SAN JOAQUIN RIVER RESTORATION PROGRAM

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Updated 2019 Restoration Allocation & Default Flow Schedule

April 12, 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 February 2017, version 2.0, 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 tear 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 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 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 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 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 fluctuate. 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 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 "Natural River" Unimpaired Inflow, Apr 11, 2019 [1]	698.5 TAF				
Accumulated Unimpaired Inflow as percent of normal	122%				
DWR, Apr 1, 2019 [3] (Published Value)	2,205 TAF	2,375 TAF	2,530 TAF	2,760 TAF	3,025 TAF
DWR, Apr 11, 2019 [4] (Runoff Adjusted)	2,227 TAF	2,372 TAF	2,508 TAF	2,707 TAF	2,947 TAF
NWS, Apr 11, 2019 (Published Daily Value [5])	2,470 TAF	2,510 TAF	2,600 TAF	2,700 TAF	2,820 TAF
Smoothed NWS, Feb 20, 2019 (7-day Smoothing [6])	2,470 TAF	2,508TAF	2,581 TAF	2,695 TAF	2,817 TAF
Smoothed NWS, Feb 20, 2019 (Runoff Adjusted [4])	2,513 TAF	2,541 TAF	2,585 TAF	2,661 TAF	2,758 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 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.

From mid-January through March, runoff has consistently met or exceeded the 50% forecasts from DWR and NWS. In general, storms have been colder than average, resulting in low elevation snow lines. By late March, the greatest water content on a depth basis was found at the mid-elevations of 7,000' to 8,000'. Since late March, the intensity of storms over the San Joaquin has tapered off considerably. Peak snowpack at low elevations appears to have occurred on April 1, while peak snowpack at high elevations appears to have occurred on April 7. With the issuance of the April 1 DWR Bulletin 120, it has come more in line with the NWS forecast. Additionally, Reclamation has the advantage at this time of 4 snowpack models plus the National Aeronautical and Space Administration (NASA) Airborne Snow Observatory data. This converging evidence has given us confidence in the runoff forecast Reclamation has provided here as the basis for the Restoration Allocation.

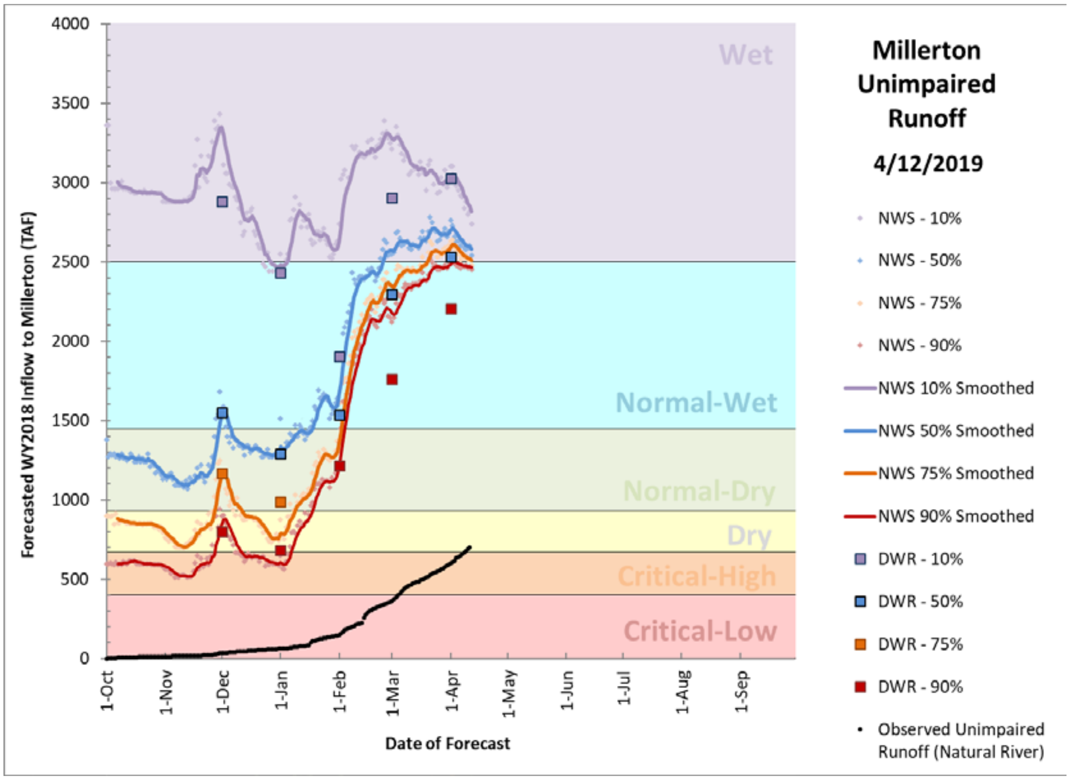

Figure 1a — Plot of 2019 Water Year forecasts, including both NWS Ensemble Streamflow Prediction Forecasts and DWR Forecasts

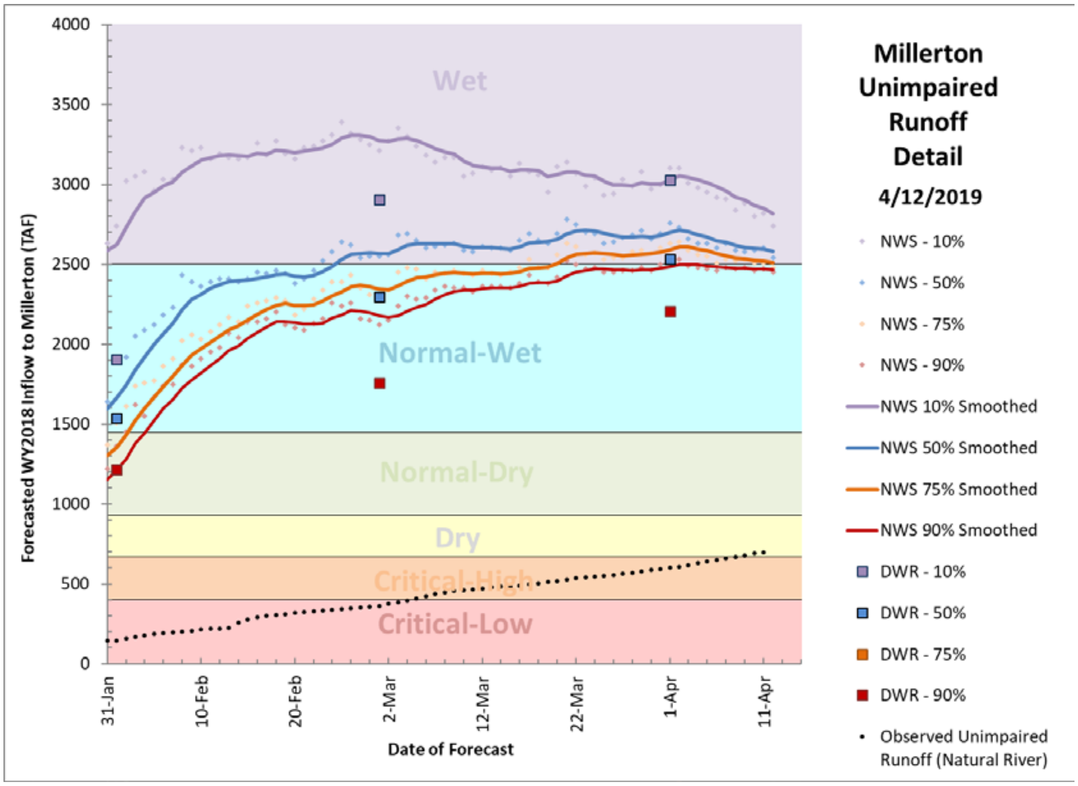

Figure 1b — Detail plot of most recent forecasts

Daily Natural River values have been tracking close to daily and monthly projections provided by NWS through the California Nevada River Forecast Center (CNRFC). Reclamation is estimating runoff ratios consistent with a well saturated soil, more saturated than 2018, but less saturated than 2017. Monthly temperatures over the past three months have been near average, with cloud cover above average; resulting in a slow onset of snowmelt. Peak snowpack for elevations below 9,000’ was reached on or about April 1, while higher elevations appear to have peaked April 7. The 10-day models indicate approximately 1” of precipitation is expected in the San Joaquin watershed, in-line with seasonal norms. Large-scale climate features such as the Quasi-biennial Oscillation and Madden-Julian Oscillation favor at or above normal precipitation in April. Weak El Nino continue, though there are few influences of El Nino after March. The long-range CFSv2 model shows drier and warmer conditions (Figure 2).

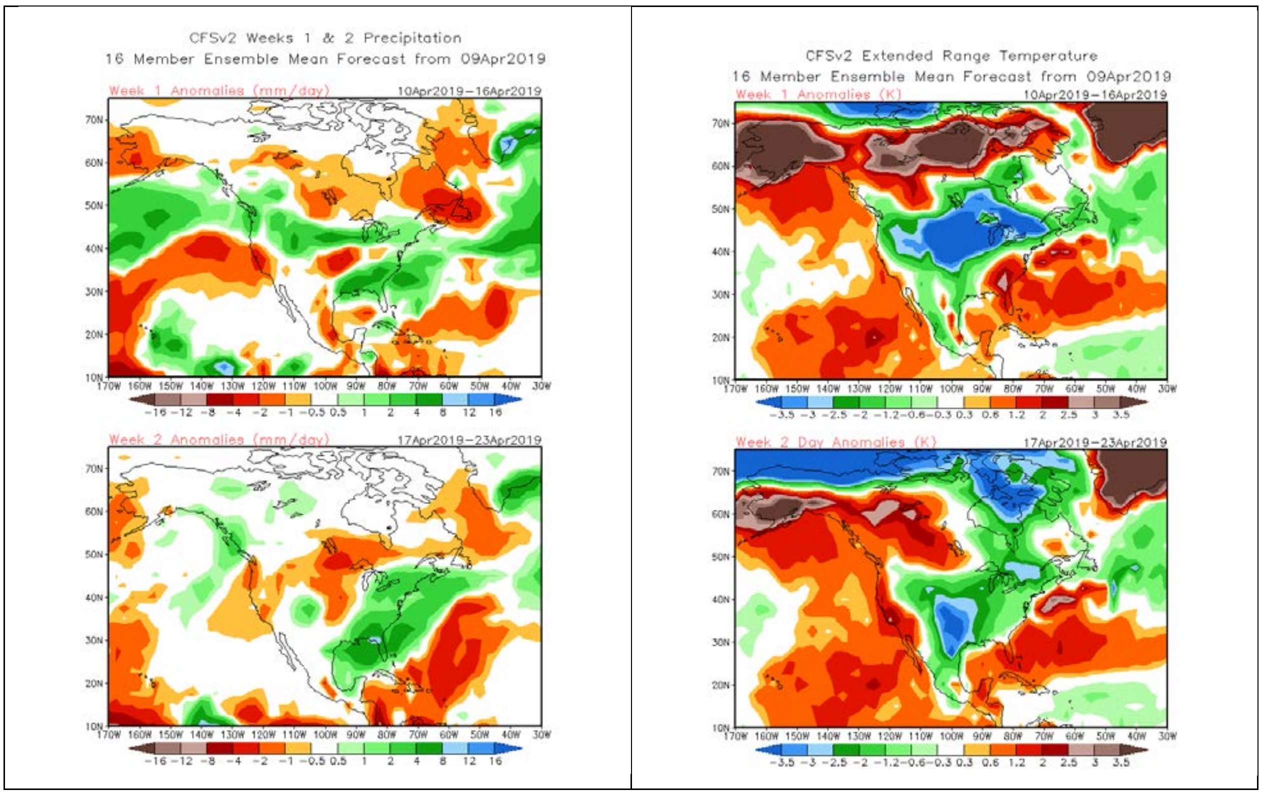

Figure 2 — CFS v2 model output from April 10 shows dry conditions in week 1 and 2 (left half) and cool temperatures in week 1 shifting to warmer temperatures in week 2 (right half).

Four snowpack models were available on April 3 or a few days before. There is now generally good agreement among three of the four models, with the CU Boulder “Real-Time SWE” estimate significantly higher. This latter product is derived from satellite imagery, and although extensively calibrated, is known to overestimate snowpack in forested areas. The NASA Airborne Snow Observatory was able to return to operations in March, collecting data on the San Joaquin watershed on March 15, 17, and 25. This data has been integrated into the ARS iSnobal model and is also available separately as a data file. A simple procedure of adjusting the various flights to a single date of April 3 was performed using trends from automated snow pillow measurements. The Reclamation consensus is 2,280 TAF, which is close to the adjusted ASO and within 120 TAF of the CNRFC, NOHRSC, and ARS models (Table 2). The distribution of snowpack is somewhat high in mid-elevations (where snow-water equivalent (SWE) depths are 30-50”) as compared to high elevations (where SWE depths are 25-45”). The “Main” subbasin in the north part of the watershed has the majority of SWE.

Table 2 — Total snowpack volume depicted by four models and a consensus estimate for April 3, 2019

Date	CNRFC	NOHRSC	CU Boulder	ARS iSnobal	NASA ASO	Reclamation Consensus
Snowpack Volume (TAF)	2,397	2,170	2,690 [1]	2,213	2,283 [2]	2,280

[1] Based on a satellite survey on March 31.
[2] ASO survey data from March 15, 17, and 25 was combined and adjusted to April 3 by using snow pillow data.

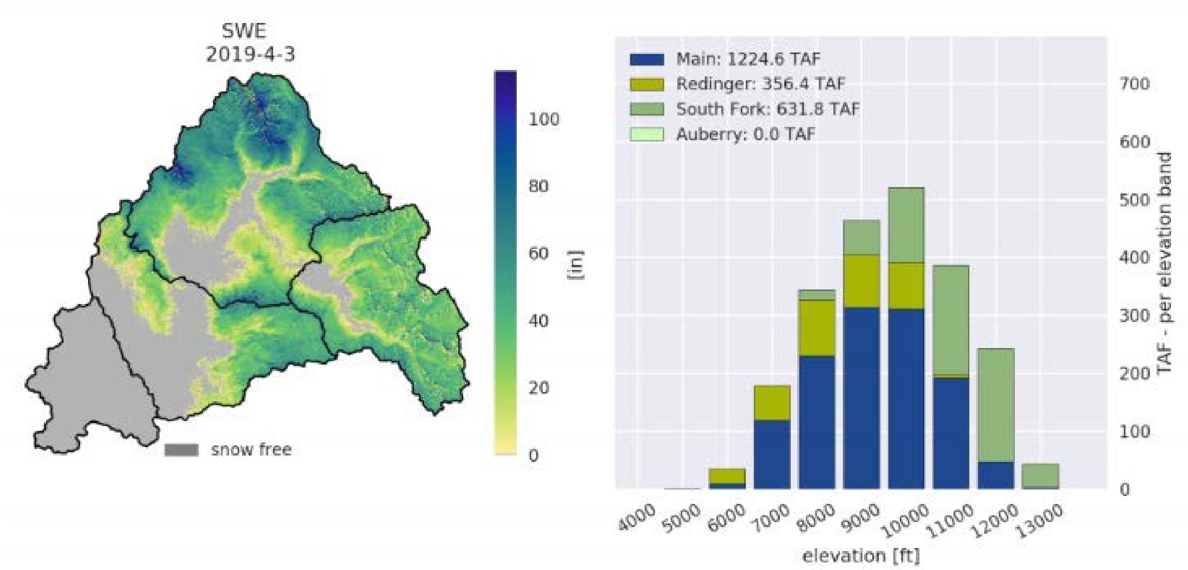

Figure 3 — iSnobal model output from April 3. Note relatively higher snow volumes in the mid-elevations as compared to the high elevations. There is also a pronounced north-south bias, with less precipitation in the South Fork subbasin.

A hypothetical runoff ratio of 78% when applied to the April 3 snowpack consensus estimate would result in a water year total of 2,570 TAF. This includes nearly 2” of additional precipitation and nominal baseflow. Reclamation is using as the upper bounds the runoff efficiencies that were seen in 2017 (85%) and the lower bounds of the runoff efficiencies that were seen in 2018 (72%). These equate to a water year total of 2,726 TAF and 2,430 TAF respectively.

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)	2,357	2,446	2,554	2,722	2,921

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, historic analogs, the seasonal climate outlook, and other performance factors. The DWR B120 forecast is given slightly lower weight primarily due to the performance of the NWS forecast in 2019. The 90% forecast represents a condition where this is little to no future precipitation and a snowmelt runoff ratio that is below what is assumed by Reclamation. Because there is a large difference in the Restoration Allocation between the 75% forecast and the 50% forecast, it will be incumbent upon Reclamation to carefully monitor runoff and the assumptions made in the creation of this forecast.

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 2,554 TAF** and a **Wet water 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 673.686 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 resulting 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)	2,357	2,446	**2,554**	2,696	3,112
Water Year Type	Normal-Wet	Normal-Wet	**Wet**	Wet	Wet
Restoration Allocation at GRF (TAF)	410.421	422.890	**556.542**	556.542	556.542
Friant Dam Flow Releases (TAF)	527.366	539.835	**673.686**	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 **166.791 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]	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	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	**673.686** [10]	**556.542**

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]	1510	190	1325	1320	182.698	159.709	59.286
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	**506.700** [10]	**389.751**	**166.791** [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, 199.636 TAF of Riparian Recruitment Flow volume would be scheduled between May 1 and July 29 instead of May 1 through June 30.

[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, and adds to the Friant Dam releases.

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

Period	Holding Contract Demand [7] (TAF)	Restoration Flow Accounting Volumes (TAF): Spring Flexible Flow	Summer Base Flow	Fall Flexible Flow	Winter Base Flow	Riparian Recruitment Flow [9]	Buffer Flow	Flexible Buffer Flow
Mar 1 – Apr 30	16.920	238.949	–	–	–	-–	25.587	–
May 1 – May 28	10.552	0		–	–	199.636		
May 29 – Jul 29	25.666	–	42.447	–	–		30.585	Of which 5.000 may be applied Mar 1–Apr 30, or Oct 1–Nov 30
Jul 30 – Sept 2	15.888	–		–	–			
Sep 3 – Sep 30	11.663	–		0	–	–		
Oct 1 – Nov 30	17.176	–	–	32.112	–	–	7.080	7.080 may be applied Sep 3–Dec 28
Dec 1 – Dec 31	7.379	–	–	0	43.398	–		
Jan 1 – Feb 29	11.901	–	–	–		–	4.117	–
	117.145 [10]	**238.949**	**42.447**	**32.112**	**43.398**	**199.636**	**67.369**	
		556.542 (Base Flow Volume)						
	673.686 [10] (Friant Dam Release Volume)							

[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, 199.636 TAF of Riparian Recruitment Flow volume would be scheduled between May 1 and July 29 instead of May 1 through June 30.

[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 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 includes 1.905 TAF that were generated in the 2019 Restoration Year and released during February 2019 of the 2018 Restoration Year.

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

Flow Account		Yearly Allocation [1] (TAF)	Released to Date [2] (TAF)	Remaining Flow Volume [1] (TAF)
Base Flows	Spring Flows (Mar 1 – Apr 30)	238.949	30.469	208.480
Base Flows	Riparian Recruitment Flows	199.636	0	199.636
Base Flows	Summer Flows (May 1 – Sep 30)	42.447	0	42.447
Base Flows	Fall Flows (Oct 1 – Nov 30)	32.112	0	32.112
Base Flows	Winter Flows (Dec 1 – Feb 29)	43.398	0	43.398
Buffer Flows		67.369	0	67.369
Unreleased Restoration Flows (Sales and Exchanges)		—	138.949	-138.949
Unreleased Restoration Flows (Returned Exchanges)		—	0	0
Purchased Water		—	0	0
		Total Restoration Flows:	**169.418**	**387.124**

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

[2] As of 4/10/2019.

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: 600-700 cfs
		Reach 4A: 235 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 approximately 18 days. The groundwater data from this evaluation has been analyzed and the Flow Bench Evaluation is posted on the RestoreSJR.net website. This evaluation also revealed groundwater behavior in Reach 2A 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 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 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)
Update	April 12, 2019	40/60	2,554 TAF (@ 50%)	556.542 TAF	169.418 TAF (RFs thru 4/10/19; URFs thru 4/30/19)

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

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: 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]	Water Year [1]	Unimpaired Inflow [2] (Natural River)	SJRRP Water Year Type [3]	Water Year [1]	Unimpaired Inflow [2] (Natural River)	SJRRP Water Year Type [3]
1931	480.2	Critical-High	1961	647.428	Critical-High	1991	1,027.209	Normal-Dry
1932	2,047.4	Normal-Wet	1962	1,924.066	Normal-Wet	1992	807.759	Dry
1933	1,111.4	Normal-Dry	1963	1,945.266	Normal-Wet	1993	2,672.322	Wet
1934	691.5	Dry	1964	922.351	Dry	1994	824.097	Dry
1935	1,923.2	Normal-Wet	1965	2,271.191	Normal-Wet	1995	3,876.370	Wet
1936	1,853.3	Normal-Wet	1966	1,298.792	Normal-Dry	1996	2,200.707	Normal-Wet
1937	2,208.0	Normal-Wet	1967	3,233.097	Wet	1997	2,817.670	Wet
1938	3,688.4	Wet	1968	861.894	Dry	1998	3,160.759	Wet
1939	920.8	Dry	1969	4,040.864	Wet	1999	1,527.040	Normal-Wet
1940	1,880.6	Normal-Wet	1970	1,445.837	Normal-Dry	2000	1,735.653	Normal-Wet
1941	2,652.5	Wet	1971	1,416.812	Normal-Dry	2001	1,065.318	Normal-Dry
1942	2,254.0	Normal-Wet	1972	1,039.249	Normal-Dry	2002	1,171.457	Normal-Dry
1943	2,053.7	Normal-Wet	1973	2,047.585	Normal-Wet	2003	1,449.954	Normal-Dry
1944	1,265.4	Normal-Dry	1974	2,190.308	Normal-Wet	2004	1,130.823	Normal-Dry
1945	2,134.633	Normal-Wet	1975	1,795.922	Normal-Wet	2005	2,826.872	Wet
1946	1,727.115	Normal-Wet	1976	629.234	Critical-High	2006	3,180.816	Wet
1947	1,121.564	Normal-Dry	1977	361.253	Critical-Low	2007	684.333	Dry
1948	1,201.390	Normal-Dry	1978	3,402.805	Wet	2008	1,116.790	Normal-Dry
1949	1,167.008	Normal-Dry	1979	1,829.988	Normal-Wet	2009	1,455.379	Normal-Wet
1950	1,317.457	Normal-Dry	1980	2,973.169	Wet	2010	2,028.706	Normal-Wet
1951	1,827.254	Normal-Wet	1981	1,067.757	Normal-Dry	2011	3,304.824	Wet
1952	2,840.854	Wet	1982	3,317.171	Wet	2012	831.582	Dry
1953	1,226.830	Normal-Dry	1983	4,643.090	Wet	2013	856.626	Dry
1954	1,313.993	Normal-Dry	1984	2,042.750	Normal-Wet	2014	509.579	Critical-High
1955	1,161.161	Normal-Dry	1985	1,135.975	Normal-Dry	2015	327.410	Critical-Low
1956	2,959.812	Wet	1986	3,031.600	Wet	2016	1,300.986	Normal-Dry
1957	1,326.573	Normal-Dry	1987	756.853	Dry	2017	4,395.400	Wet
1958	2,631.392	Wet	1988	862.124	Dry	2018	1,348.979	Normal-Dry
1959	949.456	Normal-Dry	1989	939.168	Normal-Dry			
1960	826.021	Dry	1990	742.824	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 <u>excluding</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 Recruitment 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).

<table>
<tr><th rowspan="2">Flow Period</th><th rowspan="2">Gravelly Ford 5 cfs requirement (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 Recruitment 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 rowspan="2">7.064</td></tr>
<tr><td>Feb16 – Feb 28</td><td>–</td><td>0</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>Mar 1 – Mar 15</td><td>11.139</td><td>12.198</td><td>–</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td><td rowspan="2">45.484</td></tr>
<tr><td>Mar 16 – Mar 31</td><td>-12.171</td><td>13.012</td><td>–</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Apr 1 – Apr 15</td><td>9.947</td><td>12.198</td><td>–</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td><td rowspan="2">81.815</td></tr>
<tr><td>Apr 16 – Apr 30</td><td>16.864</td><td>12.198</td><td>–</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>May 1 – May 28</td><td>21.388</td><td>13.884</td><td>8.886</td><td>–</td><td>–</td><td rowspan="3">9.788</td><td rowspan="2">0</td><td rowspan="4">0</td><td>136.810</td></tr>
<tr><td>May 29 – Jun 30</td><td>29.671</td><td>–</td><td>10.473</td><td>–</td><td>–</td><td>79.228</td></tr>
<tr><td>Jul 1 – Aug 31</td><td>14.071</td><td>–</td><td>14.757</td><td>–</td><td>–</td><td>0</td><td>14.566</td></tr>
<tr><td>Sep 1 – Sep 30</td><td>9.951</td><td>–</td><td>8.331</td><td>3.792</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Oct 1 – Oct 31</td><td>10.034</td><td>–</td><td>–</td><td>11.873</td><td>–</td><td>–</td><td>0</td><td rowspan="5">0</td><td>–</td></tr>
<tr><td>Nov 1 – Nov 6</td><td>1.807</td><td>–</td><td>–</td><td>2.656</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Nov 7 – Nov 10</td><td>1.174</td><td>–</td><td>–</td><td>1.801</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Nov 11 – Nov 30</td><td>6.038</td><td>–</td><td>–</td><td>8.999</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Dec 1 – Dec 31</td><td>8.934</td><td>–</td><td>–</td><td>0</td><td>14.342</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Jan 1 – Jan 31</td><td>8.761</td><td>–</td><td>–</td><td>–</td><td>15.578</td><td>–</td><td>0</td><td>–</td><td>–</td></tr>
<tr><td>Feb 1 – Feb 28</td><td>8.309</td><td>0</td><td>–</td><td>0.812</td><td>13.487</td><td>–</td><td>0</td><td>–</td><td>2.491</td></tr>
<tr><td rowspan="5"></td><td rowspan="4">145.917</td><td>63.490</td><td>42.447</td><td>29.933</td><td>43.398</td><td>9.788</td><td rowspan="2">0.000</td><td rowspan="3"></td><td rowspan="3">367.458</td></tr>
<tr><td colspan="5">189.056</td></tr>
<tr><td colspan="6">189.056</td></tr>
<tr><td colspan="8">556.514 (2017 Allocation = 556.542)</td></tr>
<tr><td colspan="9">702.431</td></tr>
</table>