Bureau of Reclamation
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Updated 2019 Restoration Allocation & Default Flow Schedule

February 26, 2019

Introduction

The following transmits an updated 2019 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 provides 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 Flow," and is utilized to identify the Water 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 6a) and the Default Flow Schedule with constraints (Table 6b) will be used respectively.

This is the third Restoration Allocation for 2019, and reflects the significantly wetter hydrology over the past two weeks. The Restoration Allocation will be updated regularly until the end of June, and thus the allocation to the program will vary with the unfolding hydrology. Depending on the exceedance forecast used to set the allocation, which is dictated by the Restoration Flow Guidelines, the Restoration Allocation may expand and may shrink. Any adjustments to the allocation volume must be managed by the Restoration Administrator such that the Allocation volume is not exceeded and the scheduling of the water does not result in a water delivery reduction to any Friant long-term contractor beyond what is agreed upon in Exhibit B of the Settlement.

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 or Full Natural Flow) into Millerton Lake to support the water supply allocation[1];
- 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)[3];
- The National Weather Service (NWS) Ensemble Streamflow Prediction (ESP) Water Supply Forecast for the San Joaquin River at Millerton Lake[5].

Table 1 shows the water year 2019 (October 1, 2018 to September 30, 2019) observed accumulated and forecasted water year Unimpaired Inflows at Millerton Lake. This table includes the published DWR forecast, the DWR forecast adjusted for 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 finally the NWS forecast with 7-day smoothing and adjusted for expected runoff for the current month. Figure 1a plots DWR and NWS forecast values over the entire water year, while Figure 1b shows the most recent period in detail.

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

	Forecast Exceedance Percentile				
	90%	**75**%	**50**%	**25**%	**10**%
Accumulated "Natural River" Unimpaired Inflow, February 21, 2019 [1]	323.0 TAF				
Accumulated Unimpaired Inflow as percent of normal	106%				
DWR, Feb 19, 2019 [3] (Published Value)	1,716 TAF	2,017 TAF [7]	2,274 TAF	2,619 TAF [7]	2,999 TAF
DWR, Feb 19, 2019 [4] (Runoff Adjusted)	1,728 TAF	2,019 TAF	2,266 TAF	2,601 TAF	2,971 TAF
NWS, Feb 20, 2019 (Published Daily Value [5])	2,100 TAF	2,180 TAF	2,380 TAF	2,730 TAF	3,160 TAF
Smoothed NWS, Feb 20, 2019 (7-day Smoothing [6])	2,136 TAF	2,243 TAF	2,426 TAF	2,756 TAF	3,200 TAF
Smoothed NWS, Feb 20, 2019 (Runoff Adjusted [4])	2,135 TAF	2,247 TAF	2,426 TAF	2,753 TAF	3,188 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 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: $((Forecast_n * 1) + (Forecast_{n-1} * 0.857) + (Forecast_{n-2} * 0.714) + (Forecast_{n-3} * 0.571) + (Forecast_{n-4} * 0.429) + (Forecast_{n-5} * 0.286) + (Forecast_{n-6} * 0.143)) / 4$

[7] These are interpolated values as the complete DWR forecast was not available with the most recent issuance.

The 2019 water year has now recorded five major storm series. The most recent storm series (February 13-18) began as a warm storm, melting some of the low elevation snowpack, and concluded with cold temperatures, again bringing snow to low elevations. The DWR forecast for February 19 is based on snow courses measured around February 1 and adjusted by DWR using automated snow pillows in the intervening days. The current NWS runoff forecast includes all modeled precipitation to date plus forecasted conditions over the next 15 days. There continues to be fair agreement between the DWR and NWS forecasts, and DWR has raised its 10% exceedance forecast to be more in-line with the NWS forecast.

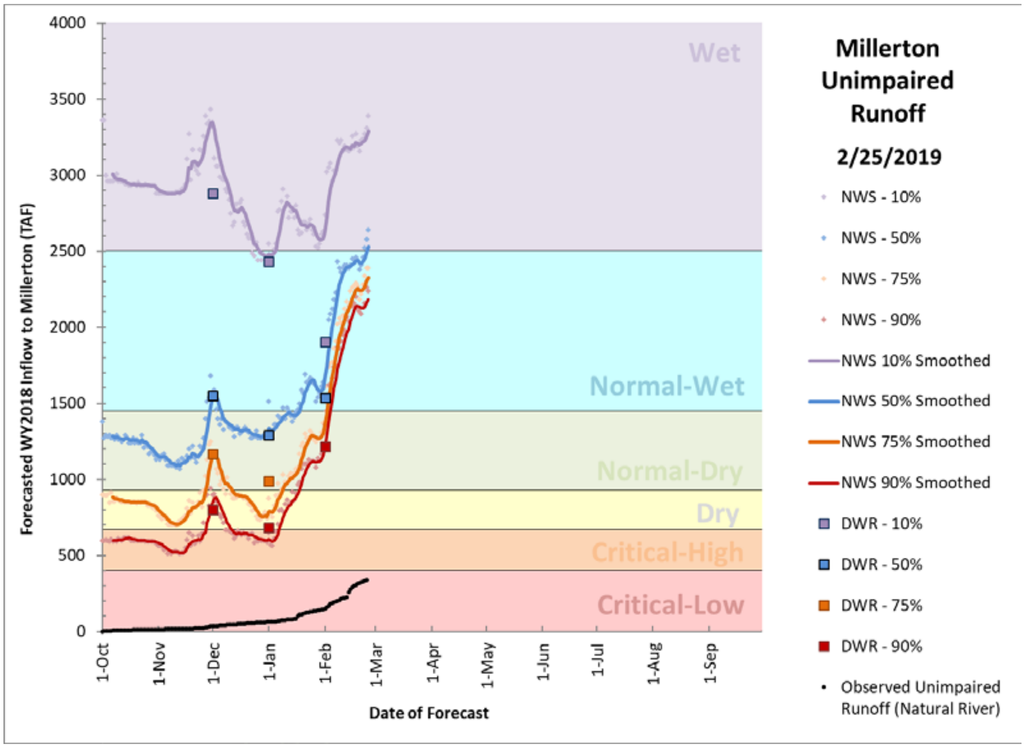

Figure 1a — Plot of 2019 Water Year forecasts, including both NWS Ensemble Streamflow Prediction Forecasts and DWR Forecasts

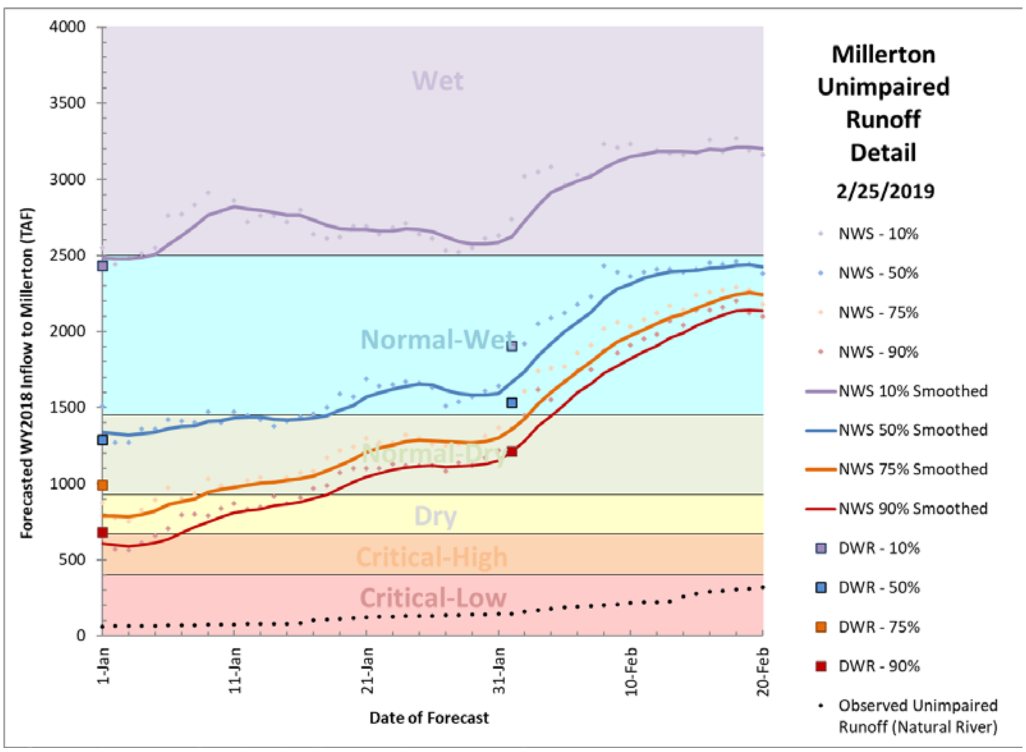

Figure 1b — Detail plot of most recent forecasts

Runoff response in the Central Sierra Nevada has indicated that soils have been saturated at low elevations (roughly below 5,000’). Natural River and tributary response to the recent storm events indicate that soil moisture conditions in the San Joaquin may be slightly drier than the watersheds to the north, but should be similar in their future response to precipitation. The lack of automated snow pillows at low elevations results in uncertainty over how much of the low elevation snowpack melted in the warm phase of the previous storm series, or how much accumulated during the cold phase.

Three snowpack models were available with synchronized updates on February 19. A forth model, the iSnobal model generated by ARS, was updated on February 12 and then adjusted by Reclamation using estimated snowpack accumulation between February 12 and February 19. These models are presented in Table 2 along with a consensus estimate. NASA Airborne Snow Observatory data was not yet available. The melt from this estimated snowpack will be the primary influence of April through July Unimpaired Inflow. The surface water input from snowmelt, multiplied by a mean runoff ratio, will result in actual runoff during this period. For Normal-Wet year types, runoff ratios between 70% and 80% would be a reasonable assumption.

Table 2 — Total snowpack volume depicted by four models and a consensus estimate.

Date	CNRFC	NOHRSC	CU Boulder	ARS	Reclamation Consensus
February 19, 2019	2,241 TAF	1,872 TAF	2,178 TAF	1,712TAF	2,075 TAF

The 15-day forecast calls for above normal precipitation and cool temperatures (but a warming trend). This is supported by the phase of the Madden Julian Oscillation (MJO), indicating enhanced probability of a wet conditions in week 2. Precipitation and temperature outlooks are shown in Figure 2.

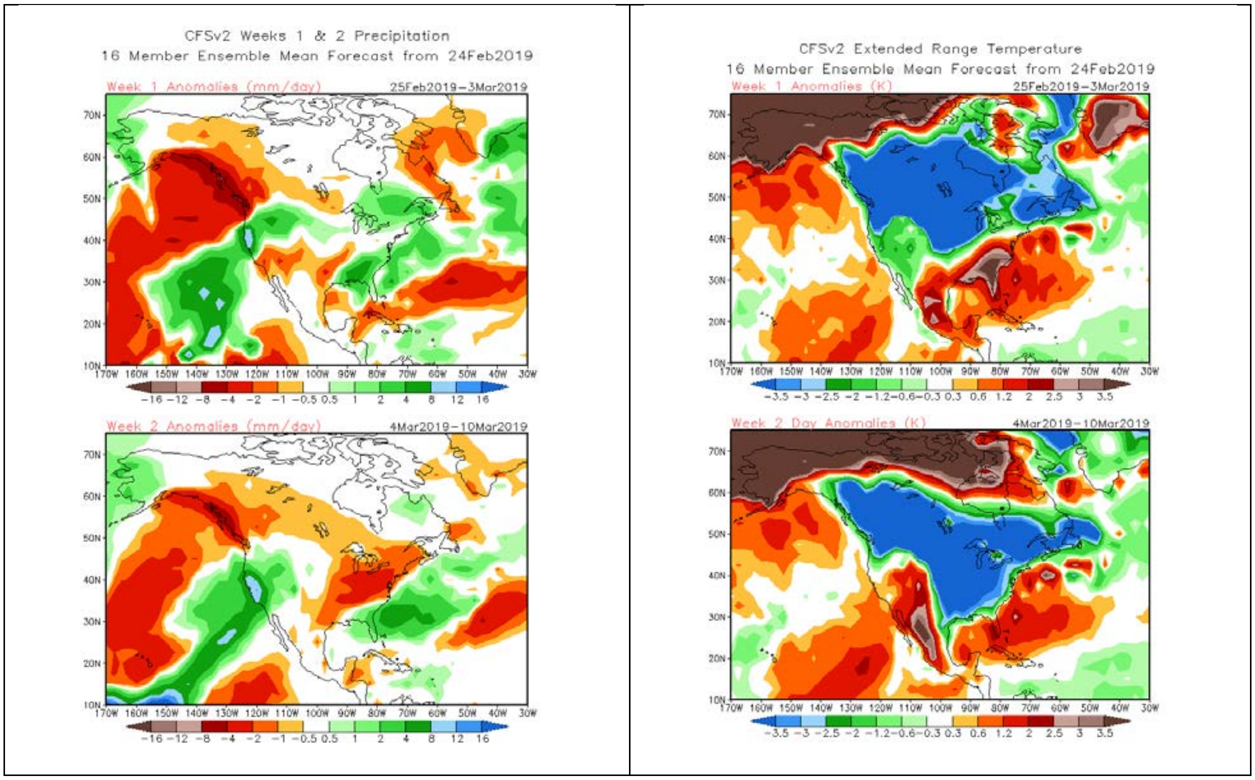

Figure 2 — CFS v2 model output from February 24 showing wet conditions in week 2 (left half) and cool conditions in week 1 and warmer in week 2 (right half).

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Combining Forecasts

Staff from the South-Central California Area Office of Reclamation and SJRRP jointly track and evaluate the accuracy of runoff forecasts. Based on the age of these forecasts, the short-term and long-term weather forecasts, the climatological outlook, 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 runoff adjusted" forecasts are combined with a 40/60 blending respectively**. This results in the Hybrid Unimpaired Inflow Forecasts shown in Table 3.

Table 3 — Current Blending and Hybrid Unimpaired Inflow Forecast

	Forecast Probability of Exceedance using blending				
	90%	**75**%	**50**%	**25**%	**10**%
Blending Ratio (DWR/NWS)	40/60				
Hybrid Unimpaired Inflow Forecast (TAF)	1,965	2,153	2,362	2,696	3,112

This blending is chosen based on the historic performance of the DWR and NWS forecasts during this time of the year, the accuracy of these forecasts in predicting monthly unimpaired inflow over the recent months, snow measurement and snowpack models, the long-range forecasted conditions over the current month, the seasonal climate outlook, and other performance factors. The DWR B120 forecast is given slightly lower weight primarily due to the confidence in a continued wet pattern, which has been incorporated into the NWS forecast. There is a high degree of certainty that runoff will meet or nearly meet the 90% blended forecast, even with little additional precipitation.

Restoration Allocation

As per the current Guidelines, the **50% exceedance** forecast is used for the allocation under current hydrologic conditions to set the Restoration Flow Allocation. Table 4 below, from the Guidelines version 2.0, depicts the progression of forecast exceedance used to set the Restoration Allocation.

Table 4 — Guidance on Percent Exceedance Forecast to Use for Allocation

		Date of Allocation Issuance					
	Value (TAF)	**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 40/60 forecast blending determined by Reclamation and, using the 50% exceedance forecast dictated by the Guidelines, Reclamation calculates an **Unimpaired Inflow hybrid forecast of 2,362 TAF** and a **Normal-Wet Water Year Type**. This provides a **Restoration Allocation of 411.122 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 528.265 TAF**. Future updates to these forecasts and their blending will alter the Restoration Allocation multiple times before it is finalized at the end of June. Other hypothetical allocations are presented in Table 5 as grayed values and indicate the range of probable forecasts and the resultant Restoration Allocation.

Table 5 — SJRRP Water Year Type and Allocation for 2019 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)	1,965	2,153	**2,362**	2,696	3,112
Water Year Type	Normal-Wet	Normal-Wet	**Normal-Wet**	Wet	Wet
Restoration Allocation at GRF (TAF)	355.504	381.842	**411.122**	556.542	556.542
Friant Dam Flow Releases (TAF)	472.647	498.985	**528.265**	673.686	673.686

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 Inflow 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 Hydrograph

Table 6a shows the 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. Volume is distributed as various flow rates across the year as per the "Method 3.1."

Table 6b shows the Default Hydrograph volumes with operational constraints, primarily controlled by a 1,210 cfs channel constraint in Reach 2B. This Default Hydrograph depicted in Table 6b 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 **107.505 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 estimated volume of water, actual URF volumes will depend on the Restoration Administrator Recommendation and real-time assessment of groundwater seepage channel constraints.

Table 6a — Default Hydrograph

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
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]	798	190	613	608	96.563	73.574
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	120	575	570	5.554	4.522
Nov 11 – Dec 31	350	120	235	230	35.405	23.266
Jan 1 – Feb 29 [10]	341	100	246	241	40.959	29.256
				Totals	**528.265** [10]	**411.122**

Table 6b — 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	1450	130	1325	1320	46.017	41.891	1.587
Apr 1 – Apr 15	1470	150	1325	1320	43.736	39.273	30.645
Apr 16 – Apr 30	1470	150	1325	1320	43.736	39.273	75.273
May 1 – Jun 30 [9]	798	190	613	608	96.563	73.574	0
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	120	575	570	5.554	4.522	0
Nov 11 – Dec 31	350	120	235	230	35.405	23.266	0
Jan 1 – Feb 29 [10]	341	100	246	241	40.959	29.256	0
				Totals	**420.763** [10]	**303.617**	**107.505** [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 and is dependent on the Restoration Administrator's recommendation.

[9] If the current draft Restoration Flow Guidelines are implemented before May 1, 54.216 TAF of Riparian Recruitment Flow volume would be scheduled between May 1 and May 10 instead of May 1 through June 30 and would then be considered spring period water for accounting purposes.

[10] Because of leap year, minor adjustments in the February flow rate are required to preserve the allocation volume. The volume of Holding Contracts is increased by 0.198 TAF due to the extra day.

Exhibit B Restoration Flow Budget

Table 7 shows the components of the restoration budget for March 1, 2019, through February 28, 2020 (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 current Restoration Allocation. The estimated total release at Friant Dam consists of 117.143 TAF release for Holding Contracts (0.198 TAF higher because of leap year) in addition to the Restoration Flows as measured at Gravelly Ford. The volume for Restoration Flows as well as various accounting flow components may change with any subsequent Restoration Allocation.

Table 7 — Restoration Budget with Flow Accounts

<table>
<tr><th rowspan="2">Period</th><th rowspan="2">Holding Contract Demand [7] (TAF)</th><th colspan="7">Restoration Flow Accounting Volumes (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 [9]</th><th>Buffer Flow</th><th>Flexible Buffer Flow</th></tr>
<tr><td>Mar 1 – Apr 30</td><td>16.920</td><td>238.949</td><td>–</td><td>–</td><td>–</td><td>-–</td><td>25.587</td><td>–</td></tr>
<tr><td>May 1 – May 28</td><td>10.552</td><td>0</td><td rowspan="4">42.447</td><td>–</td><td>–</td><td rowspan="2">54.216</td><td rowspan="4">16.043</td><td rowspan="4">Of which 5.000 may be applied Mar 1–Apr 30, or Oct 1–Nov 30</td></tr>
<tr><td>May 29 – Jul 29</td><td>25.666</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>Jul 30 – Sept 2</td><td>15.888</td><td>–</td><td>–</td><td>–</td><td></td></tr>
<tr><td>Sep 3 – Sep 30</td><td>11.663</td><td>–</td><td>0</td><td>–</td><td>–</td></tr>
<tr><td>Oct 1 – Nov 30</td><td>17.176</td><td>–</td><td>–</td><td>32.112</td><td>–</td><td>–</td><td rowspan="2">7.080</td><td rowspan="2">7.080 may be applied Sep 3–Dec 28</td></tr>
<tr><td>Dec 1 – Dec 31</td><td>7.379</td><td>–</td><td>–</td><td>0</td><td rowspan="2">43.398</td><td>–</td></tr>
<tr><td>Jan 1 – Feb 28</td><td>11.703</td><td>–</td><td>–</td><td>–</td><td>–</td><td>4.096</td><td>–</td></tr>
<tr><td></td><td rowspan="3">117.143 [10]</td><td>238.949</td><td>42.447</td><td>32.112</td><td>43.398</td><td>54.216</td><td rowspan="2">52.807</td><td></td></tr>
<tr><td></td><td colspan="5">411.122 (Base Flow Volume)</td><td></td></tr>
<tr><td></td><td colspan="6">463.929 (Restoration Flow Volume)</td><td></td></tr>
<tr><td></td><td colspan="6">528.265 [10] (Friant Dam Release Volume)</td><td colspan="2"></td></tr>
</table>

[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.

[9] If the current draft Restoration Flow Guidelines are implemented before May 1, 54.216 TAF of Riparian Recruitment Flow volume would be scheduled between May 1 and May 10 instead of May 1 through June 30 and would then be considered spring period water for accounting purposes.

[10] Because of leap year, minor adjustments in the February flow rate are required to preserve the allocation volume. The volume of Holding Contracts is increased by 0.198 TAF due to the extra day.

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 8 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.

The most recent Restoration Administrator flow recommendation includes advancing spring period volume from 2019 Restoration Year into February (2018 Restoration Year). Assuming a Gravelly Ford recommendation of 551 cfs (+ 5 for Holding Contracts) for the remainder of February, this would amount to 3.428 TAF of 2019 water advanced into the 2018 Restoration Year.

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

Flow Account		Yearly Allocation [11] (TAF)	Released to Date [12] (TAF)	Remaining Flow Volume [12,13] (TAF)
Base Flows	Spring Flows (Mar 1 – Apr 30)	238.949	0	238.949
	Riparian Recruitment Flows	54.216	0	54.216
	Summer Flows (May 1 – Sep 30)	42.447	0	42.447
	Fall Flows (Oct 1 – Nov 30)	32.112	0	32.112
	Winter Flows (Dec 1 – Feb 28)	43.398	0	43.398
Buffer Flows		52.807	0	52.807
Unreleased Restoration Flows (Sales and Exchanges)		—	0	0
Unreleased Restoration Flows (Returned Exchanges)		—	0	0
Purchased Water		—	0	0
		Total Restoration Flows:	**0**	**463.929**

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

[12] As of 2/20/2019.

[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 9 summarizes known 2019 operational constraints.

Table 9 — Summary of Operational Constraints

Constraint	Period	Flow Limitation
Levee Stability	Currently in effect	1,210 cfs in Reach 2B
	Currently in effect	580 – 1,070 cfs in Eastside Bypass
Channel Conveyance / Seepage Limitation	Currently in effect, see latest Flow Bench Evaluation	Reach 2A: 750-800 cfs
		Reach 3: 520-609 cfs
		Reach 4A: 235-380 cfs

The 2019 Channel Capacity Report identifies a maximum flow in Reach 2B of 1,210 cfs. This results in a maximum release from Friant Dam between 1,310 cfs and 1,540 cfs depending on the time of year. The 2019 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 February 2019, a flow bench was conducted to verify expected groundwater thresholds in Reach 3. The flow was held at 520 cfs (+/- 6 cfs) below Mendota Dam for over 12 days. The groundwater data from this evaluation is still being analyzed and will be distributed shortly as a Flow Bench Evaluation report. This evaluation also revealed groundwater behavior in Reach 2 and Reach 4A, although flow rates were not as stable in those reaches. The currently available information is shown in Table 9, indicating an updated seepage limitation in Reach 2, and a lower than expected seepage limitation in Reach 4A.

Reclamation will complete a Flow Bench Evaluation prior to any scheduled Restoration Flow rates above the values shown in Table 9 or as amended in the Flow Bench Evaluation report. For Reach 3, additional flow benches may be necessary using the combined Restoration Flow rate and Arroyo Canal diversion rate, and thus may be triggered by increased Arroyo Canal diversions. Reclamation will inform the Restoration Administrator of any changes to groundwater conditions that may result in a reduction in scheduled Restoration Flows, will implement monitoring of groundwater conditions as necessary, and will adjust Friant Dam releases and/or Mendota Pool recapture to stay within seepage and channel capacity constraints.

2019 Allocation History

The Restoration Allocation will be adjusted, often many times, between the date of the initial allocation and the final allocation, based on the hydrologic conditions. The Restoration Administrator is responsible for contingency planning and managing releases to stay within current and anticipated future allocations. Table 9 summarizes the Allocation History for this Restoration Year.

Table 9 — Allocation History

Allocation Type	Issue Date	Forecast Blending Applied	Unimpaired Inflow Forecast (at forecast exceedance)	Restoration Allocation at Gravelly Ford	Restoration Flows and URFs Released
Initial	January 17, 2019	30/70	971 TAF (@ 75%)	218.874 TAF	0 (thru 1/10/19)
Update	February 11, 2019	20/80	1,724 TAF (@ 75%)	321.741 TAF	0 (thru 2/8/19)
Update	February 26, 2019	40/60	2,361 TAF (@ 50%)	411.121 TAF	0 (thru 2/20/19)

Reclamation expects the next updated Restoration Allocation to be issued around March 15.

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 Water 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
2017	4,395.400	Wet
2018	1,348.979	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 Water 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 (2017) 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, 2017 through February, 2018 (no 2017 Restoration Flows and some 2017 URFs were advanced into February of 2016).

Flow Period	Gravelly Ford 5 cfs requirement (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	–	–	–	–	–	–	7.064
Feb16 – Feb 28	–	0	–	–	–	–	–	–	
Mar 1 – Mar 15	–	0	–	–	–	–	0	–	45.484
Mar 16 – Mar 31	–	0	–	–	–	–	0	–	
Apr 1 – Apr 15	–	0	–	–	–	–	0	–	81.815
Apr 16 – Apr 30	–	0	–	–	–	–	0	–	
May 1 – May 28	–	0	0	–	–	0	0	0	136.810
May 29 – Jun 30	–	–	0	–	–				79.228
Jul 1 – Aug 31	19.188	–	9.997	–	–		0		14.566
Sep 1 – Sep 30	9.951	–	8.331	3.792	–	–	0		–
Oct 1 – Oct 31	10.034	–	–	11.873	–	–	0	0	–
Nov 1 – Nov 6	1.807	–	–	2.656	–	–	0		–
Nov 7 – Nov 10	1.174	–	–	1.801	–	–	0		–
Nov 11 – Nov 30	6.038	–	–	8.999	–	–	0		–
Dec 1 – Dec 31	8.934	–	–	0	14.342	–	0		–
Jan 1 – Jan 31	8.761	–	–	–	15.578	–	0	–	–
Feb 1 – Feb 28	8.309	0	–	0.839	13.487	–	0	–	2.491
	74.196	**0**	**18.328**	**29.933**	**43.398**	**0**	**0.000**		**367.458**
		91.659							
		91.659							
		459.117 (2017 Allocation = 556.542)							
	533.313								

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, 2017 through February, 2018 (no 2017 Restoration Flows and some 2017 URFs were advanced into February of 2016).

Flow Period	Gravelly Ford 5 cfs requirement (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	–	–	–	–	–	–	7.064
Feb16 – Feb 28	–	0	–	–	–	–	–	–	
Mar 1 – Mar 15	11.139	12.198	–	–	–	–	0	–	45.484
Mar 16 – Mar 31	-12.171	13.012	–	–	–	–	0	–	
Apr 1 – Apr 15	9.947	12.198	–	–	–	–	0	–	81.815
Apr 16 – Apr 30	16.864	12.198	–	–	–	–	0	–	
May 1 – May 28	21.388	13.884	8.886	–	–	9.788	0	0	136.810
May 29 – Jun 30	29.671	–	10.473	–	–				79.228
Jul 1 – Aug 31	14.071	–	14.757	–	–		0		14.566
Sep 1 – Sep 30	9.951	–	8.331	3.792	–	–	0		–
Oct 1 – Oct 31	10.034	–	–	11.873	–	–	0	0	–
Nov 1 – Nov 6	1.807	–	–	2.656	–	–	0		–
Nov 7 – Nov 10	1.174	–	–	1.801	–	–	0		–
Nov 11 – Nov 30	6.038	–	–	8.999	–	–	0		–
Dec 1 – Dec 31	8.934	–	–	0	14.342	–	0		–
Jan 1 – Jan 31	8.761	–	–	–	15.578	–	0	–	–
Feb 1 – Feb 28	8.309	0	–	0.812	13.487	–	0	–	2.491
	145.917	**63.490**	**42.447**	**29.933**	**43.398**	**9.788**	**0.000**		**367.458**
		189.056							
		189.056							
		556.514 (2017 Allocation = 556.542)							
	702.431								