SAN JOAQUIN RIVER
RESTORATION PROGRAM

Bureau of Reclamation
2800 Cottage Way, MP-170
Sacramento, California 95825

# Final 2017 Restoration Allocation & Default Flow Schedule

July 10, 2017

## Introduction

The following transmits the final 2017 Restoration Allocation and Default Flow Schedule to the Restoration Administrator for the San Joaquin River Restoration Program (SJRRP), consistent with the Restoration Flows Guidelines (version 2.0, February 2017). This Restoration Allocation and Default Flow Schedule provide the following:

- Forecasted water year Unimpaired Inflow: the estimated flows that would occur absent regulation on the river. This value is also known as the "Natural River" or "Unimpaired Runoff" or "Full Natural," and is utilized to identify the Restoration Year Type.
- Hydrograph Volumes: the annual allocation hydrograph based on water year unimpaired inflow, utilizing the Method 3.1 with the Gamma Pathway (RFG-Appendix C, Figure C-3) 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 Unimpaired Inflow forecast.
- Unreleased Restoration Flows: the amount of Restoration Flows not released due to channel capacity constraints and 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 Flexible Flow Volume: the volume of Restoration Flows released and the remaining volume available for flexible scheduling.
- 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 Restoration Flow Guidelines (Guidelines), the Restoration Administrator is requested to recommend a flow schedule showing the use of the entire annual allocation during the upcoming Restoration Year, categorize all recommended flows by account, and recommend both an unconstrained and a capacity limited recommendation. If an unconstrained recommendation and a capacity limited recommendation are not provided by the Restoration Administrator, the Default Flow Schedule without constraints (Table 5a) and the Default Flow Schedule with constraints (Table 5b) will be used respectively.

## Forecasted Unimpaired Inflow

Unimpaired Inflow 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. It is calculated for the period of a Water Year. The forecast of the Unimpaired Inflow determines the volume of Restoration Flows available for the Restoration Year (i.e. the Restoration Allocation). Information for forecasting the Unimpaired Inflow primarily includes:

- Reclamation estimate of Unimpaired Inflow (i.e. Natural River) into Millerton Lake to support the water supply allocation[1];
- The Department of Water Resources (DWR) Bulletin 120 latest update for water year 2017 San Joaquin River inflow to Millerton Lake Unimpaired Flow, and/or the most current DWR Bulletin Water Supply Index (WSI)[3];
- The National Weather Service (NWS) Ensemble Streamflow Prediction (ESP) Water Supply Forecast (water year 2017) for the San Joaquin River at Millerton Lake[5].

Table 1 shows the water year 2017 (October 1, 2016 to September 30, 2017) observed accumulated and forecasted water year Unimpaired Inflows at Millerton Lake. This includes the published DWR forecast, the DWR forecast adjusted for expected runoff for the current month, and the NWS forecast with and without a 7-day smoothing function applied to remove the day-to-day variance. Figure 1a plots these values over the entire water year, while Figure 1b shows the most recent period in detail, indicating that the NWS and DWR forecasts have effectively converged upon the same values.

## Table 1 — San Joaquin River Water Year Actuals and Forecasts at Millerton Lake

| | Forecast Exceedance Percentile | | | | |
|---|---|---|---|---|---|
| | **90%** | **75%** | **50%** | **25%** | **10%** |
| Accumulated "Full Natural" Unimpaired Inflow, July 6, 2017 [1] | 3,941.3 TAF | | | | |
| Accumulated Unimpaired Inflow as percent of average | 244% | | | | |
| Total Unimpaired Inflow projected to end of water year [2] | 4,493 TAF | | | | |
| DWR, May 1, 2017 [3] (Published Value) | 3,985 TAF | 4,090 TAF | 4,195 TAF | 4,350 TAF | 4,505 TAF |
| DWR, July 6, 2017 [4] (Runoff Adjusted) | 4,325 TAF | 4,385 TAF | 4,445 TAF | 4,535 TAF | 4,625 TAF |
| NWS, July 7, 2017 (Published Daily Value [5]) | 4,390 TAF | 4,400 TAF | 4,430 TAF | 4,460 TAF | 4,480 TAF |
| Smoothed NWS, July 7, 2017 (7-day Smoothing [6]) | 4,405 TAF | 4,419 TAF | 4,444 TAF | 4,473 TAF | 4,501 TAF |

[1] http://www.usbr.gov/mp/cvo/vungvari/milfln.pdf

[2] Projected value only presented from May through September; based on USBR-SCCAO runoff regression method

[3] B120: http://cdec.water.ca.gov/cgi-progs/iodir?s=b120, or B120 Update: http://cdec.water.ca.gov/cgi-progs/iodir_ss/b120up, or WSI: http://cdec.water.ca.gov/cgi-progs/iodir/WSI.2017

[4] The adjusted DWR data has been updated with the actual unimpaired inflow through the current date and projected out for the remainder of the month.

[5] http://www.cnrfc.noaa.gov/water_resources_update.php?stn_id=FRAC1&stn_id2=FRAC1&product=WaterYear

[6] 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 us used: $((Forecast_n * 1) + (Forecast_{n-1} * 0.857) + (Forecast_{n-2} * 0.714) + (Forecast_{n-3} * 0.571) + (Forecast_{n-4} * 0.429) + (Forecast_{n-5} * 0.286) + (Forecast_{n-6} * 0.143)) / 4$

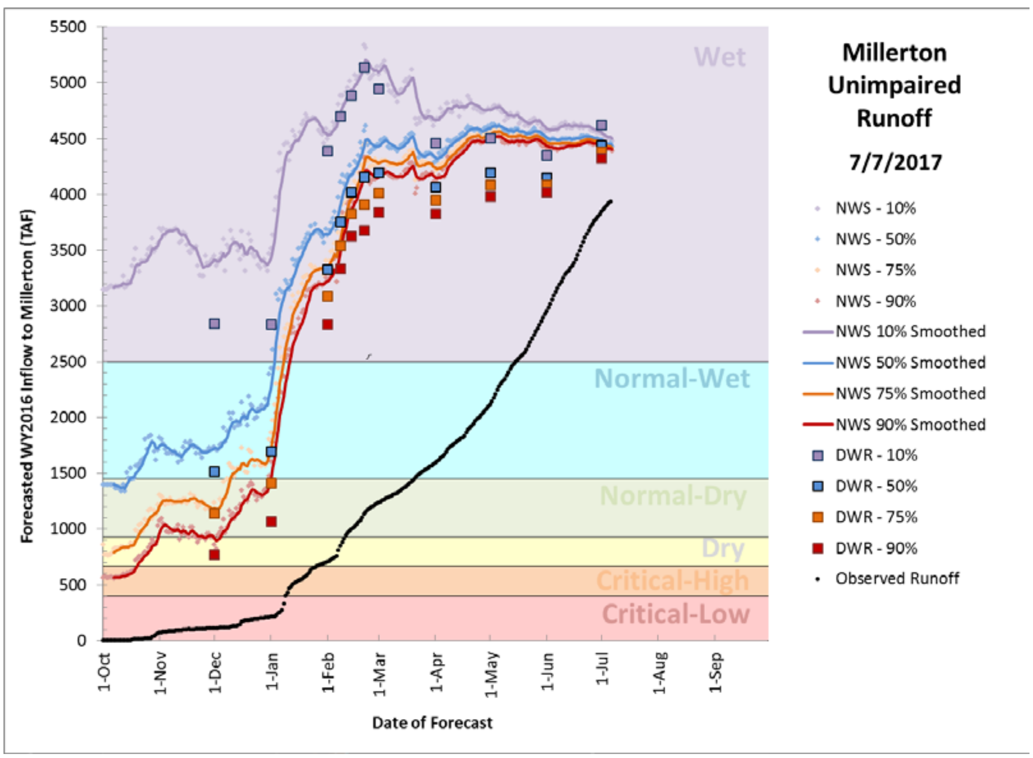


**Figure 1a — Plot of Water Year 2017 forecasts, including both NWS Ensemble Streamflow Prediction Forecast and DWR Forecast**

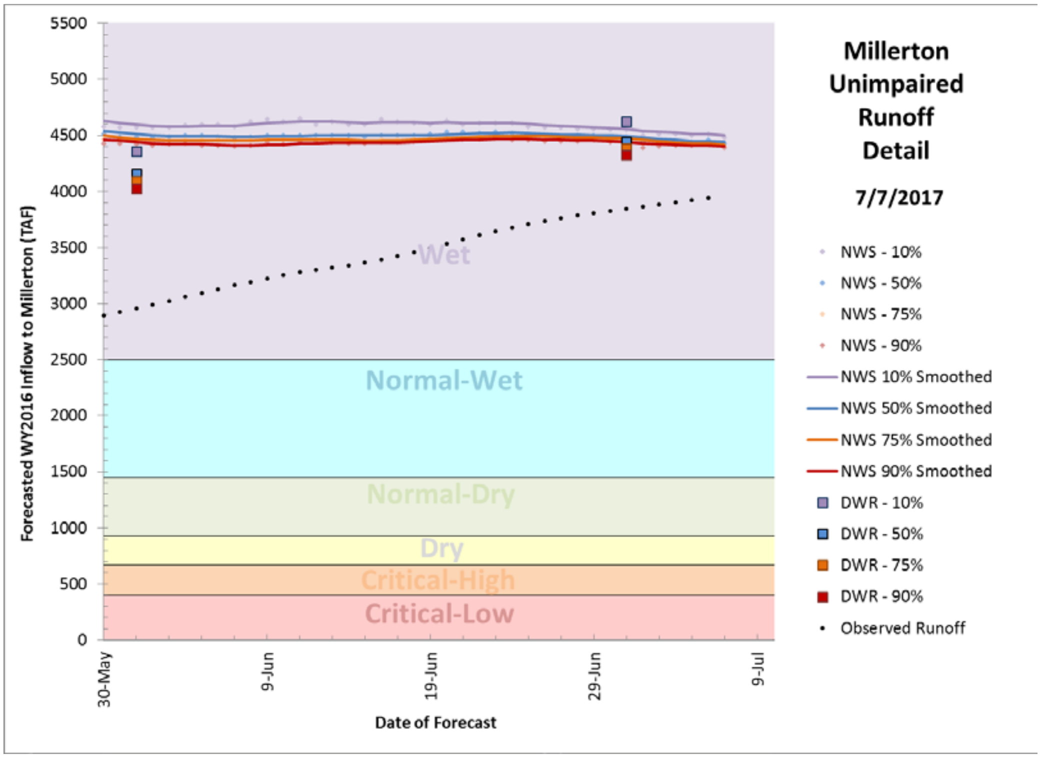


**Figure 1b — Detail plot of most recent forecasts**

## Combining Forecasts

Staff from SJRRP and the South-Central California Area Office of Reclamation jointly track and evaluate the accuracy of runoff forecasts. Based on the age of these forecasts, the short-term weather forecast, observed Unimpaired Inflow, and other available information, a hybrid forecast is generated. The weighting of the different components is regularly evaluated and selected using professional judgment and the best available information. For the current allocation, the DWR "runoff adjusted" and NWS "smoothed" forecasts are combined with a 50/50 blending respectively. This results in the Hybrid Unimpaired Inflow Forecasts shown in Table 2.

**Table 2 —Hybrid Unimpaired Inflow Forecast**

| | Forecast Probability of Exceedance using proposed blending | | | | |
|---|---|---|---|---|---|
| | **90%** | **75%** | **50%** | **25%** | **10%** |
| Hybrid Unimpaired Inflow Forecast (TAF) | 4,365 | 4,402 | 4,444 | 4,504 | 4,563 |

This 50/50 blending is chosen due to the similarity between the two forecasts, their recent convergence, and congruence with Airborne Snow Observatory measurements of snowpack. The hybrid forecast values are fairly insensitive to the blending ratios. The remaining span between the 90% and 10% hybrid forecasts represents uncertainty about precipitation in the remainder of the year, and to a lesser extent uncertainty regarding the remaining snowpack.

Another method for tracking the performance of the hybrid forecast is to plot observed Unimpaired Inflow against a 30-year average Unimpaired Inflow curve scaled to the 2017 water year hybrid forecast. Such a plot is presented in Figure 2, and shows the trace of the observed runoff tracking just above the scaled 50% exceedance hybrid forecast. The trace has been converging with the scaled runoff curve shown in gray, and the projection for the remainder of the water year is reasonable given the observation that high elevation snowpack still remains in the watershed.

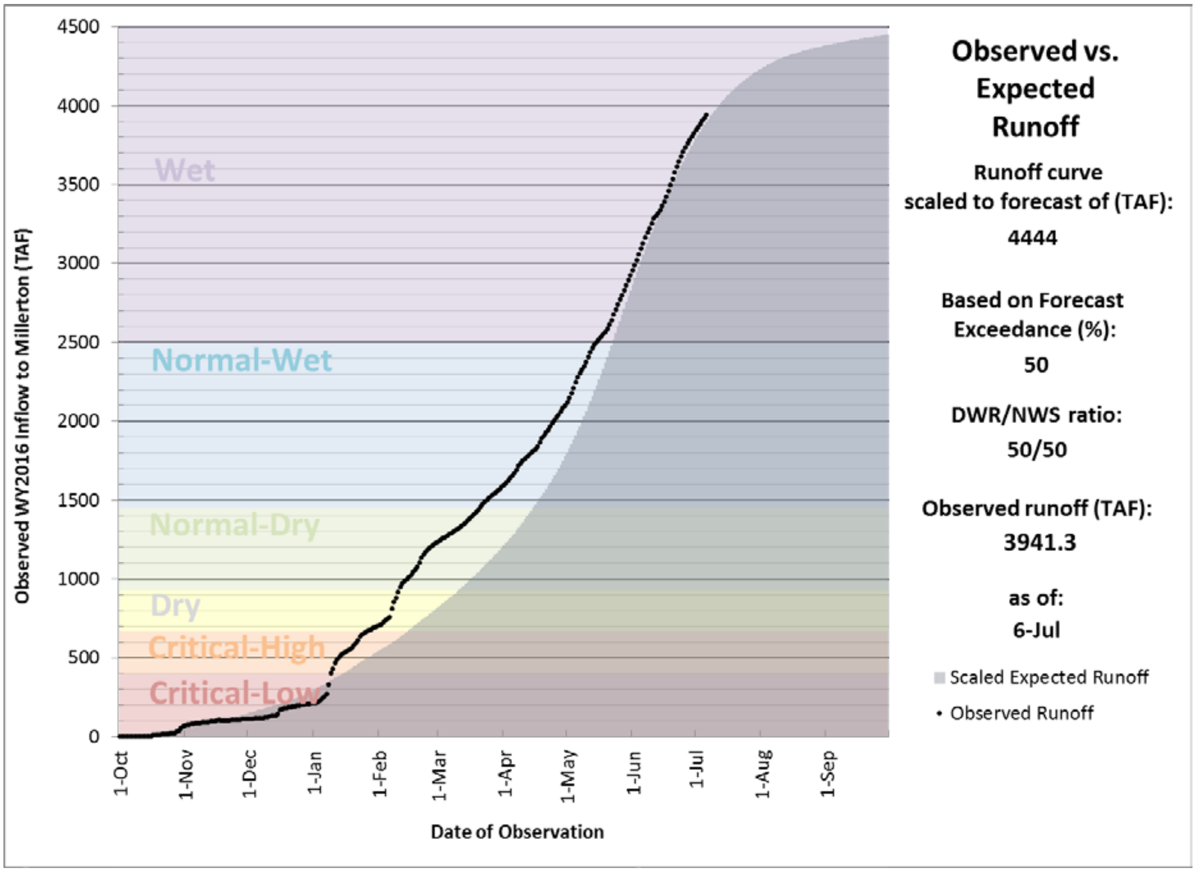


**Figure 2 — Observed Unimpaired Inflow trace shown with average Unimpaired Inflow curve scaled to the hybrid forecast value**

## Restoration Allocation

As per the current Guidelines, the 50% exceedance forecast is used for the final allocation under current hydrologic conditions to set the Restoration Flow Allocation. Table 3 below, from the Guidelines version 2.0, depicts the progression of forecast exceedance used to set the Restoration Allocation.

**Table 3 — Determining what Percent Exceedance Forecast to Use**

| | Value (TAF) | Date of Allocation Issuance | | | | | |
|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June |
| If the 50% forecast is: | Above 2200 | 50 | 50 | 50 | 50 | 50 | 50 |
| | 1100 to 2200 | 75 | 75 | 50 | 50 | 50 | 50 |
| | 900 to 1099 | 75 | 75 | 75 | 50 | 50 | 50 |
| | 700 to 899 | 90 | 90 | 75 | 50 | 50 | 50 |
| | 500 to 699 | 90 | 90 | 75 | 50 | 50 | 50 |
| | Below 500 | 90 | 90 | 90 | 90 | 75 | 50 |

Applying the 50/50 forecast blending determined by Reclamation, and using the 50% exceedance forecast dictated by the Guidelines, Reclamation calculates an **Unimpaired Inflow hybrid forecast of 4,444 TAF** and a **Wet Restoration Year Type**. This provides a **Restoration Allocation of 556.542 Thousand Acre-Feet (TAF)** as measured at Gravelly Ford (GRF). Combined with Holding Contracts on the San Joaquin River, this equates to a **Friant Dam Release of 673.488 TAF**. Future updates to the forecast are unlikely to change the Restoration Allocation. Other hypothetical allocations are presented in Table 4 as grayed values, and indicate that the range of probable forecasts results in the same Restoration Allocation.

**Table 4 — Restoration Year Type and Allocation for 2017 Restoration Year Shown with Other Hypothetical Values in Gray**

| | Forecast Probability of Exceedance using proposed blending | | | | |
|---|---|---|---|---|---|
| | 90% | 75% | **50%** | 25% | 10% |
| **Hybrid Unimpaired Inflow Forecast** (TAF) | 4,365 | 4,402 | **4,444** | 4,504 | 4,563 |
| **Restoration Year Type** | Wet | Wet | **Wet** | Wet | Wet |
| **Restoration Allocation at GRF** (TAF) | 556.542 | 556.542 | **556.542** | 556.542 | 556.542 |
| **Friant Dam Flow Releases** (TAF) | 673.488 | 673.488 | **673.488** | 673.488 | 673.488 |

# Default Flow Schedule

The Default Flow Schedule, known as Exhibit B in the Settlement, identifies how Reclamation will schedule the Restoration Allocation for the current Restoration Year Type and Unimpaired Inflow volume absent a recommendation from the Restoration Administrator. The Guidelines provides detail on how a Default Flow Schedule is derived 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 Hydrograph*

Table 5a shows the Exhibit B Method 3.1 default hydrograph flows and corresponding Restoration Allocation volumes for the entire year absent channel capacity constraints, including total releases from Friant Dam and Restoration Flows releases in excess of Holding Contracts.

Table 5b shows the Exhibit B Method 3.1 default hydrograph volumes with operational constraints, primarily controlled by a 1,120 cfs channel capacity constraint in Reach 2B. This default hydrograph depicted in Table 5b will be implemented in the absence of a specific recommendation by the Restoration Administrator. Due to levee stability related channel capacity constraints in Reach 2B that constrain Friant Dam releases, a Restoration Flow volume of **187.974 TAF** is generated that is not scheduled in the constrained Default Flow Schedule and would become Unreleased Restoration Flows (URFs) under the default hydrograph. This is an estimation, actual URF volumes will depend on the Restoration Administrator Recommendation and real-time assessment of groundwater seepage channel constraints.

## Table 5a — Default Hydrograph

| Flow Period | Flow (cfs) | | | | Volume (TAF) | |
|---|---|---|---|---|---|---|
| | Friant Dam Release | Holding Contracts[8] | 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 – Jun 30 [9] | 2000 | 190 | 1815 | 1810 | 241.983 | 218.995 |
| Jul 1 – Aug 31 | 350 | 230 | 125 | 120 | 43.041 | 14.757 |
| 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 – Dec 31 | 350 | 120 | 235 | 230 | 35.405 | 23.266 |
| Jan 1 – Feb 28 | 350 | 100 | 255 | 250 | 40.959 | 29.256 |
| | | | | **Totals** | **673.488** | **556.542** |

## Table 5b — Default Hydrograph with Channel Constraints

| Flow Period | Flow (cfs) | | | | Volume (TAF) | | |
|---|---|---|---|---|---|---|---|
| | Friant Dam Release | Holding Contracts [7] | Flow Target at GRF | Restoration Flow at GRF | Friant Dam Release | Restoration Flow at GRF | URF [8] |
| Mar 1 – Mar 15 | 500 | 130 | 375 | 370 | 14.876 | 11.008 | 0 |
| Mar 16 – Mar 31 | 1390 | 130 | 1265 | 1260 | 44.112 | 39.987 | 3.491 |
| Apr 1 – Apr 15 | 1390 | 150 | 1245 | 1240 | 41.355 | 36.893 | 33.025 |
| Apr 16 – Apr 30 | 1390 | 150 | 1245 | 1240 | 41.355 | 36.893 | 77.653 |
| May 1 – Jun 30 [9] | 1390 | 190 | 1205 | 1200 | 168.179 | 145.190 | 73.805 |
| Jul 1 – Aug 31 | 350 | 230 | 125 | 120 | 43.041 | 14.757 | 0 |
| Sep 1 – Sep 30 | 350 | 210 | 145 | 140 | 20.826 | 8.331 | 0 |
| Oct 1 – Oct 31 | 350 | 160 | 195 | 190 | 21.521 | 11.683 | 0 |
| Nov 1 – Nov 6 | 700 | 130 | 575 | 570 | 8.331 | 6.783 | 0 |
| Nov 7 – Nov 10 | 700 | 130 | 575 | 570 | 5.554 | 4.522 | 0 |
| Nov 11 – Dec 31 | 350 | 120 | 235 | 230 | 35.405 | 23.266 | 0 |
| Jan 1 – Feb 28 | 350 | 100 | 255 | 250 | 40.959 | 29.256 | 0 |
| | | | | **Totals** | **485.514** | **368.569** | **187.974** [8] |

[7] 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.

[8] This estimate of URF volume is based solely on Reach 2B channel capacity. Other flow and seepage constraints throughout the restoration area may result in higher actual URFs.

[9] Riparian Recruitment releases in Wet Restoration Year Types are included in the May 1 – June 30 flow period

## *Exhibit B Restoration Flow Budget*

Table 6 shows the components of the restoration budget for March 1, 2017, through February 28, 2018 (i.e. the Restoration Year). The base flow allocation, spring flexible flow, fall flexible flow, and riparian recruitment flow reflect the Exhibit B hydrograph for the Restoration Allocation. The estimated total release at Friant Dam consists of 116,945 acre-feet release for Holding Contracts in addition to the Restoration Flows as measured at Gravelly Ford (GRF). The volume for Restoration Flows as well as various accounting flow components may change with any subsequent Restoration Allocation.

## Table 6 — Restoration Budget with Flow Accounts

| Flow Period | Holding Contract Demand [10] (TAF) | Restoration Flow Accounting Volumes (TAF) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Spring Flexible Flow | Summer Base Flow | Fall Flexible Flow | Winter Base Flow | Riparian Recruit-ment Flow | Buffer Flow | Flexible Buffer Flow |
| Mar 1 – Mar 15 | 3.868 | 11.008 | – | – | – | -– | 1.488 | – |
| Mar 16 – Mar 31 | 4.126 | 43.478 | – | – | – | – | 4.760 | – |
| Apr 1 – Apr 15 | 4.463 | 69.917 | – | – | – | – | 7.438 | – |
| Apr 16 – Apr 30 | 4.463 | 114.545 | – | – | – | – | 11.901 | – |
| May 1 – May 28 | 10.552 | 0 | 8.886 | – | – | 199.636 within 60-90 days of flushing flow | 24.198 | Of which 5.000 may be applied Mar 1–May 1, or Oct 1–Nov 30 |
| May 29 – Jun 30 | 12.436 | – | 10.472 | – | – | | | |
| Jul 1 – Aug 31 | 28.284 | – | 14.757 | – | – | | 4.304 | |
| Sep 1 – Sep 30 | 12.496 | – | 8.331 | 0 | – | – | 2.083 | |
| Oct 1 – Oct 31 | 9.838 | – | – | 11.683 | – | – | 2.152 | Of which 7.081 may be applied Sep 3–Dec 28 |
| Nov 1 – Nov 6 | 1.547 | – | – | 6.783 | – | – | 0.833 | |
| Nov 7 – Nov 10 | 1.031 | – | – | 4.522 | – | – | 0.555 | |
| Nov 11 – Nov 30 | 4.760 | – | – | 9.124 | – | – | 1.388 | |
| Dec 1 – Dec 31 | 7.379 | – | – | 0 | 14.142 | – | 2.152 | |
| Jan 1 – Jan 31 | 6.149 | – | – | – | 15.372 | – | 2.152 | – |
| Feb 1 – Feb 28 | 5.554 | 0 | – | – | 13.884 | – | 1.944 | – |
| | **116.946** [10] | **238.949** | **42.447** | **32.112** | **43.398** | **199.636** | **67.349** | |
| | | **556.542** (Restoration Flow Volume) | | | | | | |
| | **673.488** [10] (Friant Dam Release Volume) | | | | | | | |

[10] In recent years, Holding Contract demands have been higher than assumed under Exhibit B of the Settlement, in which case, flows at Friant Dam are increased to achieve the Gravelly Ford Flow Target, and associated Friant Dam Release Volume is greater.

## Remaining Flexible Flow Volume

The amount of water remaining for flexible flow scheduling is the volume of flexible flow water released from Friant Dam in excess of releases required to meet Holding Contract demands, less past releases. Table 7 tracks these balances. The released to date volumes are derived from QA/QC daily average data when available, and partly from provisional data posted to CDEC, and thus may have future adjustments. This may affect the remaining flow volume as well.

**Table 7 — Estimated Flexible Flow Volume Remaining and Released to Date**

| **Flow Account** | **Yearly Allocation** [11] (TAF) | **Released to Date** [12] (TAF) | **Remaining Flow Volume** [12,13] (TAF) |
|---|---|---|---|
| Spring Period (Mar 1 – Apr 30) | 238.949 | 49.607 [14] | 0 |
| Riparian Recruitment | 199.636 | 23.673 [14] | 0 |
| Summer Base Flows (May 1 – Sep 30) | 42.447 | 20.787 [14] | 21.660 |
| Fall Period (Oct 1 – Nov 30) | 32.112 | 0 | 32.112 |
| Winter Base Flows (Dec 1 – Feb 28) | 43.398 | 0 | 43.398 |
| Buffer Flows | 67.349 | 0 | 17.077 |
| Unreleased Restoration Flows | — | 364.967 | 0.338 |
| Purchased Water | — | 0 | 0 |
| | **Total:** | **459.272** | |

[11] Flow Volumes assume no channel constraints, as measured at Gravelly Ford

[12] As of 7/6/2017.

[13] Restoration Flow Guidelines limit the application of the calculated Remaining Flow Volume to certain times, and thus all of this volume may not be available for use.

[14] This volume of Restoration Flows was met by flood flows

## 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 8 summarizes known 2017 operational constraints.

**Table 8 — Summary of Operational Constraints**

| Constraint | Period | Flow Limitation |
|---|---|---|
| Levee Stability | Currently in effect | 1,120 cfs in Reach 2B |
| | Currently in effect | 580 – 1,070 cfs in Eastside Bypass |
| Channel Conveyance / Seepage Limitation | Currently in effect | Approximately 300 cfs below Sack Dam / Reach 4A |

The 2017 Restoration Year Channel Capacity Report identifies a maximum flow in Reach 2B of 1,120 cfs. This results in a maximum release from Friant Dam between 1,360 cfs and 1,490 cfs depending on the time of year. The 2017 Restoration Year Channel Capacity Report also identifies a maximum flow in the Middle Eastside Bypass of 580 to 1,070 cfs, depending on the configuration of the weirs at the Merced National Wildlife Refuge. Reclamation will coordinate with the Restoration Administrator through the biweekly Flow Scheduling conference calls and on an as-needed basis to update these constraints.

In addition, flows are limited to approximately 300 cfs below Sack Dam into Reach 4A due to groundwater seepage constraints as per the current Seepage Management Plan. The exact flow rate which can be accommodated through Reach 4A is dependent on groundwater levels and will be determined through Flow Bench Evaluations. Flows are expected to be constrained to approximately 300 cfs through the spring period below Sack Dam, with the possibility of approximately 500 cfs below Sack Dam in late 2017. If flows must be reduced at Sack Dam as compared to upstream flow rates, Reclamation will make arrangements to capture excess Restoration Flows at approved points of rediversion such as Mendota Pool, upstream of Sack Dam.

Reclamation will complete a Flow Bench Evaluation prior to any flow increases to verify the scheduled increase is not anticipated to cause groundwater levels to rise above thresholds. Should the requested flow increase trigger projected groundwater level rises above seepage thresholds, Reclamation will inform the Restoration Administrator of the current constraint. After two weeks at this constraint, or once groundwater levels have stabilized at this level, Reclamation will complete another Flow Bench Evaluation to determine if further increases in flow are permitted, and if so will allow increases in six inch stage increments, based on one-dimensional hydraulic modeling, to avoid potential groundwater seepage impacts.

# Appendix A: Abbreviations, Acronyms, and Glossary

| | |
|---|---|
| af | acre–feet |
| 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 Flow Schedules |
| 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 |
| TAF | thousand acre–feet |
| URF | Unreleased Restoration Flows |
| WSI | DWR Water Supply Index |
| WY | water year, October 1 through September 30 |

# Appendix B: History of Millerton Unimpaired Inflow

## Table B — Water Year Totals in Thousand Acre-Feet

| Water Year [1] | Unimpaired Inflow [2] (Natural River) | SJRRP Restoration Year Type [3] |
|---|---|---|
| 1931 | 480.2 | Critical-High |
| 1932 | 2,047.4 | Normal-Wet |
| 1933 | 1,111.4 | Normal-Dry |
| 1934 | 691.5 | Dry |
| 1935 | 1,923.2 | Normal-Wet |
| 1936 | 1,853.3 | Normal-Wet |
| 1937 | 2,208.0 | Normal-Wet |
| 1938 | 3,688.4 | Wet |
| 1939 | 920.8 | Dry |
| 1940 | 1,880.6 | Normal-Wet |
| 1941 | 2,652.5 | Wet |
| 1942 | 2,254.0 | Normal-Wet |
| 1943 | 2,053.7 | Normal-Wet |
| 1944 | 1,265.4 | Normal-Dry |
| 1945 | 2,134.633 | Normal-Wet |
| 1946 | 1,727.115 | Normal-Wet |
| 1947 | 1,121.564 | Normal-Dry |
| 1948 | 1,201.390 | Normal-Dry |
| 1949 | 1,167.008 | Normal-Dry |
| 1950 | 1,317.457 | Normal-Dry |
| 1951 | 1,827.254 | Normal-Wet |
| 1952 | 2,840.854 | Wet |
| 1953 | 1,226.830 | Normal-Dry |
| 1954 | 1,313.993 | Normal-Dry |
| 1955 | 1,161.161 | Normal-Dry |
| 1956 | 2,959.812 | Wet |
| 1957 | 1,326.573 | Normal-Dry |
| 1958 | 2,631.392 | Wet |
| 1959 | 949.456 | Normal-Dry |
| 1960 | 826.021 | Dry |
| 1961 | 647.428 | Critical-High |
| 1962 | 1,924.066 | Normal-Wet |
| 1963 | 1,945.266 | Normal-Wet |
| 1964 | 922.351 | Dry |
| 1965 | 2,271.191 | Normal-Wet |
| 1966 | 1,298.792 | Normal-Dry |
| 1967 | 3,233.097 | Wet |
| 1968 | 861.894 | Dry |
| 1969 | 4,040.864 | Wet |
| 1970 | 1,445.837 | Normal-Dry |
| 1971 | 1,416.812 | Normal-Dry |
| 1972 | 1,039.249 | Normal-Dry |
| 1973 | 2,047.585 | Normal-Wet |
| 1974 | 2,190.308 | Normal-Wet |
| 1975 | 1,795.922 | Normal-Wet |
| 1976 | 629.234 | Critical-High |
| 1977 | 361.253 | Critical-Low |
| 1978 | 3,402.805 | Wet |
| 1979 | 1,829.988 | Normal-Wet |
| 1980 | 2,973.169 | Wet |
| 1981 | 1,067.757 | Normal-Dry |
| 1982 | 3,317.171 | Wet |
| 1983 | 4,643.090 | Wet |
| 1984 | 2,042.750 | Normal-Wet |
| 1985 | 1,135.975 | Normal-Dry |
| 1986 | 3,031.600 | Wet |
| 1987 | 756.853 | Dry |
| 1988 | 862.124 | Dry |
| 1989 | 939.168 | Normal-Dry |
| 1990 | 742.824 | Dry |
| 1991 | 1,027.209 | Normal-Dry |
| 1992 | 807.759 | Dry |
| 1993 | 2,672.322 | Wet |
| 1994 | 824.097 | Dry |
| 1995 | 3,876.370 | Wet |
| 1996 | 2,200.707 | Normal-Wet |
| 1997 | 2,817.670 | Wet |
| 1998 | 3,160.759 | Wet |
| 1999 | 1,527.040 | Normal-Wet |
| 2000 | 1,735.653 | Normal-Wet |
| 2001 | 1,065.318 | Normal-Dry |
| 2002 | 1,171.457 | Normal-Dry |
| 2003 | 1,449.954 | Normal-Dry |
| 2004 | 1,130.823 | Normal-Dry |
| 2005 | 2,826.872 | Wet |
| 2006 | 3,180.816 | Wet |
| 2007 | 684.333 | Dry |
| 2008 | 1,116.790 | Normal-Dry |
| 2009 | 1,455.379 | Normal-Wet |
| 2010 | 2,028.706 | Normal-Wet |
| 2011 | 3,304.824 | Wet |
| 2012 | 831.582 | Dry |
| 2013 | 856.626 | Dry |
| 2014 | 509.579 | Critical-High |
| 2015 | 327.410 | Critical-Low |
| 2016 | 1,300.986 | Normal-Dry |
| | | |
| | | |
| | | |
| | | |

[1] Water year is from Oct 1 through Sept 30, for example the 2010 water year began Oct 1, 2009.

[2] Also known as “Natural River” or “Unimpaired Inflow 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.

[3] The six SJRRP Restoration Year Types are based on unimpaired inflow. 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 C: Previous Year (2016) Flow Accounting

**Table C-1** — Restoration Flow Accounting and Unreleased Restoration Flows excluding Restoration Flows met by flood flows, Unreleased Restoration Flows lost to flood spill, and Holding Contracts during flood flows. For the period February, 2016 through February, 2017.

<table>
<tr><th rowspan="2">Flow Period</th><th rowspan="2">Holding Contract Demand (TAF)</th><th colspan="7">Released Restoration Flow Volumes (TAF)</th><th rowspan="2">URFs (TAF)</th></tr>
<tr><th>Spring Flexible Flow</th><th>Summer Base Flow</th><th>Fall Flexible Flow</th><th>Winter Base Flow</th><th>Riparian Recruit-ment Flow</th><th>Buffer Flow</th><th>Flexible Buffer Flow</th></tr>
<tr><td>Feb 1 – Feb 15</td><td>–</td><td>0</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>Feb16 – Feb 29</td><td>5.939</td><td>1.835</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>Mar 1 – Mar 15</td><td>1.607</td><td>2.521</td><td>–</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td><td>–</td></tr>
<tr><td>Mar 16 – Mar 31</td><td>3.735</td><td>2.541</td><td>–</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td><td>–</td></tr>
<tr><td>Apr 1 – Apr 15</td><td>4.852</td><td>3.834</td><td>–</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td><td>–</td></tr>
<tr><td>Apr 16 – Apr 30</td><td>6.488</td><td>2.555</td><td>–</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td><td>–</td></tr>
<tr><td>May 1 – May 28</td><td>12.891</td><td>0</td><td>5.080</td><td>–</td><td>–</td><td rowspan="3">0</td><td rowspan="2">0</td><td rowspan="4">0</td><td>89.473</td></tr>
<tr><td>May 29 – Jun 30</td><td>15.087</td><td>–</td><td>5.413</td><td>–</td><td>–</td><td>4.696</td></tr>
<tr><td>Jul 1 – Aug 31</td><td>32.658</td><td>–</td><td>18.260</td><td>–</td><td>–</td><td>0</td><td>19.999</td></tr>
<tr><td>Sep 1 – Sep 30</td><td>13.140</td><td>–</td><td>11.925</td><td>0</td><td>–</td><td>–</td><td>0</td><td>24.421</td></tr>
<tr><td>Oct 1 – Oct 31</td><td>13.314</td><td>–</td><td>–</td><td>11.044</td><td>–</td><td>–</td><td>0</td><td rowspan="5">0</td><td>6.546</td></tr>
<tr><td>Nov 1 – Nov 6</td><td>2.017</td><td>–</td><td>–</td><td>3.037</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Nov 7 – Nov 10</td><td>1.805</td><td>–</td><td>–</td><td>1.484</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Nov 11 – Nov 30</td><td>5.988</td><td>–</td><td>–</td><td>5.915</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Dec 1 – Dec 31</td><td>9.854</td><td>–</td><td>–</td><td>0</td><td>3.435</td><td>–</td><td>0</td><td>7.105</td></tr>
<tr><td>Jan 1 – Jan 31</td><td>1.922</td><td>–</td><td>–</td><td>–</td><td>0.438</td><td>–</td><td>0</td><td>–</td><td>–</td></tr>
<tr><td>Feb 1 – Feb 28</td><td>0</td><td>0</td><td>–</td><td>–</td><td>0</td><td>–</td><td>0</td><td>–</td><td>–</td></tr>
<tr><td></td><td rowspan="4">131.297</td><td>13.285</td><td>40.677</td><td>21.479</td><td>3.873</td><td>0</td><td rowspan="2">0.000</td><td rowspan="3"></td><td rowspan="3">152.240</td></tr>
<tr><td></td><td colspan="5">79.315</td></tr>
<tr><td></td><td colspan="6">79.315</td></tr>
<tr><td></td><td colspan="8">231.555</td></tr>
<tr><td></td><td colspan="9">362.852</td></tr>
</table>

**Table C-2** — Restoration Flow Accounting and Unreleased Restoration Flows <u>including</u> Restoration Flows met by flood flows, Unreleased Restoration Flows lost to flood spill, and Holding Contracts during flood flows. For the period February, 2016 through February, 2017.

| Flow Period | Holding Contract Demand (TAF) | Released Restoration Flow Volumes (TAF) | | | | | | | URFs (TAF) |
|---|---|---|---|---|---|---|---|---|---|
| | | Spring Flexible Flow | Summer Base Flow | Fall Flexible Flow | Winter Base Flow | Riparian Recruit-ment Flow | Buffer Flow | Flexible Buffer Flow | |
| Feb 1 – Feb 15 | – | 0 | – | – | – | – | – | – | – |
| Feb16 – Feb 29 | 5.939 | 1.835 | – | – | – | – | – | – | – |
| Mar 1 – Mar 15 | 1.607 | 2.521 | – | – | – | – | 0 | – | – |
| Mar 16 – Mar 31 | 3.735 | 2.541 | – | – | – | – | 0 | – | – |
| Apr 1 – Apr 15 | 4.852 | 3.834 | – | – | – | – | 0 | – | – |
| Apr 16 – Apr 30 | 6.488 | 2.555 | – | – | – | – | 0 | – | – |
| May 1 – May 28 | 12.891 | 0 | 5.080 | – | – | 0 | 0 | 0 | 89.473 |
| May 29 – Jun 30 | 15.087 | – | 5.413 | – | – | | | | 4.696 |
| Jul 1 – Aug 31 | 32.658 | – | 18.260 | – | – | | 0 | | 19.999 |
| Sep 1 – Sep 30 | 13.140 | – | 11.925 | 0 | – | – | 0 | | 24.421 |
| Oct 1 – Oct 31 | 13.314 | – | – | 11.044 | – | – | 0 | 0 | 6.546 |
| Nov 1 – Nov 6 | 2.017 | – | – | 3.037 | – | – | 0 | | – |
| Nov 7 – Nov 10 | 1.805 | – | – | 1.484 | – | – | 0 | | – |
| Nov 11 – Nov 30 | 5.988 | – | – | 5.915 | – | – | 0 | | – |
| Dec 1 – Dec 31 | 9.854 | – | – | 0 | 3.435 | – | 0 | | 7.105 |
| Jan 1 – Jan 31 | 24.466 | – | – | – | 9.866 | – | 0 | – | – |
| Feb 1 – Feb 28 | 9.634 | – | – | – | 13.885 | – | 0 | – | 8.428 |
| | **162.475** | **13.285** | **40.677** | **21.479** | **27.186** | **0** | **0.000** | | **160.668** |
| | | **102.627** | | | | | | | |
| | | **102.627** | | | | | | | |
| | | **263.295** | | | | | | | |
| | **426.770** | | | | | | | | |