SAN JOAQUIN RIVER
RESTORATION PROGRAM

Bureau of Reclamation
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Updated 2020 Restoration Allocation & Default Flow Schedule

February 19, 2020

Introduction

The following transmits an updated 2020 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) Draft Restoration Flow Guidelines (Guidelines). 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 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 Unimpaired Inflow 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 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 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 capacity limited recommendation. If either an unconstrained recommendation or a capacity limited recommendation is not provided by the Restoration Administrator, the Capacity Constrained Default Flow Schedule (Table 6b) will be implemented.

Because this updated allocation provides the same volume of water as the previous allocation dated February 7, 2020, it is at the Restoration Administrator's option to update or retain the previous flow schedule.

Forecasted Unimpaired Inflow

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[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].
- 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 2020 (October 1, 2019 to September 30, 2020) observed accumulated and forecasted water year Unimpaired Inflows at 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 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 Unimpaired Runoff ("Natural River") February 18, 2020 [1]	124.5 TAF				
Accumulated Unimpaired Runoff as percent of normal [2]	43%				
DWR, February 18, 2020 [3] (Published Value)	730 TAF	845 TAF [7]	955 TAF	1,080TAF [7]	1,195 TAF
DWR, February 18, 2020 [4] (Runoff Adjusted)	731 TAF	841 TAF [7]	946 TAF	1,066 TAF [7]	1,176 TAF
NWS, February 19, 2020 (Published Daily Value [5])	441 TAF	546 TAF	658 TAF	905 TAF	1,340 TAF
Smoothed NWS, February 19, 2020 (7-day Smoothing [6])	450 TAF	563 TAF	687 TAF	958 TAF	1,430 TAF
Smoothed NWS, February 19, 2020 (Runoff Adjusted [4])	452 TAF	564 TAF	687 TAF	957 TAF	1,424 TAF

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

[2] Based on average accumulation of Unimparired Runoff

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

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

The 2020 Water Year has so far produced far less than normal runoff (43%). Daily Unimpaired Runoff values are currently equivalent to what would be expected in the low range of a Dry Water Year Type (about 750 TAF), yet they continue to decline in relation to a Dry Water Year Type. Runoff ratio to date is currently 42%, calculated by measured Unimpaired Runoff divided by modeled Surface Water Input (also known as watershed yield, this statistic tracks the fraction of water reaching the soil surface that produces runoff). Runoff ratio continues to increase slowly; although a value of 42% is slightly low for February, it appears to be higher than the runoff ratio experienced during the recent drought years of 2014 and 2015. This is indicative that soil moisture conditions are better now than during those drought years, but still shy of a normal year. It should be noted that 2020 is following the wet year of 2019 which boosted antecedent moisture conditions in the watershed.

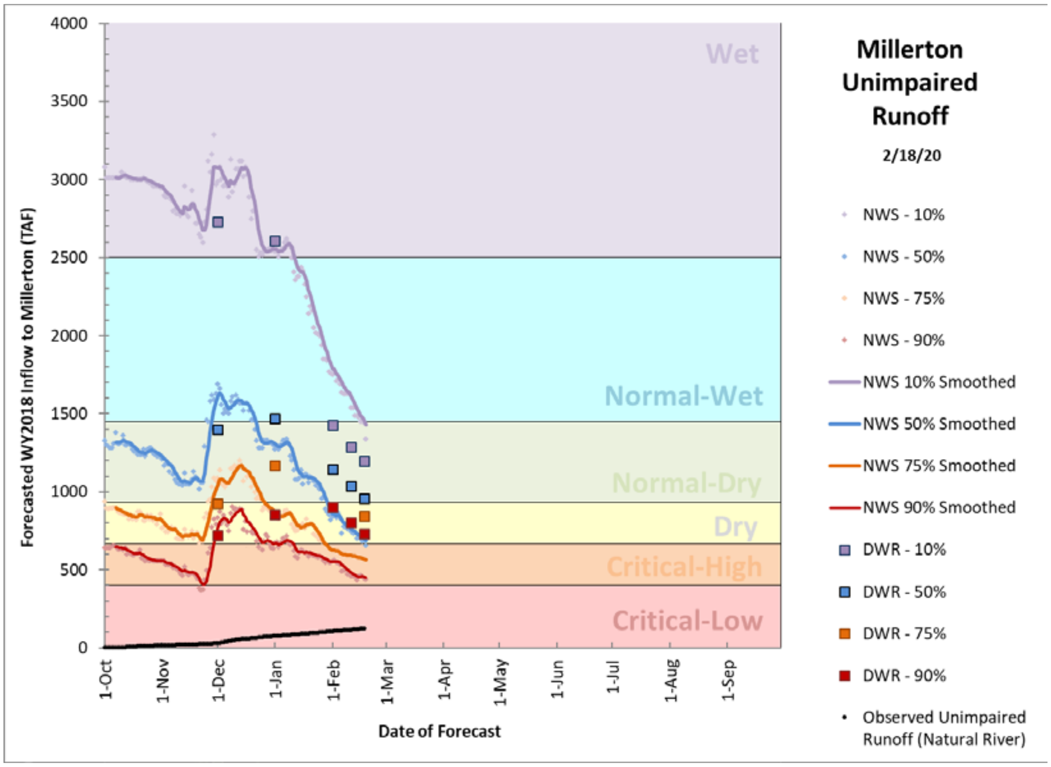

Figure 1a — Plot of 2020 Water Year forecasts, including both NWS Ensemble Streamflow Prediction Forecasts and DWR Forecasts

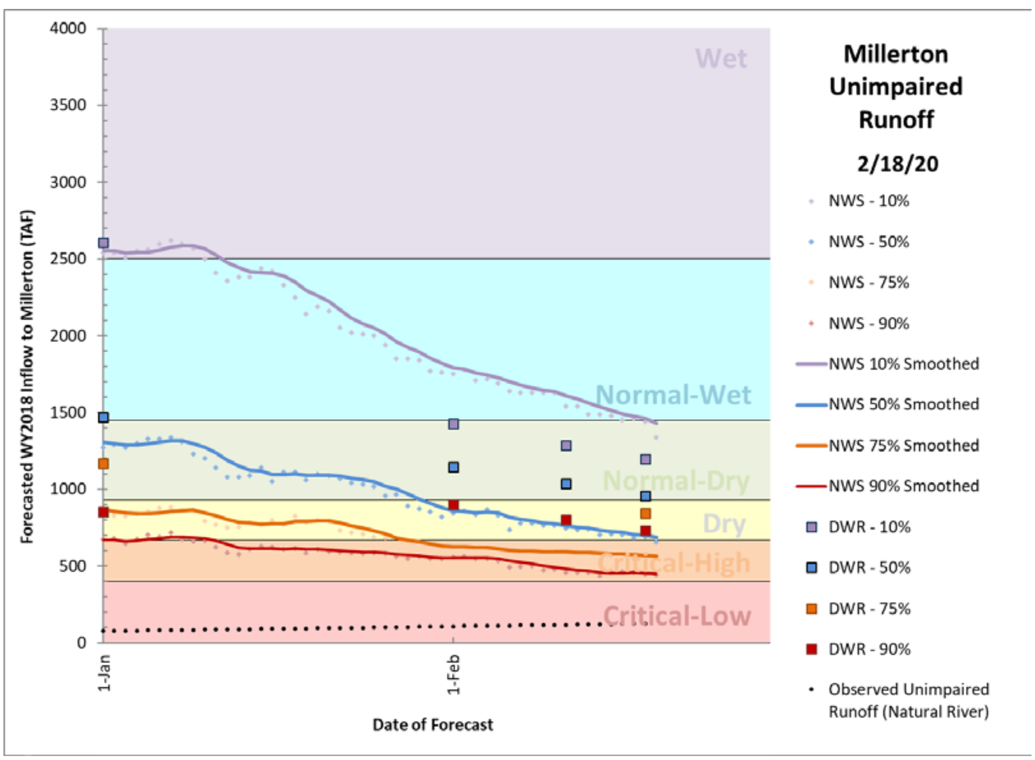

Figure 1b — Detail plot of most recent forecasts

A notable aspect of the current water supply forecasts for the San Joaquin is the DWR Bulletin 120 forecast being significantly different than and higher than the Ensemble Streamflow Prediction values published by the National Weather Service. Typically, the NWS forecast has a higher bias than the DWR forecast. Both forecasts are current, the principle difference appears due to the different methodologies and differing understandings of how much snowpack exists is the watershed. At the 90% exceedance, the DWR forecast is a startling 65% higher than the NWS forecast. This presents a challenge to Reclamation in blending the two primary forecasts used for managing the Millerton Lake water supply.

Four snowpack models were available between February 14 and February 19. The models are in fairly good agreement (Table 2). Reclamation has consensus value of 520 TAF given past model performance and snow pillow measurements. The distribution of the Snow Water Equivalent (SWE) modeled by ARS iSnobal is shown in Figure 2.

Table 2 — Total snowpack volume depicted by four models and a consensus estimate for February 19, 2020.

Date	CNRFC	NOHRSC	CU Boulder	ARS iSnobal	NASA ASO	Reclamation Consensus
Snow Water Equivalent Volume (TAF)	503	500	520 [8]	539 [9]	N/A [10]	**520**

[8] CU Boulder "Real-time SWE" model was dated February 16
[9] USDA-ARS "iSnobal" model was dated February 14
[10] First ASO surveys of 2020 are expected to be available late March

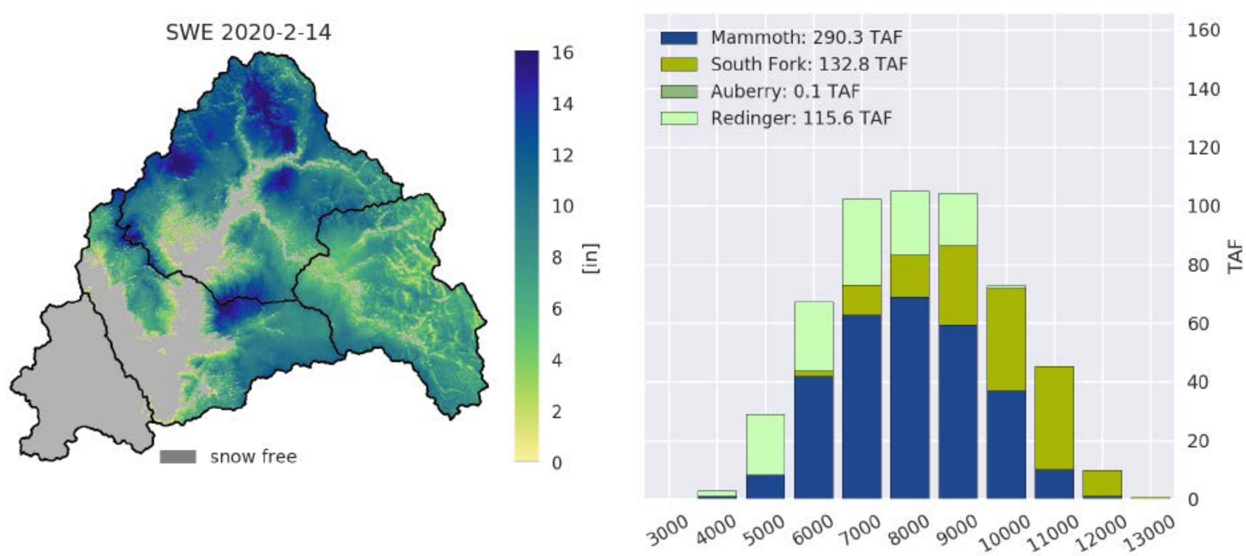

Figure 2 — iSnobal model output from February 14. Substantial volume of snow exists as low as 6000' elevation. A pronounced bias toward the northern side of the watershed (adjacent to the Merced) is depicted. Snow pillow and snow course data indicates that snowpack in the South Fork of the San Joaquin may be underestimated by the iSnobal model and there may actually be greater snowpack on the southern side of the watershed (adjacent to the Kings).

The long-term weather models, which cover out to a maximum of 16 days, depict between 0.2” and 0.5” of precipitation for the San Joaquin. An unusual, but not unprecedented, dry period has persisted since December. Circulation in the northern hemisphere has been dominated recently by a strongly positive Arctic Oscillation which has diminished the sequence of high and low pressure systems that typically sweep over California. Climate models for the remainder of the winter and early spring indicate drier than average conditions, although there are some signs that the recent trend will shift back toward a pattern that is less dry.

Reclamation continues to track 2020 watershed performance in relation to other analog years. With the continued dry conditions, analogs now contain previous Critical-High as well as Dry year types. Current conditions are bounded by 1964, 1968, and 1990 (now appearing wetter than 2020) and 2015 (still appearing drier than 2020). 2014 and 2007 are the most similar analogs at this time in terms of snowpack, although the antecedent moisture condition was lower in 2014 than 2020. Appendix C shows the unimpaired runoff from previous years for reference.

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 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 20/80 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)	20/80				
Hybrid Unimpaired Inflow Forecast (TAF)	506	619	739	980	1,377

This blending produced on February 19 was 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 measurements and snowpack models, application of hypothetical runoff ratios, the long-range forecast, historic analogs, the seasonal climate outlook, the age of the forecasts, and other performance factors. Reclamation continues to hold the opinion that NWS models are underestimating snowpack in the watershed, as evidenced by snow pillow and snow course data, especially data from the South Fork sub-basin of the watershed. Likewise, we continue to believe that the DWR forecast is overestimating current snowpack (in addition to its normal bias of not considering the 16-day forecast).

Restoration Allocation

As per the draft Guidelines, the **90% 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 exceedance used to set the Restoration Allocation.

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

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

Applying the 20/80 forecast blending determined by Reclamation and, using the 90% exceedance forecast dictated by the Guidelines, Reclamation calculates an **Unimpaired Inflow hybrid forecast of 506 TAF** and a **Critical-High Water Year Type**. This provides a **Restoration Allocation of 70.919 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 187.785 TAF**. Other hypothetical allocations are presented in Table 5 as grayed values and indicate the range of probable forecasts and the resulting Restoration Allocation.

Table 5 — SJRRP Water Year Type and Allocation for 2020 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)	**506**	619	739	980	1,377
Water Year Type	**Critical-High**	Critical-High	Dry	Normal-Dry	Normal-Dry
Restoration Allocation at GRF (TAF)	**70.919**	70.919	170.732	220.086	273.528
Friant Dam Flow Releases (TAF)	**187.785**	187.785	287.678	337.031	390.473

Note that the current allocation is based on the draft January 2020 Restoration Flow Guidelines (version 2.1), yet the current allocation would be identical under the previous February 2018 Guidelines (version 2.0).

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 Flow Schedules

Table 6a shows the "Basic" Default Flow Schedule 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 methods explained in the Restoration Flow Guidelines.

Table 6b shows the 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 **0 TAF** is generated that cannot be scheduled for release without 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, recapture of Restoration Flows at Mendota Pool, and real-time assessments of groundwater constraints.

Table 6a — Basic Default Flow Schedule

Flow Period	Flow (cfs)				Volume (TAF)	
	Friant Dam Release	Holding Contracts [11]	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	200	150	55	50	5.950	1.488
Apr 16 – Apr 30	200	150	55	50	5.950	1.488
May 1 – May 28	215	190	30	25	11.940	1.388
May 29 – Jun 30	215	190	30	25	14.073	1.636
July 1 – July 29	255	230	30	25	14.668	1.438
Jul 30 – Aug 31	255	230	30	25	16.691	1.636
Sep 1 – Sep 30	260	210	55	50	15.471	2.975
Oct 1 – Oct 31	160	160	5	0	9.838	0.000
Nov 1 – Nov 6	400	130	275	270	4.760	3.213
Nov 7 – Nov 10	120	120	5	0	0.952	0.000
Nov 11 – Nov 30	120	120	5	0	4.760	0.000
Dec 1 – Dec 31	120	120	5	0	7.379	0.000
Jan 1 – Jan 31	110	100	15	10	6.764	0.615
Feb 1 – Feb 28	110	100	15	10	6.109	0.555
				Totals	**187.785**	**70.909**

Table 6b — Capacity Constrained Default Flow Schedule

Flow Period	Flow (cfs)				Volume (TAF)		
	Friant Dam Release	Holding Contracts [11]	Flow Target at GRF	Restoration Flow at GRF	Friant Dam Release	Restoration Flow at GRF	Unreleased Restoration Flow [12]
Mar 1 – Mar 15	525	130	400	395	14.876	11.008	-0.744
Mar 16 – Mar 31	525	130	400	395	47.603	43.478	30.942
Apr 1 – Apr 15	525	150	400	395	5.950	1.488	-10.264
Apr 16 – Apr 30	525	150	400	395	5.950	1.488	-10.264
May 1 – May 28	389	190	204	399	11.940	1.388	-9.669
May 29 – Jun 30	215	190	30	25	14.073	1.636	0
July 1 – July 29	255	230	30	25	14.668	1.438	0
Jul 30 – Aug 31	255	230	30	25	16.691	1.636	0
Sep 1 – Sep 30	260	210	55	50	15.471	2.975	0
Oct 1 – Oct 31	160	160	5	0	9.838	0.000	0
Nov 1 – Nov 6	400	130	275	270	4.760	3.213	0
Nov 7 – Nov 10	120	120	5	0	0.952	0.000	0
Nov 11 – Nov 30	120	120	5	0	4.760	0.000	0
Dec 1 – Dec 31	120	120	5	0	7.379	0.000	0
Jan 1 – Jan 31	110	100	15	10	6.764	0.615	0
Feb 1 – Feb 28	110	100	15	10	6.109	0.555	0
				Totals	**187.785**	**70.909**	**0** [12]

[11] 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.

[12] 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. 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 March 1, 2020, through February 28, 2021 (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 116.866 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

<table>
<tr><th rowspan="2">Period</th><th rowspan="2">Holding Contract Demand (TAF)</th><th colspan="6">Restoration Flow Account Volumes (TAF)</th></tr>
<tr><th>Continuity Flow Account</th><th>Spring Flexible Flow</th><th>Riparian Recruitment Flows</th><th>Fall Flexible Flows</th><th>Buffer Flow [14]</th><th>Flexible Buffer Flow</th></tr>
<tr><td>Feb 1 – Feb 28</td><td>–</td><td>0</td><td rowspan="3">40.959 (Feb 1 – May 38)</td><td>–</td><td>–</td><td>0</td><td></td></tr>
<tr><td>Mar 1 – Apr 30</td><td>16.920</td><td>16.502</td><td>–</td><td>–</td><td>7.438</td><td>–</td></tr>
<tr><td>May 1 – May 28</td><td>10.552</td><td>1.388</td><td rowspan="2">0</td><td>–</td><td>1.194</td><td rowspan="4">Of which 3.642 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>3.074</td><td>–</td><td>–</td><td>2.874</td></tr>
<tr><td>Jul 30 – Aug 31</td><td>15.888</td><td>1.636</td><td>–</td><td>–</td><td>–</td><td>1.669</td></tr>
<tr><td>Sep 1 – Sep 30</td><td>11.662</td><td>2.975</td><td>–</td><td>–</td><td rowspan="3">0.595 (Sep 3 – Dec 38)</td><td>1.547</td></tr>
<tr><td>Oct 1 – Nov 30</td><td>17.098</td><td>2.618</td><td>–</td><td>–</td><td>2.031</td><td rowspan="2">2.769 may be applied Sep 3–Dec 28</td></tr>
<tr><td>Dec 1 – Dec 31</td><td>7.378</td><td>0</td><td>–</td><td>–</td><td>0.738</td></tr>
<tr><td>Jan 1 – Feb 28</td><td>11.901</td><td>1.170</td><td>–</td><td>–</td><td>–</td><td>1.287</td><td>–</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">116.866 [13]</td><td>29.365</td><td>40.959</td><td>0</td><td>0.595</td><td rowspan="2">18.778</td><td rowspan="2"></td></tr>
<tr><td colspan="4">70.919 (Base Flow Volume)</td></tr>
<tr><td></td><td colspan="5">187.785 (Friant Release Volume)</td><td></td><td></td></tr>
</table>

[13] 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.

[14] Buffer Flow volumes are based on actual releases, and are not an allocated volume per se.

Remaining Flexible Flow Volume

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. The releases 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. This may affect the remaining flow volume as well.

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

Flow Account		Yearly Allocation [15] (TAF)	Released to Date [16] (TAF)	Remaining Flow Volume (TAF)
Base Flows	Continuity Flow Account (Mar 1 — Feb 28)	29.365	0	29.365
	Spring Flexible Flows (Mar 1 – Apr 30)	40.959	0	40.959
	Riparian Recruitment Flows (May 1 — Jul 29)	0	0	0
	Fall Flexible Flows (Oct 1 – Nov 30)	0.595	0	0.595
Buffer Flows [14]		18.778	0	—
Unreleased Restoration Flows (Sales and Exchanges)		—	0	0
Unreleased Restoration Flows (Returned Exchanges)		—	0	0
Purchased Water		—	0	0
		Totals:	**0**	**70.919**

[14] Buffer Flow volumes are based on actual releases, and are not an allocated volume per se.

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

[16] As of 2/18/2020

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 2020 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	1,070 cfs in Eastside Bypass
Channel Conveyance / Seepage Limitation	Currently in effect, see latest Flow Bench Evaluation for precise values	Reach 2A: 800 – 820 cfs @ GRF
		Reach 3: 850 cfs @ MEN
		Reach 4A: 260 – 300 cfs @ SDP
Merced NWR weir Removal	June – September 2020	100 cfs 3-day average flow rate in Eastside Bypass

The Draft 2020 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 2020 Restoration Year Channel Capacity Report also identifies a maximum flow in the Middle Eastside Bypass of 1,070 cfs due to levee stability constraints. These values are unchanged from 2019.

In 2020, multiple flow benches were conducted to verify expected seepage thresholds in Reach 2A and Reach 3. Analysis revealed a seepage limitation of 800 to 820 cfs in Reach 2A (measured at the GRF gauge) and 850 cfs in Reach 3 (measured at the MEN gauge). These seepage limitations fluctuate with prevailing groundwater conditions and may be slightly lower or higher at a given time. The limitation in Reach 3 must accommodate both Restoration Flows and diversion to Arroyo Canal, thus Reach 3 may be the limiting reach in certain times of the year. SJRRP will coordinate with the Restoration Administrator on specific flow schedules that are close to these limits. Flow – groundwater relationships from October 2019 through January 2020 were examined to determine a new seepage limitation in Reach 4A. For the current Reach 4A seepage limitation, wells installed in 2017 and later were incorporated into the analysis. Inclusion of these additional data points revealed that the seepage limitation is a lower flow rate than previously expected. Because of the shorter period of record, the estimated limitation of 250 –

300 cfs in Reach 4A is of lower certainty and careful flow bench evaluations will be necessary to determine the exact value within this range.

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 (as preferred by the Restoration Administrator) to stay within seepage and channel capacity constraints.

Removal of the Merced National Wildlife Refuge weir is expected to take place between June and September. Based on the current information, a limitation of 100 cfs is expected. This limitation is based on a 3-day running average, allowing short period excursions of up to 120 cfs. This timing and rate of this flow limitation may be refined closer to the project period.

2020 Allocation History

The Restoration Allocation will be 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 next Restoration Allocation is scheduled to be issued between March 10 and March 21. The Restoration Administrator is responsible for contingency planning and managing releases to stay within the current allocation. Table 10 summarizes the Allocation History for this Restoration Year.

Table 10 — 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 16, 2020	20/80	928 TAF (@ 75%)	212.909 TAF	0 (thru 1/16/20)
Updated	February 7, 2020	10/90	664 TAF (@ 75%)	70.919 TAF	0 (thru 2/05/20)
Updated	February 19, 2020	20/80	506 TAF (@ 90%)	70.919 TAF	0 (thru 2/18/20)

Appendix A: Abbreviations, Acronyms, and Glossary

af	acre–feet
ARS	USDA Agricultural Research Service
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
NASA	National Aeronautics and Space Administration
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: Previous Year (2018) Flow Accounting

Table B — Restoration Flow Accounting and Unreleased Restoration Flows, and Holding Contracts, for the period February 2018 through February 2019. No flood management releases to San Joaquin River occurred during this period This accounting excludes flow volume that was generated in the 2019 Restoration Year and advanced into the final days of February 2019 (from the 2018 Restoration Year).

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 Recruitment Flow	Buffer Flow	Flexible Buffer Flow	
Feb 1 – Feb 28	–	–	–	–	–	–	–	–	–
Mar 1 – Mar 31	4.881	10.941	–	–	–	–	0	–	2.491
Apr 1 – Apr 30	9.191	13.031	–	–	–	–	0	–	40.000
May 1 – May 31	11.274	12.224		–	–		0		53.677
Jun 1 – Jun 30	12.805	–	11.054	–	–	0			12.632
Jul 1 – Jul 31	14.753	–	12.052	–	–		0	0	4.419
Aug 1 – Aug 31	15.126	–	11.879	–	–		0		–
Sep 1 – Sep 30	13.500	–	11.617	–	–	–	0		–
Oct 1 – Oct 31	12.115	–	–	11.730	–	–	0		–
Nov 1 – Nov 30	11.484	–	–	13.347	–	–	0	0	–
Dec 1 – Dec 31	10.504	–	–	14.037	–	–	0		–
Jan 1 – Jan 31	9.396	–	–	–	15.727	–	0	–	–
Feb 1 – Feb 28	4.038	0	–	–	19.957	–	0	–	11.572
	129.068	**36.196**	**46.602**	**39.114**	**35.329**	**0**	**0.000**		**124.791**
		157.596							
		157.596							
		282.387 (2018 Allocation: 280.252 + 2.129 Returned Exchange = error of 0.007 TAF)							
	411.455								

Appendix C: History of Millerton Unimpaired Runoff

Table C — Water Year Totals in Thousand Acre-Feet

Water Year [1]	Unimpaired Runoff [2] (Natural River)	SJRRP Water Year Type [3]	Water Year [1]	Unimpaired Runoff [2] (Natural River)	SJRRP Water Year Type [3]	Water Year [1]	Unimpaired Runoff [2] (Natural River)	SJRRP Water Year Type [3]
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
1933	1,111.4	Normal-Dry	1965	2,271.191	Normal-Wet	1997	2,817.670	Wet
1934	691.5	Dry	1966	1,298.792	Normal-Dry	1998	3,160.759	Wet
1935	1,923.2	Normal-Wet	1967	3,233.097	Wet	1999	1,527.040	Normal-Wet
1936	1,853.3	Normal-Wet	1968	861.894	Dry	2000	1,735.653	Normal-Wet
1937	2,208.0	Normal-Wet	1969	4,040.864	Wet	2001	1,065.318	Normal-Dry
1938	3,688.4	Wet	1970	1,445.837	Normal-Dry	2002	1,171.457	Normal-Dry
1939	920.8	Dry	1971	1,416.812	Normal-Dry	2003	1,449.954	Normal-Dry
1940	1,880.6	Normal-Wet	1972	1,039.249	Normal-Dry	2004	1,130.823	Normal-Dry
1941	2,652.5	Wet	1973	2,047.585	Normal-Wet	2005	2,826.872	Wet
1942	2,254.0	Normal-Wet	1974	2,190.308	Normal-Wet	2006	3,180.816	Wet
1943	2,053.7	Normal-Wet	1975	1,795.922	Normal-Wet	2007	684.333	Dry
1944	1,265.4	Normal-Dry	1976	629.234	Critical-High	2008	1,116.790	Normal-Dry
1945	2,134.633	Normal-Wet	1977	361.253	Critical-Low	2009	1,455.379	Normal-Wet
1946	1,727.115	Normal-Wet	1978	3,402.805	Wet	2010	2,028.706	Normal-Wet
1947	1,121.564	Normal-Dry	1979	1,829.988	Normal-Wet	2011	3,304.824	Wet
1948	1,201.390	Normal-Dry	1980	2,973.169	Wet	2012	831.582	Dry
1949	1,167.008	Normal-Dry	1981	1,067.757	Normal-Dry	2013	856.626	Dry
1950	1,317.457	Normal-Dry	1982	3,317.171	Wet	2014	509.579	Critical-High
1951	1,827.254	Normal-Wet	1983	4,643.090	Wet	2015	327.410	Critical-Low
1952	2,840.854	Wet	1984	2,042.750	Normal-Wet	2016	1,300.986	Normal-Dry
1953	1,226.830	Normal-Dry	1985	1,135.975	Normal-Dry	2017	4,395.400	Wet
1954	1,313.993	Normal-Dry	1986	3,031.600	Wet	2018	1,348.979	Normal-Dry
1955	1,161.161	Normal-Dry	1987	756.853	Dry	2019	2,734.772	Wet
1956	2,959.812	Wet	1988	862.124	Dry			
1957	1,326.573	Normal-Dry	1989	939.168	Normal-Dry			
1958	2,631.392	Wet	1990	742.824	Dry			
1959	949.456	Normal-Dry	1991	1,027.209	Normal-Dry			
1960	826.021	Dry	1992	807.759	Dry			
1961	647.428	Critical-High	1993	2,672.322	Wet			
1962	1,924.066	Normal-Wet	1994	824.097	Dry			

[1] 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 differ slightly from the calculated water year total.

[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 D: Final Restoration Allocations and Error

Table D — History of Restoration Allocations

Year	Type	Date of Final Allocation Issuance	Natural River Forecast in Final Allocation (TAF)	Restoration Allocation in Final Issuance (TAF)	Observed Natural River on Sep. 30 (TAF)	Error (Natural River / Allocation)
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 [1]	509.579	+8.421 / 0 [1]
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

[1] No water was provided under this Critical-High designation due to Friant Dam releases for the Exchange Contract.