation (see Table 1.D) (ac-ft)	7 Calc. Total Inflow (ac-ft)	8 Adjusted Lake Inflow * (ac-ft)	9 Adjusted Lake Evap * (ac-ft)	10 Adjusted Evap Rate * (feet/month)
January	57.13	34,206	318	2,094	164	213	694	694	213	0.101
February	57.29	34,524	(637)	2,105	149	214	(274)	0	488	0.233
March	57.01	33,887	1,485	2,081	77	424	1,986	1,986	424	0.201
April	57.70	35,372	(743)	2,138	67	652	(24)	0	676	0.318
May	57.35	34,629	(946)	2,109	84	901	39	39	901	0.431
June	56.88	33,683	(1,428)	2,073	91	1,113	(224)	0	1,337	0.654
July	56.22	32,255	(408)	2,016	121	1,271	984	984	1,271	0.633
August	56.00	31,847	(1,579)	2,000	114	1,242	(223)	0	1,465	0.740
September	55.19	30,268	(1,258)	1,957	102	1,025	(131)	0	1,156	0.596
October	54.53	29,010	(576)	1,922	89	740	253	253	740	0.387
November	54.23	28,434	(192)	1,906	142	516	466	466	516	0.271
December	54.15	28,242	0	1,900	191	204	395	395	204	0.107
December	54.13	28,242		1,900						
TOTALS			(5,964.0)		1,390.7	8,515	3,941	4,817.8	9,391.1	4.673

* NOTE: Evaporation adjusted to eliminate negative inflow

**CALENDAR YEAR
2018
BIG BEAR WATERMASTER**

**TABLE 1.A
ACTUAL OPERATION OF BIG BEAR LAKE
Summary Details**

Month	1	2	3	4	5	6	7	8	9
		Actual Spillway Flood Control Releases (Input Data) (ac-ft)	Actual Outlet Works Flood Control Releases (Input Data) (ac-ft)	Actual Lake Releases (see Table 1.B) (ac-ft)	Actual Estimated Leakage (not used) (Input Data) (ac-ft)	Estimated Net Lake Withdrawal (see Table 1.C) (ac-ft)			Total Spills Releases Leakage Withdrawals (ac-ft)
January		-	-	79.5	-	84.4			163.9
February		-	-	72.2	-	76.8			149.0
March		-	-	70.3	-	6.8			77.2
April		-	-	64.6	-	2.7			67.2
May		-	-	65.6	-	18.3			83.9
June		-	-	68.5	-	22.2			90.7
July		-	-	97.6	-	23.4			121.0
August		-	-	93.9	-	20.0			113.9
September		-	-	82.6	-	19.5			102.0
October		-	-	77.9	-	11.2			89.0
November		-	-	72.3	-	69.3			141.7
December		-	-	54.5	-	136.7			191.2
TOTALS		-	-	899.4	-	491.3			1,390.7

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BIG BEAR WATERMASTER**

**TABLE 1.B
ACTUAL OPERATION OF BIG BEAR LAKE
Release Details**

Month	1 Mutual's Shareholder Releases (Input Data) (ac-ft)	2 Mutual's Other Releases (Input Data) (ac-ft)	3 Mutual's Total Releases (Col.1 + Col.2) (ac-ft)	4 Big Bear's Releases for SBVMWD (Input Data) (ac-ft)	5 Big Bear's Spreading Releases (Input Data) (ac-ft)	6 Big Bear's Other Releases (Input Data) (ac-ft)	7 Big Bear's Total Releases Col.4+Col.5+Col.6 (ac-ft)	8 SWRCB Order NO. 95-4 Releases (Input Data) (ac-ft)	9 Total Actual Releases (Cols.3+ 7+ 8) (ac-ft)
January	-	-	-	-	-	-	-	79.5	79.5
February	-	-	-	-	-	-	-	72.2	72.2
March	-	-	-	-	-	-	-	70.3	70.3
April	-	-	-	-	-	-	-	64.6	64.6
May	-	-	-	-	-	-	-	65.6	65.6
June	-	-	-	-	-	-	-	68.5	68.5
July	-	-	-	-	-	-	-	97.6	97.6
August	-	-	-	-	-	-	-	93.9	93.9
September	-	-	-	-	-	-	-	82.6	82.6
October	-	-	-	-	-	-	-	77.9	77.9
November	-	-	-	-	-	-	-	72.3	72.3
December	-	-	-	-	-	-	-	54.5	54.5
TOTALS	-	-	-	-	-	-	-	899.40	899.4

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BIG BEAR WATERMASTER**

**TABLE 1.C
ACTUAL OPERATION OF BIG BEAR LAKE
Lake Withdrawal Details**

Month	1	2	3	4	5	6	7	8	9
		Snowmaking Withdrawals (Input Data) (ac-ft)			Total Lake Withdrawals (ac-ft)		Return from Snow melt @ 50.0% (ac-ft)		Estimated Net Lake Withdrawals (ac-ft)
January		168.74			168.74		84.37		84.37
February		153.68			153.68		76.84		76.84
March		13.69			13.69		6.85		6.84
April		5.32			5.32		2.66		2.66
May		18.34			18.34		-		18.34
June		22.17			22.17		-		22.17
July		23.40			23.40		-		23.40
August		20.04			20.04		-		20.04
September		19.48			19.48		-		19.48
October		22.33			22.33		11.17		11.16
November		138.68			138.68		69.34		69.34
December		273.33			273.33		136.67		136.66
TOTALS		879.20			879.20		387.90		491.30

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BIG BEAR WATERMASTER**

**TABLE 1.D
ACTUAL OPERATION OF BIG BEAR LAKE
Evaporation Details**

1	2	3	4	5	6	7	8	9
Month		Lake Surface Area (acres)	Average Lake Area (acres)	Average Air Temperature (Input Data) (deg F)	Calculated Evaporation Rate (feet/month)			Estimated Lake Evaporation (ac-ft)
January		2,094	2,100	40.80	0.101			212.6
February		2,105	2,093	35.50	0.102			213.6
March		2,081	2,110	39.00	0.201			424.1
April		2,138	2,124	48.00	0.307			651.8
May		2,109	2,091	52.10	0.431			901.0
June		2,073	2,045	61.10	0.544			1,113.0
July		2,016	2,008	67.90	0.633			1,271.1
August		2,000	1,979	66.10	0.628			1,241.8
September		1,957	1,940	60.70	0.529			1,025.2
October		1,922	1,914	48.20	0.387			740.0
November		1,906	1,903	43.40	0.271			516.2
December		1,900	1,900	37.30	0.107			204.0
TOTALS					4.241			8,514.5

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2018
BIG BEAR WATERMASTER**

**TABLE 2
SYNTHESIZED MUTUAL OPERATION OF BIG BEAR LAKE**

Month	1 Gauge Height 1st of Month (feet)	2 Mutual's Lake Account (ac-ft)	3 Change in Storage (*) (ac-ft)	4 Lake Surface Area (acres)	5 Mutual's Lake Inflow (feet) (see Table 1)	6 Mutual's Net Wastewater Export Credit (ac-ft) (see Table 2.A)	7 Mutual's Lake Evap. (ac-ft) (see Table 2.B)	8 Mutual's Snowmaking Advances to Big Bear (ac-ft) (see Table 3)	9 Mutual's Credit for Return of Advances (ac-ft) (see Table 3)	10 Mutual's Releases Leakage Spills & In-lieu Del. (ac-ft) (see Table 2.A)
January	44.20	12,122	489	1,297	694.4	80.1	132.6	-	-	153.1
February	44.55	12,611	(406)	1,323	-	65.3	305.9	-	-	165.7
March	44.25	12,205	1,611	1,301	1,986.3	88.8	270.1	-	-	194.4
April	45.45	13,815	(705)	1,386	-	50.3	434.9	-	-	320.4
May	44.90	13,110	(966)	1,347	38.9	49.4	569.6	-	-	484.9
June	44.20	12,144	(2,096)	1,297	-	56.9	806.8	-	-	1,345.9
July	42.50	10,048	(2,010)	1,174	984.0	56.6	702.3	-	-	2,348.7
August	40.70	8,038	(2,358)	1,048	-	50.6	697.5	-	-	1,710.8
September	38.20	5,680	(1,392)	845	-	34.3	423.8	-	-	1,002.3
October	36.30	4,288	(9)	597	253.1	47.0	230.8	-	-	77.9
November	36.30	4,280	286	597	465.9	60.9	170.2	-	-	70.3
December	36.75	4,566	369	658	395.2	87.3	74.3	-	-	39.1
December	37.25	4,935		726						
TOTALS			(7,187)		4,817.8	727.3	4,818.8	-	-	7,913.4
					3,704	532	4,344			7,726

(*) Col. 3 = Col. 5 + Col. 6 - Col. 7 - Col. 8 + Col. 9 - Col. 10

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2018
BIG BEAR WATERMASTER**

**TABLE 2.A
SYNTHESIZED MUTUAL OPERATION OF BIG BEAR LAKE
Lake Outflow Details**

Month	1 Mutual's Spills & FC Releases from Table 2.C (ac-ft)	2 Mutual's Lake Releases from Table 1.B (ac-ft)	3 Mutual's Leakage from Table 2.C (ac-ft)	4 Mutual's Order No. 95-4 Releases from Table 2.C (ac-ft)	5 Big Bear's In-lieu Supply Delveries (see Table 3.B) (ac-ft)	6 Mutual's Releases Leakage Spills & In-lieu Del. (to Table 2) (ac-ft)	7	8 Net Credit for Wastewater Exports (Input Data)	9 Spilled from Mutual's Lake Acct. (Input Data) (ac-ft)	10 Net Wastewater Export Credit (to Table 2) (ac-ft)
January	-	-	-	69.6	83.5	153.1		80.1	-	80.1
February	-	-	-	70.6	95.1	165.7		65.3	-	65.3
March	-	-	-	50.4	144.0	194.4		88.8	-	88.8
April	-	-	-	63.4	257.0	320.4		50.3	-	50.3
May	-	-	-	65.6	419.3	484.9		49.4	-	49.4
June	-	-	-	68.5	1,277.4	1,345.9		56.9	-	56.9
July	-	-	-	97.6	2,251.1	2,348.7		56.6	-	56.6
August	-	-	-	91.6	1,619.2	1,710.8		50.6	-	50.6
September	-	-	-	82.6	919.7	1,002.3		34.3	-	34.3
October	-	-	-	77.9	-	77.9		47.0	-	47.0
November	-	-	-	70.3	-	70.3		60.9	-	60.9
December	-	-	-	39.1	-	39.1		87.3	-	87.3
TOTALS	-	-	-	847.1	7,066.30	7,913.4		727.3	-	727.3
				660	7,066			532		

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BIG BEAR WATERMASTER**

**TABLE 2.B
SYNTHESIZED MUTUAL OPERATION OF BIG BEAR LAKE
Synthesized Evaporation Calculation**

Month	1 Starting Volume (ac-ft)	2 Starting Area (acres)	3 Assumed Evap (ac-ft)	4 Estimated Ending Volume (ac-ft)	5 Estimated Ending Area (acres)	6 Average Area (acres)	7 Mutuals Lake Evap. (to Table 2) (ac-ft)	8 Big Bear's Lake Evap. (to Table 3.A) (ac-ft)	9 Revised Ending Volume Estimate (ac-ft)	10
January	12,122.0	1,297.0	131.3	12,612.2	1,323.0	1,310.0	132.6	80.0	12,610.9	
February	12,610.9	1,323.0	308.4	12,202.0	1,301.0	1,312.0	305.9	182.1	12,204.5	
March	12,204.5	1,301.0	261.6	13,823.6	1,386.0	1,343.5	270.1	154.0	13,815.1	
April	13,815.1	1,386.0	441.1	13,104.0	1,347.0	1,366.5	434.9	240.9	13,110.1	
May	13,110.1	1,347.0	580.4	12,133.1	1,297.0	1,322.0	569.6	331.4	12,143.9	
June	12,143.9	1,297.0	848.4	10,006.5	1,170.0	1,233.5	806.8	530.5	10,048.1	
July	10,048.1	1,174.0	743.1	7,996.9	1,045.0	1,109.5	702.3	568.8	8,037.7	
August	8,037.7	1,048.0	776.0	5,601.5	836.0	942.0	697.5	767.6	5,680.0	
September	5,680.0	845.0	503.6	4,208.4	577.0	711.0	423.8	732.2	4,288.3	
October	4,288.3	597.0	230.8	4,279.6	597.0	597.0	230.8	509.2	4,279.6	
November	4,279.6	597.0	162.0	4,574.1	658.0	627.5	170.2	346.0	4,565.9	
December	4,565.9	658.0	70.7	4,938.6	726.0	692.0	74.3	129.7	4,935.0	
TOTALS							4,818.8	4,572.3		

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2018
BIG BEAR WATERMASTER**

**TABLE 2.C
SYNTHESIZED MUTUAL OPERATION OF BIG BEAR LAKE
Mutual's Leakage, Spills & FC Releases, and SWRCB Releases**

Month	1 Total Leakage from Input Data (ac-ft)	2 Mutual's Leakage to Table 2.A (ac-ft)	3 Big Bear's Leakage to Table 3.B (ac-ft)	4 Actual Spills & FC Releases from Input Data (ac-ft)	5 Big Bear's Spills & FC Releases to Table 3.B (ac-ft)	6 Mutual's Spills & FC Releases to Table 2.A (ac-ft)	7 SWRCB Order 95-4 Releases from Input Data (ac-ft)	8 Mutual's Order 95-4 Direct Use from Input Data (ac-ft)	9 Mutual's Order 95-4 Releases to Table 2.A (ac-ft)	10 Big Bear's Order 95-4 Releases to Table 3.B (ac-ft)
January	-	-	-	-	-	-	79.5	64.1	69.6	9.9
February	-	-	-	-	-	-	72.2	69.74	70.6	1.6
March	-	-	-	-	-	-	70.3	39.21	50.4	19.9
April	-	-	-	-	-	-	64.6	62.58	63.4	1.2
May	-	-	-	-	-	-	65.6	65.56	65.6	-
June	-	-	-	-	-	-	68.5	68.52	68.5	-
July	-	-	-	-	-	-	97.6	97.56	97.6	-
August	-	-	-	-	-	-	93.9	90.80	91.6	2.3
September	-	-	-	-	-	-	82.6	82.55	82.6	-
October	-	-	-	-	-	-	77.9	77.87	77.9	-
November	-	-	-	-	-	-	72.3	69.93	70.3	2.0
December	-	-	-	-	-	-	54.5	36.18	39.1	15.4
TOTALS	-	-	-	-	-	-	899.40	824.62	847.06	52.34

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2018
BIG BEAR WATERMASTER**

**TABLE 3
DETERMINATION OF BIG BEAR'S LAKE ACCOUNT STATUS
Lake Account and Advance Account**

Month	1 Actual Lake Account (see Table 1) (ac-ft)	2 Mutual's Lake Account (see Table 2) (ac-ft)	3 Big Bear's Lake Account (calc.) (ac-ft)	4 Change in Big Bear's Lake Account (calc.) (ac-ft)	5	6 Big Bear's Advances From Mutual (calc.) (ac-ft)	7 Big Bear's Payments Against Advances (calc.) (ac-ft)	8 Big Bear's Advance Account Balance (calc.) (ac-ft)	9 Big Bear's 0% Repayment Premium (calc.) (ac-ft)	10 Mutual's Credit for Return of Advances (to Table 2) (ac-ft)
January	34,206	12,122	22,084	(170.9)		-	-	-	-	-
February	34,524	12,611	21,913	(230.6)		-	-	-	-	-
March	33,887	12,205	21,682	(125.6)		-	-	-	-	-
April	35,372	13,815	21,557	(38.0)		-	-	-	-	-
May	34,629	13,110	21,519	20.2		-	-	-	-	-
June	33,683	12,144	21,539	667.8		-	-	-	-	-
July	32,255	10,048	22,207	1,602.4		-	-	-	-	-
August	31,847	8,038	23,809	778.7		-	-	-	-	-
September	30,268	5,680	24,588	133.8		-	-	-	-	-
October	29,010	4,288	24,722	(567.4)		-	-	-	-	-
November	28,434	4,280	24,154	(478.3)		-	-	-	-	-
December	28,242	4,566	23,676	(369.1)		-	-	-	-	-
	28,242	4,935	23,307					-		
TOTALS				1,223.0		-	-	-	-	-

**CALENDAR YEAR
2018
BIG BEAR WATERMASTER**

**TABLE 3.A
DETERMINATION OF BIG BEAR'S LAKE ACCOUNT STATUS
Lake Inflow Details**

Month	1 In-lieu SWP Water from SBVMWD (Input Data) (ac-ft)	2 In-lieu Water from Other's Wells (Input Data) (ac-ft)	3 In-lieu Supplies from Mutual's Wells (Input Data) (ac-ft)	4	5 Valley District In Lieu Lake Supplies (Input Data) (ac-ft)	6 Big Bear's In-lieu Deliveries to Mutual (calc.) (ac-ft)	7	8 Big Bear's Advances From Mutual (from Table 3) (ac-ft)	9	10 Big Bear's Total Lake Inflows (calc.) (ac-ft)
January	83.5	-	-		-	83.5		-		83.5
February	95.1	-	-		-	95.1		-		95.1
March	144.0	-	-		-	144.0		-		144.0
April	257.0	-	-		-	257.0		-		257.0
May	419.3	-	-		-	419.3		-		419.3
June	1,242.1	35.3	-		-	1,277.4		-		1,277.4
July	2,087.9	163.2	-		-	2,251.1		-		2,251.1
August	1,469.3	149.9	-		-	1,619.2		-		1,619.2
September	820.2	99.5	-		-	919.7		-		919.7
October	-	-	-		-	-		-		-
November	-	-	-		-	-		-		-
December	-	-	-		-	-		-		-
TOTALS	6,618.4	447.9	-		-	7,066.3		-		7,066.3

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2018
BIG BEAR WATERMASTER**

**TABLE 3.B
DETERMINATION OF BIG BEAR'S LAKE ACCOUNT STATUS
Lake Outflow Details**

Month	1 Big Bear's Snowmaking Withdrawals (Input Data) (ac-ft)	2 Big Bear's Total Releases Table 1.B (ac-ft)	3 Return Flow from Snowmelt 50.0% (Table 1.C) (ac-ft)	4 Big Bear's Net Lake Withdrawal (calc.) (ac-ft)	5 Big Bear's Payments Against Advances (see Table 3) (ac-ft)	6 Big Bear's Spills & FC Releases from Table 2.C (ac-ft)	7 Big Bear's Leakage + SWRCB Rel. from Table 2.C (ac-ft)	8 Big Bear's Lake Evaporation from Table 2.B (ac-ft)	9 Net Wastewater Export Credit (from Table 2.A) (ac-ft)	10 Big Bear's Total Lake Outflows (calc.) (ac-ft)
January	168.7	-	84.4	84.4	-	-	9.9	80.0	80.1	254.4
February	153.7	-	76.8	76.8	-	-	1.6	182.1	65.3	325.7
March	13.7	-	6.9	6.8	-	-	19.9	154.0	88.8	269.6
April	5.3	-	2.7	2.7	-	-	1.2	240.9	50.3	295.0
May	18.3	-	-	18.3	-	-	-	331.4	49.4	399.1
June	22.2	-	-	22.2	-	-	-	530.5	56.9	609.6
July	23.4	-	-	23.4	-	-	-	568.8	56.6	648.7
August	20.0	-	-	20.0	-	-	2.3	767.6	50.6	840.5
September	19.5	-	-	19.5	-	-	-	732.2	34.3	785.9
October	22.3	-	11.2	11.2	-	-	-	509.2	47.0	567.4
November	138.7	-	69.3	69.3	-	-	2.0	346.0	60.9	478.3
December	273.3	-	136.7	136.7	-	-	15.4	129.7	87.3	369.1
TOTALS	879.2	-	387.9	491.3	-	-	52.3	4,572.3	727.3	5,843.3

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BIG BEAR WATERMASTER**

**TABLE 4
BASIN MAKE-UP ACCOUNT**

Month	1 Big Bear's Basin Additions (see Table 4.A) (ac-ft)	2	3 Mutual's Basin Additions (see Table 4.B) (ac-ft)	4	5 Net Credit (Debit) (ac-ft)	6	7 Total Basin Replenishment (see Table 4.C) (ac-ft)	8	9 Basin Comp. Account Balance (ac-ft)
January	81.7		76.6		5.1		-		27,170
February	83.7		82.9		0.8		-		27,175
March	107.5		97.3		10.2		-		27,176
April	160.8		160.2		0.6		-		27,186
May	242.4		242.4		-		-		27,187
June	655.3		673.0		(17.7)		-		27,187
July	1,092.7		1,174.3		(81.6)		-		27,169
August	781.6		855.4		(73.8)		-		27,087
September	451.4		501.1		(49.8)		-		27,014
October	38.9		38.9		-		-		26,964
November	36.2		35.1		1.0		-		26,964
December	27.4		19.6		7.8		-		26,965
TOTALS	3,759.6		3,956.9		-197.3		0.0		26,973

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2018
BIG BEAR WATERMASTER**

**TABLE 4.A
BIG BEAR'S BASIN ADDITIONS**

Month	SPILLS			LAKE RELEASES				IN LIEU SUPPLIES		10 Big Bear's Basin Additions (ac-ft)
	1 Actual Spills & FC Releases (ac-ft)	2 Actual SWRCB 95-4 Releases (ac-ft)	3 Basin Addition @ 51.0% (ac-ft)	4 Lake Release for Mutual (ac-ft)	5 SWRCB 95-4 Releases for Mutual (ac-ft)	6 Big Bear's Total Releases Table 1.B (ac-ft)	7 Basin Addition @ 50.0% (ac-ft)	8 Imported In Lieu Deliveries (ac-ft)	9 Basin Addition @ 50.0% (ac-ft)	
January	-	15.4	7.8	-	64.1	-	32.1	83.5	41.8	81.7
February	-	2.5	1.2	-	69.7	-	34.9	95.1	47.6	83.7
March	-	31.1	15.9	-	39.2	-	19.6	144.0	72.0	107.5
April	-	2.0	1.0	-	62.6	-	31.3	257.0	128.5	160.8
May	-	-	-	-	65.6	-	32.8	419.3	209.7	242.4
June	-	-	-	-	68.5	-	34.3	1,242.1	621.1	655.3
July	-	-	-	-	97.6	-	48.8	2,087.9	1,044.0	1,092.7
August	-	3.1	1.6	-	90.8	-	45.4	1,469.3	734.7	781.6
September	-	-	-	-	82.6	-	41.3	820.2	410.1	451.4
October	-	-	-	-	77.9	-	38.9	-	-	38.9
November	-	2.4	1.2	-	69.9	-	35.0	-	-	36.2
December	-	18.4	9.4	-	36.2	-	18.1	-	-	27.4
TOTALS	0.0	74.8	38.1	0.0	824.6	0.0	412.3	6,618.4	3,309.2	3,759.6

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**TABLE 4.B
MUTUAL'S BASIN ADDITIONS**

Month	SPILLS & FISH RELEASES			LAKE RELEASES			7 Total Basin Additions (ac-ft)
	1 Mutual's Spills (ac-ft)	2 Mutual's SWRCB 95-4 Releases (ac-ft)	3 Basin Addition @ 51.0% (ac-ft)	4 Mutual's Lake Demands (ac-ft)	5 SWRCB 95-4 Releases for Mutual (ac-ft)	6 Basin Addition @ 50.0% (ac-ft)	
January	-	5.5	2.8	83.5	64.1	73.8	76.6
February	-	0.9	0.5	95.1	69.7	82.4	82.9
March	-	11.2	5.7	144.0	39.2	91.6	97.3
April	-	0.8	0.4	257.0	62.6	159.8	160.2
May	-	-	-	419.3	65.6	242.4	242.4
June	-	-	-	1,277.4	68.5	673.0	673.0
July	-	-	-	2,251.1	97.6	1,174.3	1,174.3
August	-	0.8	0.4	1,619.2	90.8	855.0	855.4
September	-	-	-	919.7	82.6	501.1	501.1
October	-	-	-	-	77.9	38.9	38.9
November	-	0.4	0.2	-	69.9	35.0	35.1
December	-	3.0	1.5	-	36.2	18.1	19.6
TOTALS	0.0	22.4	11.4	7,066.3	824.6	3,945.5	3,956.9

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TABLE 4.C
BASIN REPLENISHMENTS

Month	1	2 Amount Replenished From SBVMWD (ac-ft)	3	4	5 Amount Replenished From Releases (ac-ft)	6 Amount Replenished From Others (ac-ft)	7	8 Total Amount Replenished (ac-ft)	9
January		-			-	-		-	
February		-			-	-		-	
March		-			-	-		-	
April		-			-	-		-	
May		-			-	-		-	
June		-			-	-		-	
July		-			-	-		-	
August		-			-	-		-	
September		-			-	-		-	
October		-			-	-		-	
November		-			-	-		-	
December		-			-	-		-	
		<u>0.0</u>			<u>0.0</u>	<u>0.0</u>		<u>0.0</u>	