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## Final 2023 Restoration Allocation & Default Flow Schedule May 18, 2023

### Summary

The final Restoration Allocation is based on an Unimpaired Runoff Forecast at the 50% probability of exceedance of 4,664 TAF. This results in a Wet water year type. This value for the runoff forecast was arrived at by blending the DWR and NWS forecasts with a 50/50 ratio and adjusting for observed runoff to date. Accordingly, 557.038 TAF is allocated to the Restoration Program as measured at Gravelly Ford. The Restoration Administrator may elect to return a recommendation at any time.

### Overview

The following transmits the final 2023 Restoration Allocation and Default Flow Schedule to the Restoration Administrator for the San Joaquin River Restoration Program (SJRRP), consistent with the January 2020 (version 2.1) Restoration Flow Guidelines (Guidelines). This Restoration Allocation and Default Flow Schedule provides the following:

- Forecasted water year Unimpaired Runoff: the estimated flows that would occur absent regulation on the river. This value is also known as the “Natural River,” “Unimpaired Runoff,” “Unimpaired Inflow,” or “Full Natural Flow,” and is utilized to identify the water year type.
- Hydrograph Volumes: the annual allocation hydrograph based on water year unimpaired runoff, utilizing Method 3.1 with the Gamma Pathway (RFG-Appendix C, Figure C3) agreed to by the Parties in December 2008.
- Default Flow Schedule: the schedule of Restoration Flows in the absence of a recommendation from the Restoration Administrator.
- Additional Allocations: the hypothetical Restoration Allocations that would result from 10%, 50%, 75%, and 90% probability of exceedance of the Unimpaired Runoff forecast.
- Unreleased Restoration Flows: the amount of Restoration Flows not released due to channel capacity constraints, without delaying completion of Phase 1 improvements.

- Flow targets at Gravelly Ford: the flows at the head of Reach 2, and estimated scheduled releases from Friant Dam adjusted for the assumed Holding Contract demands and losses in Exhibit B.
- Restoration Budget: the volumes for the annual allocation, spring flexible flow, base flow, riparian recruitment, and fall flexible flow.
- Remaining Flow Volume: the volume of Restoration Flows released, the remaining volume available, and associated limitations and flexibility.
- Operational Constraints: the flow release limitations based on downstream channel capacity, regulatory, or legal constraints.

Consistent with Paragraph 18 of the Settlement, the Restoration Administrator shall make recommendations to the Secretary of the Interior concerning the manner in which the hydrographs shall be implemented. As described in the Guidelines, the Restoration Administrator is requested to recommend a flow schedule showing the use of the entire annual allocation during the upcoming Restoration Year or otherwise identify Unreleased Restoration Flows and categorize recommended flows by account, if a recommendation is not provided by the Restoration Administrator, the Capacity Constrained Default Flow Schedule (Table 6b) or the most recently approved schedule will be implemented.

**Since this allocation is essentially unchanged from the previous issuance, the Restoration Administrator may return a revised recommendation at their discretion.**

## **Forecasted Unimpaired Runoff**

Unimpaired Runoff represents the natural water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds (a.k.a “Unimpaired Inflow” or “Natural River” or “Full Natural Flow”). It is calculated for the period of a water year. The forecast of the Unimpaired Runoff determines the volume of Restoration Flows available for the Restoration Year (i.e. the Restoration Allocation). Information for forecasting the Unimpaired Runoff includes:

- Observation of Unimpaired Runoff into Millerton Lake to support the water supply allocation<sup>1</sup>;
- The California Department of Water Resources (DWR) Bulletin 120 latest update for San Joaquin River inflow to Millerton Lake Unimpaired Flow, and/or the most current DWR Bulletin Water Supply Index (WSI)<sup>3</sup>;
- The National Weather Service (NWS) Ensemble Streamflow Prediction (ESP) Water Supply Forecast for the San Joaquin River at Millerton Lake<sup>5</sup>;
- Other forecast models, ground-based observations, remotely-sensed observations, hydrologic models, analysis of historic patterns, and short-term weather forecasts as appropriate.

Table 1 shows the water year 2023 (October 1, 2022 to September 30, 2023) observed accumulated and forecasted water year Unimpaired Runoff into Millerton Lake. This table also includes the published DWR forecast, the DWR forecast adjusted for an expected runoff for the current month, the NWS forecast with and without a 7-day smoothing function applied to

remove the day-to-day variance, and the NWS forecast with 7-day smoothing and adjustment for the expected runoff for the current month (Reclamation adjusts the DWR and NWS values by replacing the forecasted runoff for the current month with Reclamation’s own estimate of runoff for the current month, which increases accuracy and incorporates the latest data). Figure 1a plots DWR and NWS forecast values over the entire water year, while Figure 1b shows the most recent period in detail.

The DWR Water Supply Index forecast for May 1 (issued May 8) was updated by DWR on May 16 and adjusted by Reclamation to better align with observed runoff conditions to date and projections for the remainder of the month (becoming the “Runoff Adjusted DWR values”). NWS forecast values were also adjusted for expected runoff for the remainder of the month. The NWS forecasts consider the modeled future weather over the next 15 days whereas the DWR B120 forecast does not account for current trends to the same degree.

**Table 1 — San Joaquin River Water Year Actuals and Forecasts at Millerton Lake, in Thousands of Acre-Feet (TAF)**

	Forecast Probability of Exceedance				
	90%	75%	50%	25%	10%
Accumulated Unimpaired Runoff (“Natural River”) May 17, 2023 <sup>1</sup>	2207.7				
Accumulated Unimpaired Runoff as percent of normal <sup>2</sup>	234%				
DWR, May 1, 2023 <sup>3</sup> (Published Value)	4,450	4,540	4,670	4,820	4,945
DWR, May 18, 2023 <sup>4,7</sup> (Runoff Adjusted)	4,652	4,759	4,889	5,007	5,128
NWS, May 18, 2023 <sup>5</sup> (Published Daily Value)	4,450	4,530	4,580	4,630	4,690
Smoothed NWS, May 18, 2023 <sup>6</sup> (7-day Smoothing)	4,457	4,525	4,572	4,631	4,679
NWS, May 18, 2023 <sup>4</sup> (Smoothed and Runoff Adjusted)	4,335	4,412	4,438	4,523	4,594

<sup>1</sup> <http://www.usbr.gov/mp/cvo/vungvari/milfn.pdf>

<sup>2</sup> Based on average accumulation of Unimpaired Runoff totaling 1830 TAF.

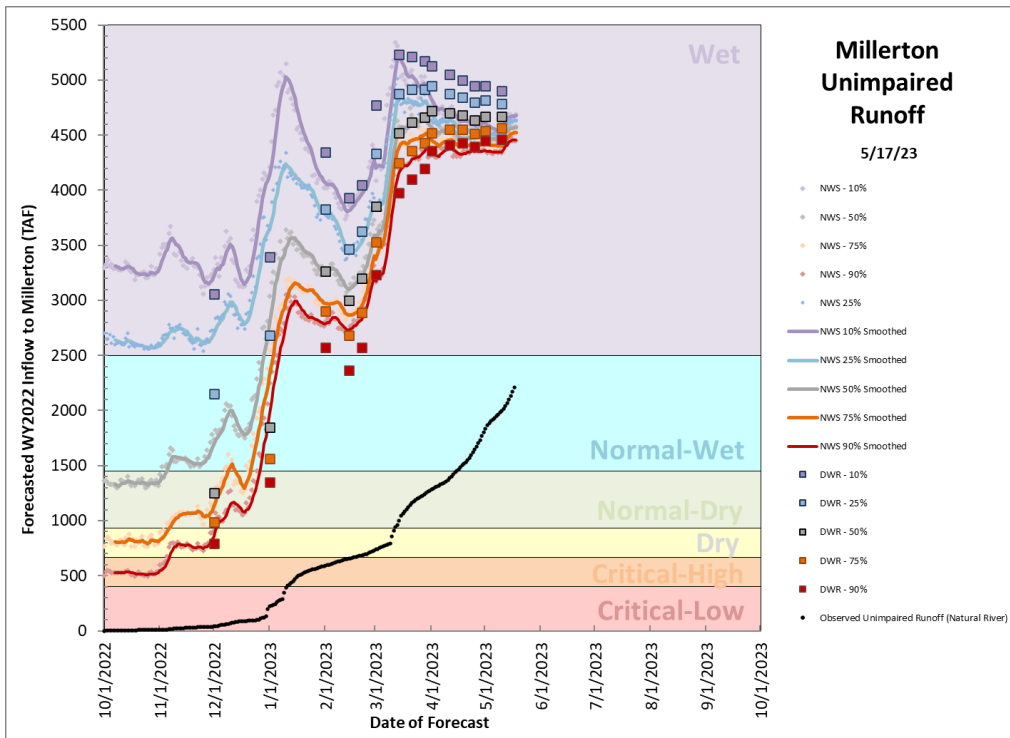
<sup>3</sup> B120: <http://cdec.water.ca.gov/cgi-progs/iudir?s=b120>, or B120 Update: [http://cdec.water.ca.gov/cgi-progs/iudir\\_ss/b120up](http://cdec.water.ca.gov/cgi-progs/iudir_ss/b120up), or WSI: <http://cdec.water.ca.gov/cgi-progs/iudir/WSI.2020>. April-July runoffs are converted to Water Year equivalents in this table.

<sup>4</sup> The adjusted data has been updated with the actual Unimpaired Runoff through the current date and projected out for the remainder of the month.

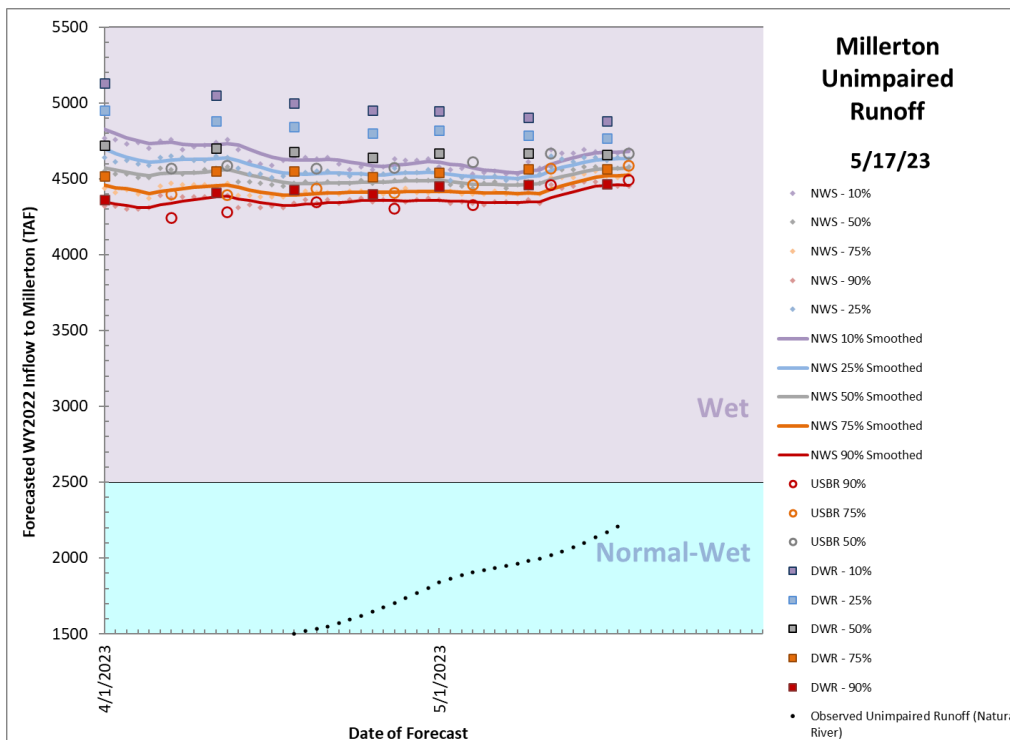
<sup>5</sup> <https://www.cnrfc.noaa.gov/ensembleProduct.php?id=FRAC1&prodID=9>

<sup>6</sup> The NWS smoothed data uses a 7-day triangular weighted moving average, where the most recent day (n) is given greater weight than each previous forecast day (n-1, 2, 3, etc.); this reduces noise stemming from ESP model input. The following formula is used:  $((Forecast_n * 1) + (Forecast_{n-1} * 0.857) + (Forecast_{n-2} * 0.714) + (Forecast_{n-3} * 0.571) + (Forecast_{n-4} * 0.429) + (Forecast_{n-5} * 0.286) + (Forecast_{n-6} * 0.143)) / 4$

<sup>7</sup> Values at the 75% exceedance and 25% exceedance are interpolated.



**Figure 1a — Plot of 2023 Water Year forecasts.** This includes both NWS Ensemble Streamflow Prediction Forecasts and DWR Forecasts



**Figure 1b — Detail plot of most recent forecasts.** Also shown are Reclamation’s “hybrid” forecast with open circles.

Beginning in November 2022, precipitation received in the Upper San Joaquin watershed has exceeded seasonal norms. 5.6” of precipitation (as rain or snow water content) fell in November, which was 142% of normal. 16.8” of precipitation fell in December, which was 256% of normal. In January 21.9” of precipitation fell, or 284% of normal for the month. In February, 9.4” of precipitation fell, or 125% of normal for the month. In March, 22.3” of precipitation fell, or 357% of normal for the month. April was dry with only 0.2” of precipitation or 6% of normal, and so far the month of May is tracking close to normal with 0.5” of precipitation.

The snowpack appeared to have reached peak snow water equivalent (SWE) about April 6<sup>th</sup>. SWE volume at that time was an estimated 3.60 MAF. Many snow pillows recorded their highest reading in 2023, with records dating back to the 1980s. Fifteen snow courses in and around the San Joaquin watershed measured during the April 1 survey recorded their highest SWE values, with records dating back to the 1950s. The 2023 snowpack easily exceeded the snowpack of 2017 and is roughly 10% greater than the April 1 snowpack volumes recorded in 1969 and 1983. By May 1, the 2023 snowpack had declined to be on-par with 1983 and 1969. 2023 is likely the largest peak snowpack experienced in the Southern Sierra Nevada since 1906.

Table 2 depicts the aggregate snowpack volume from multiple models and the April 14-15 Airborne Snow Observatory (ASO) flight. Model results from M3Works iSnobal model and CU Boulder’s Real-time SWE model have been synthesized into our current understanding of the watershed and those models have also been informed by ASO data. Reclamation’s consensus estimate now closely tracks with iSnobal model data along with 9 of 16 “snow pillows” still operating within the watershed and around the margins which weigh the overlying snow and measure the SWE.

**Table 2 — Total snowpack volume (TAF of Snow Water Equivalent) depicted by models and remote sensing, and a consensus estimate for May 18, 2023.**

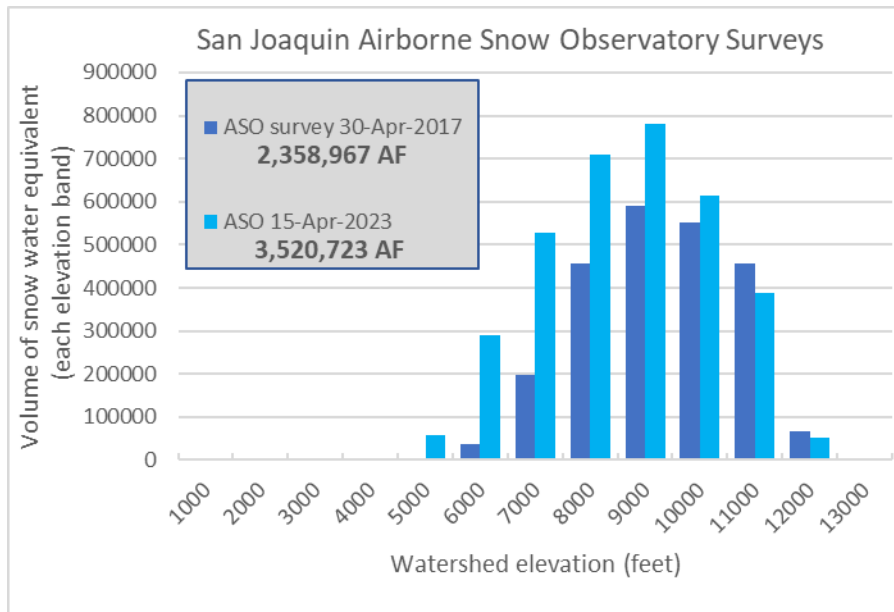
	Snowpack Model Volumes					Reclamation Consensus
	CNRFC	NOHRSC	CU Boulder	iSnobal (M3W)	Aerial Snow Survey (ASO)	
May 18, 2023	2,430	2,579	2,892 <sup>8</sup>	2,777 <sup>9</sup>	3,421 <sup>10</sup>	<b>2,510</b>

<sup>8</sup> CU Boulder “Real-time SWE” model was published for May 15

<sup>9</sup> The “iSnobal” model for the San Joaquin is produced by M3Works under a contract with ASO. The model updated was published for May 16

<sup>10</sup> Third ASO survey made on April 14-15

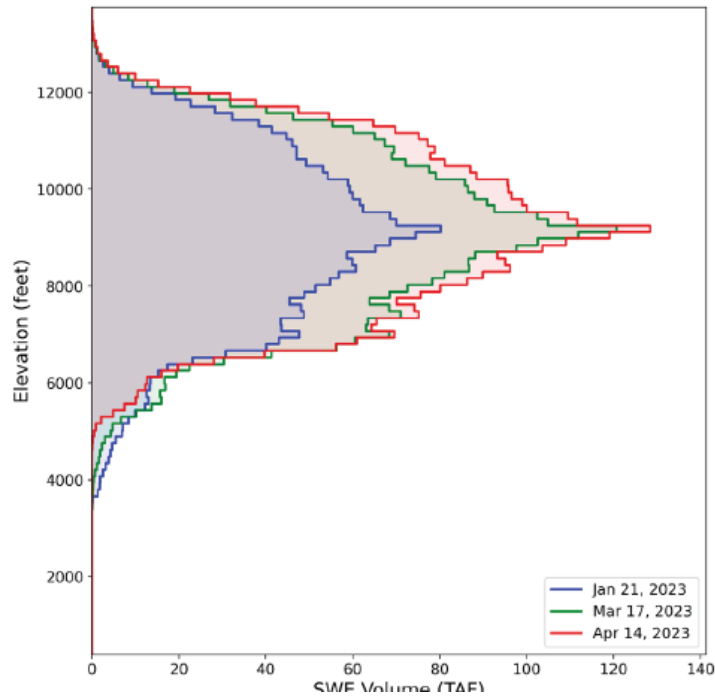
Figure 2 shows the SWE by elevation band in 2023 water year as compared to 2017 during the month of April. These measures by ASO are more accurate than looking at snow pillows or snow courses alone.



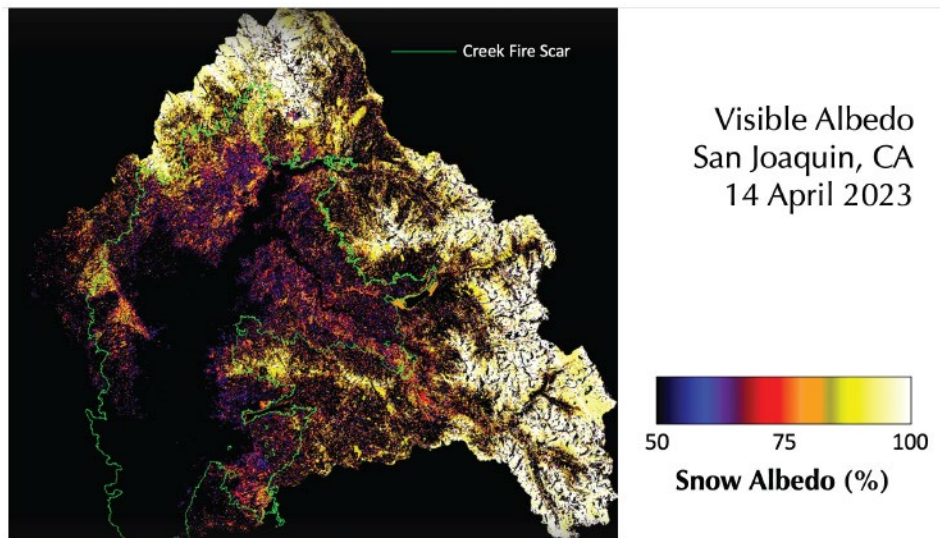
**Figure 2 — Comparison of snow water equivalent (SWE) at all elevation bands as measured by Airborne Snow Observatory in 2017 and 2023.** As of mid-April 2023, watershed had 49% more snow volume than late-April 2017.

Airborne Snow Observatory surveys have been particularly useful in 2023 as many snow pillows have become inoperative under heavy snow load and many snow courses were inaccessible. This technology uses precision lidar to measure snow depth and is then combined with modeled snowpack density grids to produce a reliable measure of SWE. Considerable effort was required to carefully model snowpack density, made more difficult by the absence of some ground-based measurements. This data helps to counteract the complexity of the extreme snowpack, which exceeds historic analogs. Figure 3 depicts SWE volume by elevation, with peak SWE occurring between the second and third surveys (peak volume was likely 100 TAF higher than what was captured on April 14-15).

Figure 4 shows the spatial pattern of albedo (snow reflectivity) in the watershed. Hyperspectral cameras aboard the ASO platform capture the brightness of the snow. Atypically high albedos in 2023 have delayed snowmelt and will require more heat and sunlight to melt than usual. This data helps Reclamation forecast when the snow will melt and runoff.



**Figure 3 — Distribution of SWE for three ASO surveys.** Comparison of snowpack growth between mid-January, mid-March, and mid-April shows the prodigious water volume captured in snow between 8,000' and 10,000' elevation. Snow persisted at elevations below 6,000', even into April, which is quite unusual in recent decades.



**Figure 4 — Visible band albedo (reflectivity) across the watershed.** The outline of the 2020 Creek Fire is shown in green, and substantially lower albedos are found within the burn area due to soot and other impurities in the snow. The remainder of the watershed has unusually high albedo and will resist melting.

## Combining Forecasts

Staff from the South-Central California Area Office of Reclamation and SJRRP jointly track and evaluate the accuracy of runoff forecasts on a regular basis. Based on the age of these forecasts, the short-term and long-term weather forecasts, the climatological outlook, observed Unimpaired Runoff, and other available information, a hybrid forecast is generated. The weighting of the different components is regularly evaluated and selected using the best available information and professional judgment. **For the current allocation, the DWR “runoff adjusted” and NWS “smoothed and runoff adjusted” forecasts are combined with a 50/50 blending respectively.** The selection of this blending ratio is based on the long-term performance of the forecasts and is further guided by an experimental WRF-Hydro model, an in-house water budget model produced by Reclamation, and historic analog years. Note in Table 3 below that the 50%, 25%, and 10% probability of exceedances surpass the record year for the San Joaquin runoff — 1983 which had 4,643 TAF of unimpaired runoff.

Reclamation has removed the “offsetting” the forecast values used in the previous Restoration Allocation. With recent adjustments made by DWR and NWS to their respective forecast products, an offset was no longer necessary. Reclamation continues to retain some hydrologic uncertainty in the expected runoff efficiency into the future; we expect that this uncertainty will incrementally resolve with each of the two remaining ASO surveys.

**Table 3 — Current Blending and Hybrid Unimpaired Runoff Forecasts (TAF)**

	Forecast Probability of Exceedance using blending				
	90%	75%	50%	25%	10%
Blending Ratio (DWR/NWS)	50/50 (no offset)				
Hybrid Unimpaired Runoff Forecast (TAF)	4,494	4,585	4,664	4,765	4,861



## **Restoration Allocation**

As per the Guidelines, the **50% probability of exceedance** forecast is used for the allocation under current hydrologic conditions to set the Restoration Flow Allocation. Table 4 below, from the Guidelines version 2.1, depicts the progression of forecast exceedances used to set the Restoration Allocation.

**Table 4 — Guidance on Percent Exceedance Forecast to Use for Allocation.** The final allocation issuance is made in May this year as per the Guidelines.

	Value (TAF)	Date of Forecast Used for the Allocation					
		January	February	March	April	May	June
<b>If the 50% forecast is:</b>	Above 2200	50	50	50	50	<b>50</b>	—
	1600 to 2200	75	75	50	50	50	—
	900 to 1599	75	75	75	50	50	—
	500 to 899	90	90	75	50	50	50
	Below 500	90	90	90	90	75	50

Applying the forecast blending and offsets determined by Reclamation and using the 50% probability of exceedance forecast dictated by the Guidelines, Reclamation calculates an **Unimpaired Runoff hybrid forecast of 4,664 Thousand Acre-Feet (TAF) and a Wet Water Year Type. This provides a Restoration Allocation of 557.038 TAF as measured at Gravelly Ford (GRF).** Combined with Holding Contracts on the San Joaquin River, **this results in a Friant Dam Release of approximately 674.182 TAF.** Other hypothetical allocations are presented in Table 5 as grayed values and indicate the range of probable forecasts and the resulting Restoration Allocations.

**Table 5 — SJRRP Water Year Type and Allocation for 2023 Restoration Year Shown with Other Hypothetical Values in Gray**

	Forecast Probability of Exceedance using proposed blending				
	90%	75%	50%	25%	10%
Hybrid Unimpaired Runoff Forecast (TAF)	4,494	4,585	<b>4,664</b>	4,765	4,861
Water Year Type	Wet	Wet	<b>Wet</b>	Wet	Wet
Restoration Allocation at GRF (TAF)	557.038	557.038	<b>557.038</b>	557.038	557.038
Friant Dam Flow Releases (TAF)	674.182	674.182	<b>674.182</b>	674.182	674.182

## **Unreleased Restoration Flow Pricing**

The first allocation issuance after March 21 sets the price for 2023 Tier 2 Unreleased Restoration Flows (URFs) which may be made available to Friant Contractors. Accordingly, the price of Tier 2 URFs is set to \$57.36, should any become available in 2023. Tier 1 URF pricing is

independent of hydrology and fixed at \$23.00 per acre-foot. The first three blocks of Tier 1 URFs have been released for delivery as sales. Additional blocks of Tier 1 URFs are anticipated.

## **Contractual Obligation Considerations**

Consistent with Section 10004(j) of the San Joaquin River Restoration Settlement Act, the Settlement and the Settlement Act do not modify the rights and obligations of the United States under the Purchase Contract between Miller and Lux and the United States (Purchase Contract) and the Second Amended Exchange Contract between the United States, Department of the Interior, Bureau of Reclamation and Central California Irrigation District, San Luis Canal Company, Firebaugh Canal Water District, and Columbia Canal Company (Exchange Contract). Reclamation's obligations in the Purchase Contract and Exchange Contract remain unchanged. This is consistent with Condition 17 of Reclamation's 2013 Water Rights order addressing Restoration Flows.

Hydrologic conditions in Northern California have improved to the extent that Reclamation is very likely to satisfy a "non-Shasta Critical" allocation for the San Joaquin River Exchange Contract with South-of-Delta supplies, obviating the need for supplementary water from Millerton Lake.

## **Default Flow Schedule**

The Default Flow Schedule, derived from Exhibit B in the Settlement, identifies how Reclamation will schedule the Restoration Allocation for the current Water Year Type and Unimpaired Runoff volume absent a recommendation from the Restoration Administrator. The Guidelines provide detail on how a Default Flow Schedule is parsed from the allocation volume. This approved method of distributing water throughout the year is referred to as “Method 3.1” with the “gamma pathway.”

### **Exhibit B Method 3.1 Default Flow Schedules**

Table 6a shows the Basic Default Flow Schedule flows and corresponding Restoration Allocation volumes for the entire year absent channel capacity and seepage constraints, including total releases from Friant Dam and Restoration Flows releases in excess of Holding Contracts. Volume is distributed as various flow rates across the year as per the methods explained in the Guidelines.

Table 6b shows the Capacity Constrained Default Flow Schedule volumes with all expected operational constraints, primarily controlled by seepage limitations in Reach 4A. Any volume within the Spring Flexible Flow Account and Fall Flexible Flow Account that cannot be released on the default schedule is shifted to times with available capacity as per the Guidelines. This Capacity Constrained Default Flow Schedule depicted in Table 6b will be implemented in the absence of a specific recommendation by the Restoration Administrator. **With these known constraints, a Restoration Flow volume of 334.089 TAF is generated that cannot be scheduled for release without shifting outside of the flexible flow periods (which would require a Water Supply Test). This volume would become Unreleased Restoration Flows (URFs) under the Capacity Constrained Default Flow Schedule.** This is an estimated volume of water, actual URF volumes will depend on several factors including the Restoration Administrator Recommendation, flow schedule to-date, recapture of Restoration Flows at Mendota Pool, any Friant Dam releases made for the Exchange Contract, and real-time assessments of groundwater constraints.

**Table 6a — Basic Default Flow Schedule**

Flow Period	Flow (cfs)				Volume (TAF)	
	Friant Dam Release	Holding Contracts <sup>11</sup>	Flow Target at GRF	Restoration Flow at GRF	Friant Dam Release	Restoration Flow at GRF
Mar 1 – Mar 15	500	130	375	370	14.876	11.008
Mar 16 – Mar 31	1500	130	1375	1370	47.603	43.478
Apr 1 – Apr 15	2500	150	2355	2350	74.380	69.917
Apr 16 – Apr 30	4000	150	3855	3850	119.008	114.545
May 1 – May 28	1468	190	1283	1278	81.547	70.995
May 29 – Jun 30	1468	190	1283	1278	96.109	83.673
July 1 – July 29	1468	230	1243	1238	84.459	71.230
Jul 30 – Aug 31	350	230	125	120	22.909	7.855
Sep 1 – Sep 30	350	210	145	140	20.826	8.331
Oct 1 – Oct 31	350	160	195	190	21.521	11.683
Nov 1 – Nov 6	700	130	575	570	8.331	6.783
Nov 7 – Nov 10	700	130	575	570	5.554	4.522
Nov 11 – Nov 30	350	120	235	230	13.884	9.124
Dec 1 – Dec 31	350	120	235	230	21.521	14.142
Jan 1 – Jan 31	350	100	255	250	21.521	15.372
Feb 1 – Feb 29	350	100	255	250	20.132	14.380
<b>Totals</b>					<b>674.182</b>	<b>557.038</b>

**Table 6b — Capacity Constrained Default Flow Schedule**

Flow Period	Flow (cfs)				Volume (TAF)		
	Friant Dam Release	Holding Contracts <sup>11</sup>	Flow Target at GRF	Restoration Flow at GRF	Friant Dam Release	Restoration Flow at GRF	Unreleased Restoration Flow <sup>12</sup>
Mar 1 – Mar 15	567	130	442	437	16.857	12.989	-1.981
Mar 16 – Mar 31	567	130	442	437	17.981	13.855	29.623
Apr 1 – Apr 15	587	150	442	437	17.452	12.989	56.928
Apr 16 – Apr 30	587	150	442	437	17.452	12.989	101.556
May 1 – May 28	627	190	442	437	34.798	24.246	46.749
May 29 – Jun 30	627	190	442	437	41.012	28.576	55.097
July 1 – July 29	667	230	442	437	38.342	25.112	46.117
Jul 30 – Aug 31	350	230	120	120	22.909	7.855	0.000
Sep 1 – Sep 30	350	210	145	140	20.826	8.331	0.000
Oct 1 – Oct 31	350	160	195	190	21.521	11.683	0.000
Nov 1 – Nov 6	567	130	442	437	6.743	5.196	1.588
Nov 7 – Nov 10	567	130	442	437	4.495	3.464	1.059
Nov 11 – Nov 30	417	120	302	297	16.531	11.770	-2.646
Dec 1 – Dec 31	350	120	235	230	21.521	14.142	0.000
Jan 1 – Jan 31	350	100	255	250	21.521	15.372	0.000
Feb 1 – Feb 29	350	100	255	250	20.132	14.380	0.000
<b>Totals</b>					<b>340.093</b>	<b>222.949</b>	<b>334.089</b>

<sup>11</sup> In recent years, Holding Contract demands have been higher than assumed under Exhibit B of the Settlement, in which case, flows at Friant are increased to achieve the Gravelly Ford Flow Target.

<sup>12</sup> This estimate of URF volume is based on the most constraining reach, with Spring Flexible Flows redistributed March 1 through May 28 as necessary and Fall Flexible Flows redistributed Sept 3 through December 28 as necessary up to channel capacity constraints. Constrained values are based on actual losses, not Exhibit B losses. Actual URF volume will depend on the Restoration Administrator's recommendations.

## Exhibit B Restoration Flow Budget

Table 7 shows the components of the annual water budget for February 1, 2023, through February 29, 2024 (i.e. the Restoration Year). The Continuity Flow Account, Spring Flexible Flow Account, Riparian Recruitment Flow Account, and Fall Flexible Flow Account reflect the Exhibit B hydrograph for the current Restoration Allocation. The expected 117.143 TAF for Holding Contracts is shown. The volume for each flow account may change with subsequent Restoration Allocations.

**Table 7 — Restoration Budget with Flow Accounts**

Period	Holding Contract Demand (TAF)	Restoration Flow Accounts (TAF)			
		Continuity Flow Account	Spring Flexible Flow Account	Riparian Recruitment Flow Account	Fall Flexible Flow Account
Feb 1 – Feb 28	–	0	213.520	–	–
Mar 1 – Apr 30	16.919	25.428		–	–
May 1 – May 28	10.552	8.886		199.636	–
May 29 – Jul 29	25.666	17.375	–		–
Jul 30 – Aug 31	15.055	7.855	–	–	–
Sep 1 – Sep 30	12.496	8.331	–	–	6.942
Oct 1 – Nov 30	17.177	25.175	–	–	
Dec 1 – Dec 31	7.379	14.142	–	–	
Jan 1 – Feb 29	11.702	29.752	–	–	–
	<b>117.143</b> <sup>13</sup>	<b>136.939</b>	<b>213.520</b>	<b>199.636</b>	<b>6.942</b>
		<b>557.038</b> (Base Flow Volume)			
		<b>674.182</b> (approximate Friant Release Volume) <sup>13</sup>			

<sup>13</sup> In recent years, Holding Contract demands have been higher than assumed under Exhibit B of the Settlement, in which case, flows at Friant are increased to achieve the Gravelly Ford Flow Target.

## Remaining Flow Volumes

The amount of water remaining for scheduling is the volume of flows released from Friant Dam in excess of releases required to meet Holding Contract demands, less past releases. Table 8 tracks these balances among the four flow accounts. Tracking these four flow accounts is necessary for application of the Water Supply Test. The released to date volumes are derived from quality-assurance/quality-control daily average data when available, and partly from provisional data posted to CDEC, and thus may have future adjustments. Such adjustments may also affect the remaining flow volume.

Note that the Restoration Administrator has the option on the return of URF exchanges in 2023 (Table 9).

**Table 8 — Estimated Restoration Flow Volume Remaining and Released to Date**

Flow Account		Yearly Allocation (TAF)	Released to river to Date <sup>15</sup> (TAF)	Released as URFs to Date <sup>15</sup> (TAF)	Remaining Flow Volume (TAF)
Base Flows	Continuity Flow Account (Mar 1 — Feb 28)	136.939	30.188	0	106.751
	Spring Flexible Flows (Feb 1 – May 28)	213.520	24.784	188.736	0
	Riparian Recruitment Flows (May 1 — Jul 29)	199.636	6.992	153.581	39.063
	Fall Flexible Flows (Sep 3 – Dec 28)	6.942	0	0	6.942
Buffer Flows <sup>14</sup>		—	0	0	—
Unreleased Restoration Flows (Returned Exchanges)		—	0	—	0
Purchased Water		—	0	—	0
<b>Totals:</b>			<b>61.964</b>	<b>342.317</b>	<b>152.757</b>

<sup>14</sup> Buffer Flow volumes are based on actual releases, and are not an allocated volume per se.

<sup>15</sup> Through 5/15/2023

<sup>16</sup> 188.736 TAF of URF water was derived from Spring Flexible Flows and 153.581 TAF was derived from Riparian Recruitment Flows.

## Available URF Exchange Returns

Reclamation is in the process of extending and revising three existing Unreleased Restoration Flow exchanges. The available water for return to the Restoration Administrator, incorporating the expected agreement revisions, is shown in Table 9.

**Table 9 — Volume available from URF Exchange Returns**

Exchange Partner	Period of return <sup>16</sup>	Minimum Required Return (TAF)	Maximum Annual Return (TAF)	Notes
AEWSD	Mar-Sep	3.500 <sup>16</sup>	3.500 <sup>17</sup>	Expires Feb 2025, requiring the use of 3,500 AF for each of the remaining two years
DEID	Mar-Sep	0	1.200	In Normal-Dry through Wet year types only. Must not be any Exchange Contractor Call. Expires in 2024.
FID	Flexible	2.000 <sup>16</sup>	2.000	Expires Feb 2023 (2018 agreement)
FID	Mar-Sep	0	3.600	Exchange is reduced by 10% per year, expiring Feb 2025 (2016 agreement modified in 2022)
FID	Jun-Oct	0	2.000	May not be called upon in same year as 2016/2022 agreement. In Normal-Dry through Wet year types only. Expires in 2024.
OCID	Mar-Sep	0	Up to 3.000	Return ratio depends upon Class 1 declaration, expiring Feb 2025
OCID	Mar-Sep	4.667 <sup>16</sup>	Variable, up to 9.334, 4.667 in any one year	In Normal-Dry through Wet year types only. Must be 50% Class 1 or greater. Expires in 2024.

<sup>16</sup> if minimum volume of water is not taken, unused water is purchased by District

<sup>17</sup> unless otherwise by mutual agreement



## Operational Constraints

Operating criteria, such as channel conveyance capacity, ramping rate constraints, scheduled maintenance, reservoir storage, contractual obligations, and downstream seepage concerns, may restrict the release of Restoration Flows. Table 10 summarizes known 2023 operational constraints.

**Table 10 — Summary of Operational Constraints**

Type of Constraint	Period	Flow Limitation
Levee Stability	Currently in effect	1,210 cfs in Reach 2B
	Currently in effect	2,600 cfs in Middle Eastside Bypass
	Currently in effect	2,350 cfs in Reach 5
Channel Conveyance / Seepage Limitation	Currently in effect, see latest Flow Bench Evaluation for precise values	Reach 2A: Approx. 600 cfs @ GRF <sup>1</sup>
		Reach 3: Approx. 850 cfs @ MEN
		Reach 4A: Approx. 315 cfs @ SDP
USFWS Biological Opinion	Until consultation for "Phase 2"	1,660 cfs of Restoration Flows released at Friant Dam

<sup>1</sup> Expect a seepage limitation of approx. 600 cfs at GRF during typical operations. The limitation as of date of this allocation accounts for drainage of elevated groundwater conditions from January - February 2023 flood management releases and is approximately 380 cfs at GRF.

The 2023 Channel Capacity Report identifies a maximum flow in Reach 2B of 1,210 cfs due to levee stability constraints. This results in a maximum release from Friant Dam between 1,310 cfs and 1,540 cfs depending on the time of year. The 2023 Channel Capacity Report also identifies a maximum flow in the Middle Eastside Bypass of 2,600 cfs, which has increased from the 2022 Channel Capacity Report value of 1,070 cfs due to the completion of the Reach O levee improvements project and the removal of two weirs within the Eastside Bypass.

## 2023 Allocation History

The Restoration Allocation is adjusted multiple times between the date of the initial allocation and the final allocation; issuances will generally take place on a monthly schedule but may also be issued based on rapidly changing hydrologic conditions. The Restoration Administrator is responsible for contingency planning and managing releases to stay within the current allocation to the extent possible, in accordance with the Guidelines. Table 11 summarizes the Allocation History for this Restoration Year.

**Table 11 — Allocation History**

Allocation Type	Issue Date	Forecast Blending Applied	Unimpaired Runoff Forecast (at forecast exceedance)	Year Type	Restoration Allocation at Gravelly Ford	Restoration Flows and URFs Released
Initial	January 20, 2023	0/100	3,403 TAF (@ 50%)	Wet	556.542 TAF	0 (through 1/19/2023)
Updated	February 17, 2023	30/70	3,080 TAF (@ 50%)	Wet	557.038 TAF	167.564 (through 2/16/2023)
Updated	March 14, 2023	0/100	4,537 TAF (@ 50%)	Wet	557.038 TAF	179.992 (through 3/13/2023)
Updated	April 20, 2023	60/40 (0/0/+50/+100/+200 offset)	4,569 TAF (@ 50%)	Wet	557.038 TAF	212.083 (through 4/20/2023)
Final	May 18, 2023	50/50	4,664 TAF (@ 50%)	Wet	557.038 TAF	408.525 (through 5/15/2023)

## Appendix A: Abbreviations, Acronyms, and Glossary

af	Acre-feet
ARS	USDA Agricultural Research Service
ASO	Airborne Snow Observatory
B120	DWR Bulletin #120 which forecasts water supply
CALSIM	California Statewide Integrated Model
CCID	Central California Irrigation District
CDEC	California Data Exchange Center
cfs	Cubic feet per second
CVP	Central Valley Project
Delta	Sacramento–San Joaquin Delta
DWR	California Department of Water Resources
ESP	Ensemble Streamflow Prediction
Exhibit B	Exhibit B of the Settlement depicting Default Hydrograph
GRF	Gravelly Ford Flow Gauge
Guidelines	Restoration Flow Guidelines
LSJLD	Lower San Joaquin Levee District
NWS	National Weather Service
QA/QC	Quality Assurance/Quality Control (i.e. finalized)
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Restoration Year	the cycle of Restoration Flows, March 1 through February 28/29
RWA	SJRRP Reclaimed Water Account
Secretary	U.S. Secretary of the Interior
Settlement	Stipulation of Settlement in NRDC, et al., v. Kirk Rodgers, et al.
SJREC	San Joaquin River Exchange Contractors
SJRRP	San Joaquin River Restoration Program
SLCC	San Luis Canal Company
SMP	Seepage Management Plan
SWE	Snow Water Equivalent
SWP	State Water Project
TAF	thousand acre–feet
URF	Unreleased Restoration Flows
WSI	DWR Water Supply Index
WY	Water year, October 1 through September 30

## Appendix B: Previous Year (2022) Flow Accounting

**Table B — Restoration Flow Accounting and Unreleased Restoration Flows, and Holding Contracts, for the period February 2022 through February 2023.** Flood management releases to San Joaquin River occurred January 5 – February 5, 2023. Releases of 201.275 TAF for the Exchange Contractor occurred April 1 – July 12, 2022. The final Restoration Allocation was 232.470 TAF. Additionally, Unreleased Restoration Flow exchange returns of 3.500 TAF were released, and 0 TAF of Buffer Flows. A total of 6.436 TAF was advanced into February 2022. The Restoration Allocation was expended with -0.200 TAF ending balance.

Feb 1 – Feb 28	–	–		–	6.436	–	–	–	–	
Mar 1 – Mar 31	11.796	0		13.527	13.010	–	–	0	–	
Apr 1 – Apr 30	13.234	40.380		3.967	2.553	–	–	0	–	
May 1 – May 31	14.858	74.884	47.982	0	0 <sup>1</sup>	–	0	0	0	
Jun 1 – Jun 30	16.980	76.951	53.094	0	–	–		0		
Jul 1 – Jul 31	13.831	9.735		0	–	–		0		
Aug 1 – Aug 31	15.017	0.865		0	–	–		0		
Sep 1 – Sep 30	14.227	0.791		0	–	0	–	0		
Oct 1 – Oct 31	16.141	0.238		10.651	–	0	–	0	0	
Nov 1 – Nov 30	14.339	0		14.521	–	1.870	–	0		
Dec 1 – Dec 31	12.367	0		19.444	–	5.072	–	0		0.139
Jan 1 – Jan 31	17.554	221.786		22.922	–	–	–	0	–	3.361
Feb 1 – Feb 28	7.892	17.635		17.621	–	–	–	0	–	
				<b>102.653</b>	<b>21.999</b>	<b>6.942</b>	<b>0</b>	<b>0</b>	<b>0</b>	
				<b>131.594</b> (allocated Restoration Flows)				<b>0</b> (all Buffer Flows)		<b>3.500</b>
				<b>131.594</b> (Restoration Flows affecting Friant water supply)						
				<b>135.094</b> (Restoration Flows released to river)						
				<b>232.670</b> (Restoration Allocation used)						
				<b>687.602</b> (Friant Dam releases — excludes removed URFs and excludes contributions from tributary inflows)						

<sup>1</sup> Prior to May 28, 67.086 TAF of the Spring Flexible Flow account was transferred into the Continuity Flow Account, passing a Water Supply Test, and became Unreleased Restoration Flows sold or exchanged to Friant Contractors.

# Appendix C: History of Millerton Unimpaired Runoff

**Table C — Water Year Totals in Thousand Acre-Feet**

Water Year <sup>1</sup>	Unimpaired Runoff <sup>2</sup>	SJRRP Water Year Type <sup>3</sup>	Water Year <sup>1</sup>	Unimpaired Runoff <sup>2</sup>	SJRRP Water Year Type <sup>3</sup>	Water Year <sup>1</sup>	Unimpaired Runoff <sup>2</sup>	SJRRP Water Year Type <sup>3</sup>	Water Year <sup>1</sup>	Unimpaired Runoff <sup>2</sup>	SJRRP Water Year Type <sup>3</sup>
1901	3,227.9	Wet	1933	1,111.4	Normal-Dry	1965	2,271.191	Normal-Wet	1997	2,817.670	Wet
1902	1,704.0	Normal-Wet	1934	691.5	Dry	1966	1,298.792	Normal-Dry	1998	3,160.759	Wet
1903	1,727.0	Normal-Wet	1935	1,923.2	Normal-Wet	1967	3,233.097	Wet	1999	1,527.040	Normal-Wet
1904	2,062.0	Normal-Wet	1936	1,853.3	Normal-Wet	1968	861.894	Dry	2000	1,735.653	Normal-Wet
1905	1,795.4	Normal-Wet	1937	2,208.0	Normal-Wet	1969	4,040.864	Wet	2001	1,065.318	Normal-Dry
1906	4,367.8	Wet	1938	3,688.4	Wet	1970	1,445.837	Normal-Dry	2002	1,171.457	Normal-Dry
1907	3,113.9	Wet	1939	920.8	Dry	1971	1,416.812	Normal-Dry	2003	1,449.954	Normal-Dry
1908	1,163.4	Normal-Dry	1940	1,880.6	Normal-Wet	1972	1,039.249	Normal-Dry	2004	1,130.823	Normal-Dry
1909	2,900.7	Wet	1941	2,652.5	Wet	1973	2,047.585	Normal-Wet	2005	2,826.872	Wet
1910	2,041.5	Normal-Wet	1942	2,254.0	Normal-Wet	1974	2,190.308	Normal-Wet	2006	3,180.816	Wet
1911	3,586.0	Wet	1943	2,053.7	Normal-Wet	1975	1,795.922	Normal-Wet	2007	684.333	Dry
1912	1,043.9	Normal-Dry	1944	1,265.4	Normal-Dry	1976	629.234	Critical-High	2008	1,116.790	Normal-Dry
1913	879.4	Dry	1945	2,134.633	Normal-Wet	1977	361.253	Critical-Low	2009	1,455.379	Normal-Wet
1914	2,883.4	Wet	1946	1,727.115	Normal-Wet	1978	3,402.805	Wet	2010	2,028.706	Normal-Wet
1915	1,966.3	Normal-Wet	1947	1,121.564	Normal-Dry	1979	1,829.988	Normal-Wet	2011	3,304.824	Wet
1916	2,760.5	Wet	1948	1,201.390	Normal-Dry	1980	2,973.169	Wet	2012	831.582	Dry
1917	1,936.2	Normal-Wet	1949	1,167.008	Normal-Dry	1981	1,067.757	Normal-Dry	2013	856.626	Dry
1918	1,466.8	Normal-Wet	1950	1,317.457	Normal-Dry	1982	3,317.171	Wet	2014	509.579	Critical-High
1919	1,297.5	Normal-Dry	1951	1,827.254	Normal-Wet	1983	4,643.090	Wet	2015	327.410	Critical-Low
1920	1,322.5	Normal-Dry	1952	2,840.854	Wet	1984	2,042.750	Normal-Wet	2016	1,300.986	Normal-Dry
1921	1,604.4	Normal-Wet	1953	1,226.830	Normal-Dry	1985	1,135.975	Normal-Dry	2017	4,395.400	Wet
1922	2,355.1	Normal-Wet	1954	1,313.993	Normal-Dry	1986	3,031.600	Wet	2018	1,348.979	Normal-Dry
1923	1,654.3	Normal-Wet	1955	1,161.161	Normal-Dry	1987	756.853	Dry	2019	2,734.772	Wet
1924	444.1	Critical-High	1956	2,959.812	Wet	1988	862.124	Dry	2020	886.025	Dry
1925	1,438.7	Normal-Dry	1957	1,326.573	Normal-Dry	1989	939.168	Normal-Dry	2021	521.853	Critical-High
1926	1,161.4	Normal-Dry	1958	2,631.392	Wet	1990	742.824	Dry	2022	1059.492	Normal-Dry
1927	2,001.3	Normal-Wet	1959	949.456	Normal-Dry	1991	1,027.209	Normal-Dry	2023	<i>pending</i>	Wet
1928	1,153.7	Normal-Dry	1960	826.021	Dry	1992	807.759	Dry			
1929	862.4	Dry	1961	647.428	Critical-High	1993	2,672.322	Wet			
1930	859.1	Dry	1962	1,924.066	Normal-Wet	1994	824.097	Dry			
1931	480.2	Critical-High	1963	1,945.266	Normal-Wet	1995	3,876.370	Wet			
1932	2,047.4	Normal-Wet	1964	922.351	Dry	1996	2,200.707	Normal-Wet			

<sup>1</sup> Water year is from Oct 1 through Sept 30, for example the 2010 water year began Oct 1, 2009. Unimpaired Runoff is based on Reclamation calculations, and hypothetical water year types are shown here; actual Restoration water year types are based on the final allocation, which may sometimes differ slightly from the calculated water year total.

<sup>2</sup> Also known as "Natural River" or "Unimpaired Runoff into Millerton" – This is the total runoff that would flow into Millerton Lake if there were no dams or diversions upstream. There was a lower level of precision prior to 1945. Friant Dam uses 1.9835 conversion from cfs to AF.

<sup>3</sup> The six SJRRP Water Year Types are based on Unimpaired Runoff and are not updated as climatology changes as per the Settlement. Critical-Low= <400 TAF, Critical-High=400-669.999 TAF, Dry= 670-929.999 TAF, Normal-Dry 930-1449.999, Normal-Wet 1450-2500, Wet>2500

## Appendix D: Final Restoration Allocations and Error

**Table D — History of Restoration Allocations**

Year	Type	Date of Final Allocation Issuance <sup>2</sup>	Unimpaired Runoff Forecast in Final Allocation (TAF)	Restoration Allocation in Final Issuance (TAF)	Observed Unimpaired Runoff on Sep. 30 (TAF)	Unimpaired Runoff Forecast Error	Allocation Error
2009	Interim Flows			261.5	1,455.379	—	—
2010	Interim Flows			98.2	2,028.706	—	—
2011	Interim Flows			152.4	3,304.824	—	—
2012	Interim Flows			183	831.582	—	—
2013	Interim Flows			65.5	856.626	—	—
2014	Restoration Flows	Mar 3	518	0 <sup>1</sup>	509.579	+8.421	0 <sup>1</sup>
2015	Restoration Flows	Sep 28	327	0	327.410	-0.410	0
2016	Restoration Flows	Sep 30	1300.986	263.295	1,300.986	0	0
2017	Restoration Flows	Jul 10	4,444	556.542	4,395.400	+48.600	0
2018	Restoration Flows	May 22	1,427	280.258	1,348.979	+78.021	+10.503
2019	Restoration Flows	May 20	2,690	556.542	2,734.772	-44.772	0
2020	Restoration Flows	June 19	880	202.197	886.025	-6.025	-1.345
2021	Restoration Flows	June 25	529	70.919	521.853	+7.147	0
2022	Restoration Flows	May 13	1072	232.470	1059.492	+12.508	+1.684
2023	Restoration Flows	May 18	4664	557.038	<i>pending</i>	<i>pending</i>	0

<sup>1</sup> No water was provided under this Critical-High designation due to necessity for Friant Dam to release flows for the Exchange Contract.

<sup>2</sup> In 2018 with the completion of Version 2.0 of the Restoration Flows Guidelines, the date of final Restoration Allocation issuance was advanced from September 30 to May (or June under dry hydrologic conditions).

## Appendix E: Unreleased Restoration Flow History

**Table E1 — URF Distributions (TAF)**

Restoration Year	Gross Volume of URF Sales to Class 1	Gross Volume of URF Sales to Class 2	Net Volume of URF Sales to Class 1	Net Volume of URF Sales to Class 2	Gross Volume of URF put into Exchanges	Net Volume of URF put into Exchanges	Gross Volume of URFs spilled	Gross Total URF
2013	—	—	—	—	12.694	12.694	—	12.694
2014	11.219	—	11.219	—	—	—	0.206	11.425
2015	—	—	—	—	—	—	—	0
2016	70.860	56.959	67.317	54.111	18.947	18.000	—	146.766
2017	5.474	364.967	5.200	346.716	2.491	2.366	—	372.932
2018	65.249	40.000	61.986	38.000	19.543	18.565	—	124.792
2019	—	326.954	—	310.607	16.298	15.482	22.509	365.761
2020	43.500	—	41.325	—	20.002	19.697	—	63.502
2021	—	—	—	—	—	—	—	0
2022	75.178	—	71.419	—	26.951	25.603	—	102.128
2023	—	279.197	—	265.237	—	—	—	279.197
<b>Total</b>	<b>271.480</b>	<b>1,068.077</b>	<b>258.466</b>	<b>1,014.671</b>	<b>116.926</b>	<b>112.407</b>	<b>22.715</b>	<b>1,479.197</b>

Note: 2023 URF actions have not yet completed

**Table E2 — Expected URF Revenue for the Restoration Fund**

Restoration Year	Revenue Generated from URF Sales	Revenue Generated from URF Exchanges	Total URF Revenue
2013	—	—	—
2014	\$3,470,650	—	\$3,470,650
2015	—	—	—
2016	\$9,686,790	—	\$9,686,790
2017	\$7,038,380	—	\$7,038,380
2018	\$6,123,858	\$494,504	\$6,618,362
2019	\$6,393,286	\$306,680	\$6,699,966
2020	\$8,922,481	\$1,251,630	\$10,174,111
2021	—	\$525,000	\$525,000
2022	\$13,488,907	\$1,909,267	\$15,398,173
2023	\$6,100,451	—	\$6,100,451
<b>Total</b>	<b>\$61,224,803</b>	<b>\$4,487,081</b>	<b>\$65,711,883</b>

Note: 2023 URF actions have not yet completed

**Table E3 — URF Exchanges Returned to the Program (TAF)**

Restoration Year	Volume Returned	Notes
2013	—	—
2014	11.425	From 2013 URF Exchange with FID, used for 2014 sales
2015	—	—
2016	—	—
2017	5.474	Returned from San Luis Reservoir, 5.200 net URF sold
2018	2.129	Returned from 2018 DEID exchange
2019	9.000	Returned to SLR from 2019 AEWS and LTRID exchange, transferred to CVO for San Luis Unit supply
2020	0.487	Returned from FID from 2019 exchange
2021	10.425	Returned from multi-party 2020 exchange
2022	3.500	From 2016 URF Exchange with AEWS
2023	<i>pending</i>	<i>pending</i>
<b>Total</b>	<b>42.440</b>	