RECLAMATION
Managing Water in the West

Flaming Gorge Technical Working Group

March 7, 2017 Hydrology Summary

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For the purposes of discussions related to implementing the ROD in 2017, an evaluation has been made of the current hydrologic conditions in the Upper Green River (*i.e*. above Flaming Gorge Dam) and Yampa River Basins. The evaluation centered on the historical unregulated inflow statistics for Flaming Gorge Dam during the period from 1963 through 2016. The March 1, 2017 final forecast was 2,260,000 acre-feet for Flaming Gorge. The hydrologic classification will be wet (<10% exceedance) for spring 2017.

The combined April through July forecast of the Yampa River at Maybell and Little Snake at Lily is 1,500,000 acre-feet. This forecast would fall into the average (above median) hydrologic classification of the ROD.

Snow water equivalent (SWE) as of February 14, 2017, for the Upper Green River and Yampa/White River Basins are 175 and 120 percent of median, respectively. Flaming Gorge SWE is similar to 1986 and 1997, while Deerlodge SWE is similar to 2008 and 2009. The Tower snotel site, used as a reference point for Yampa snowpack and runoff, currently has 38.4 inches of SWE (112 percent of median). On March 7, Tower SNOTEL measured SWE inches of:

- 2008 = 33.7 in; Yampa 1,846 kaf obs spring (145%)
- 2009 = 37.5 in; Yampa 1,653 kaf obs spring (130%)

The difference between the Tower SNOTEL figures and Yampa River observed spring volume differs significantly and needs to be considered when comparing any values this early in the snow accumulation season.

Basin Hydrology

Green River Basin Hydrology

The March 1, 2017, ESP forecast of April through July unregulated inflow (current forecast) for Flaming Gorge Reservoir is 2,260,000 acre-feet (AF) (231% of 30-year average). This forecast falls at < 5% exceedance based on the historic unregulated inflow record (1963-2016).

Figure 1 illustrates the Upper Green River SWE as of March 7, 2017 and compares it against water years 1986 and 1997. Figures 2 and 3 show the spatial extent of significant areas of modeled snow accumulation for the Upper Green River Basin and how this is incorporated into the water supply forecasts. Figure 3 indicates that the forecast for Flaming Gorge Reservoir has continued to increase and the March 1, 2017, final forecast has increased from 1,986 kaf to 2,260 kaf from two weeks ago.

Historic year unregulated inflow volumes that compare with current snowpack are 1986 with total inflow into Flaming Gorge of 2,222 kaf (maximum historic year) and 1997 with total inflow into Flaming Gorge of 1,668 kaf (170 percent of average).

Figure 4 illustrates the current forecast in relation to the historic unregulated inflow volumes. Figure 5 illustrates Flaming Gorge Reservoir March final forecast probability (percent exceedance).

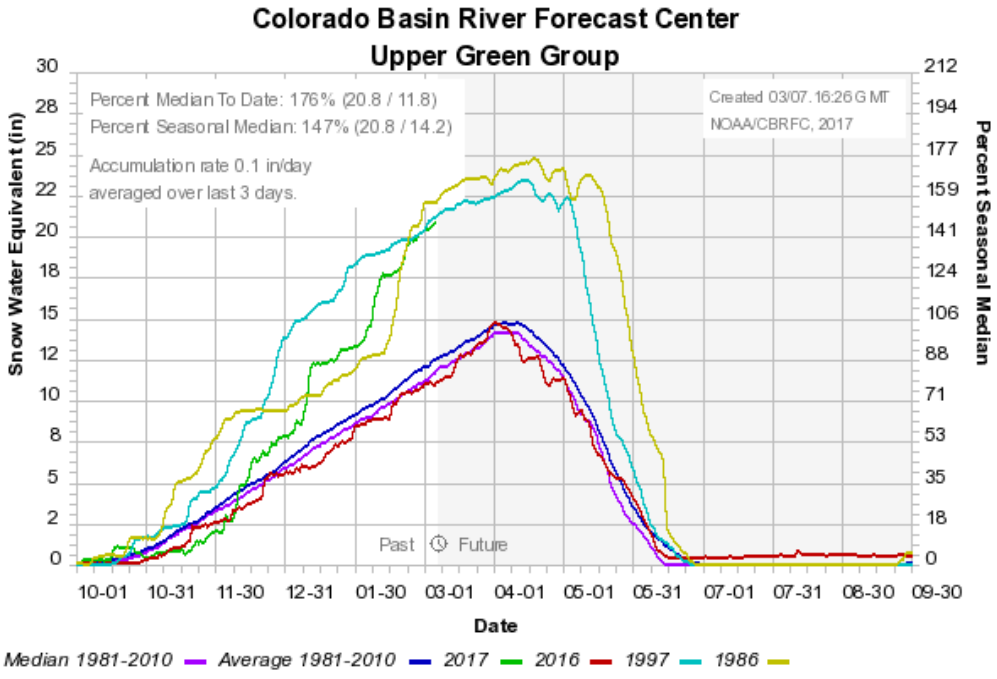

FIGURE 1. Upper Green River Basin Snotel Tracking. 1981-2010 percent of median compared against 2017 YTD Snow Water Equivalent (SWE) and 1986, 1997 and 2016 percent of average SWE

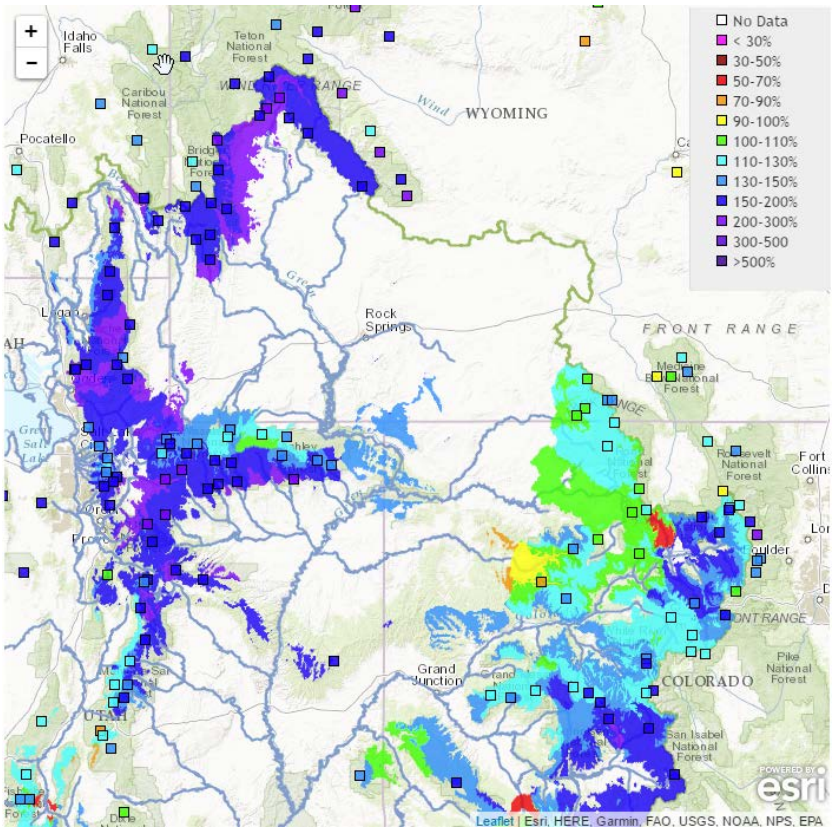

FIGURE 2. Upper Green River Basin modeled SWE significant areas as of March 7, 2017.

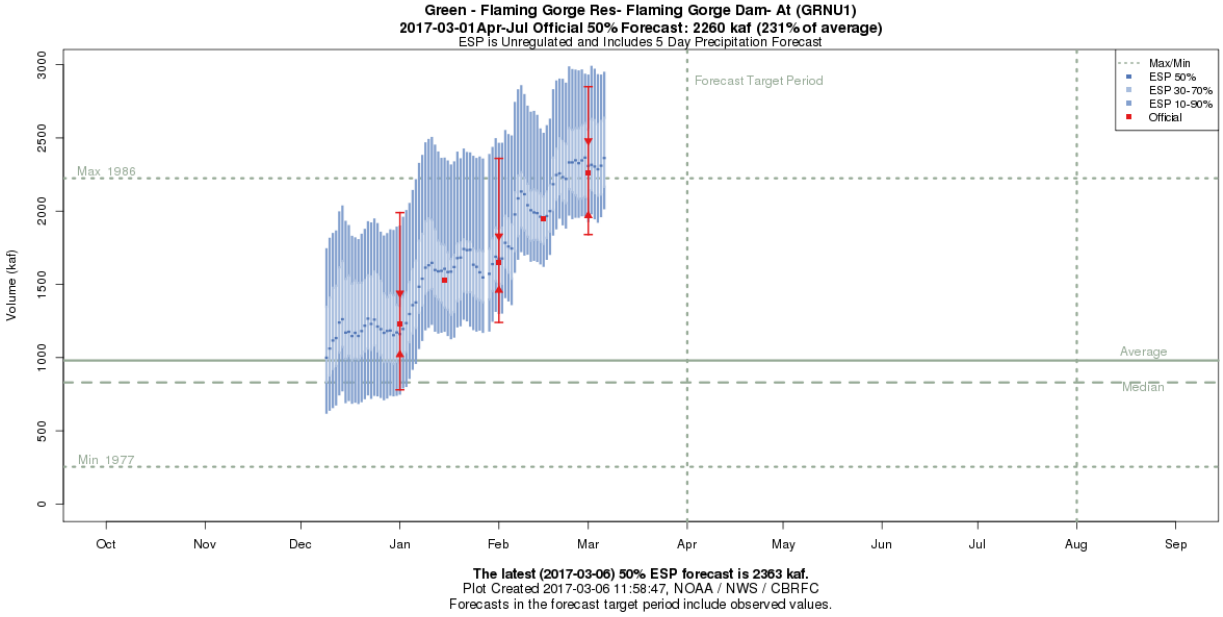

FIGURE 3. Upper Green River Basin Water Supply Forecast as of March 7, 2017.

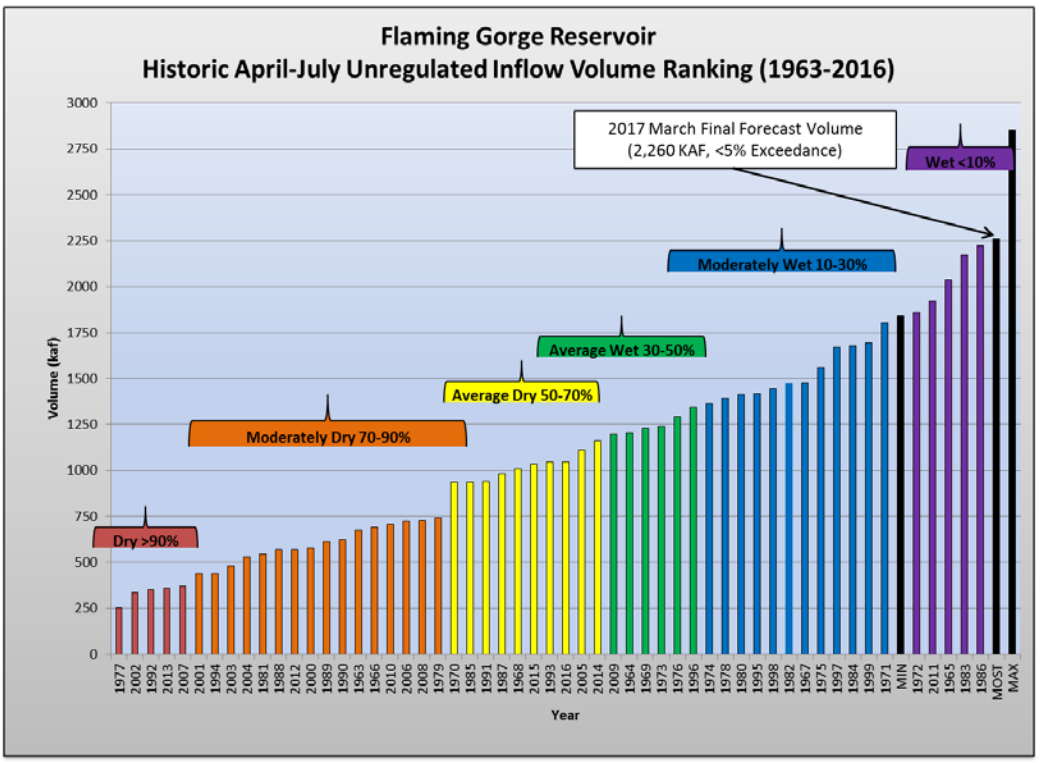

FIGURE 4. Flaming Gorge Reservoir March 1, 2017 forecast and ranked historic April-July unregulated inflow volume for years 1963-2016

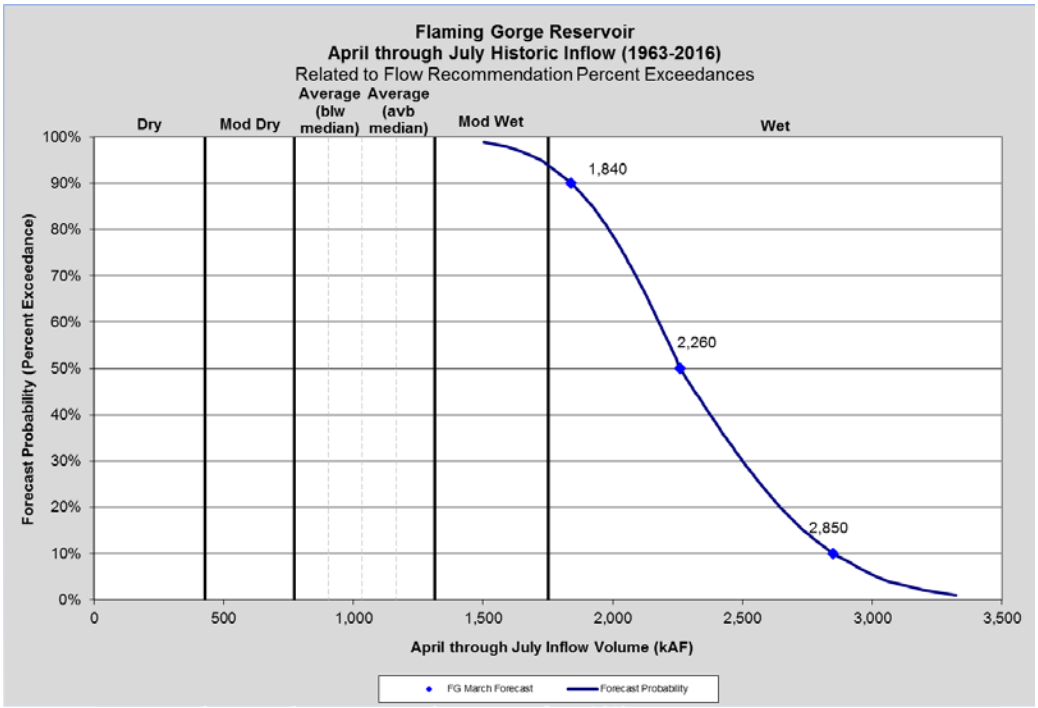

FIGURE 5. Flaming Gorge Reservoir March final forecast probability (percent exceedance) and historic April-July unregulated inflow volume for years 1963-2016

Yampa River Basin Hydrology

The combined current forecast for the Little Snake at Lily plus Yampa River at Maybell is 1,500,000 AF (121% of 30-year average). This forecast falls at approximately 30% exceedance based on a ranking of the historic record (1922-2016).

Figure 6 illustrates the Yampa River at Deerlodge Park SWE as of March 7, 2017 and compares it against water years 2008 and 2009.

Figures 7 and 8 show the spatial extent of significant areas of modeled snow accumulation for the Yampa River Basin and how this is incorporated into the water supply forecasts. Figure 8 indicates that the forecast for the Yampa River at Deerlodge is remaining stable and the March 1, 2017, final forecast increased from 1,377 kaf to 1,500 kaf from two weeks ago.[1]

Figure 9 below shows the current forecast in relation to historic flow volumes. Figure 10 illustrates the Yampa River at Maybell plus Lily March final forecast probability (percent exceedance).

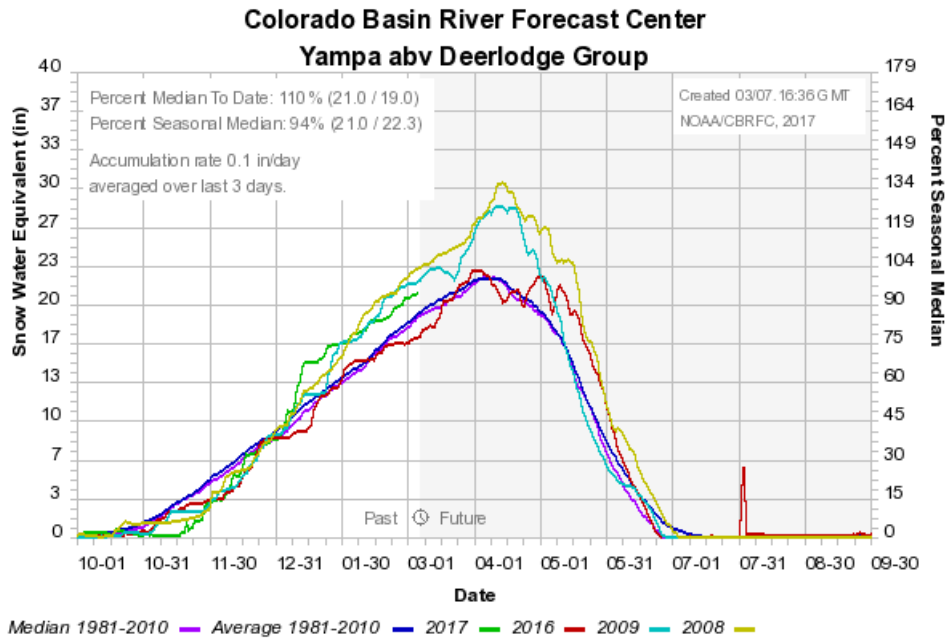

FIGURE 6. Yampa River above Deerlodge SNOTEL Group. 1981-2010 percent of average SWE compared against 2017 YTD, and analog years 2008, 2009, and 2016 percent of median SWE

[1] The Yampa River at Deerlodge forecast volume differs from the Yampa River – Maybell Plus Lily volume. The historic gage record to calculate the Maybell plus Lily forecast volume is significantly longer than the Deerlodge dataset. The forecast volumes will be close, but the actual volume may differ due to routing in the CBRFC forecast model.

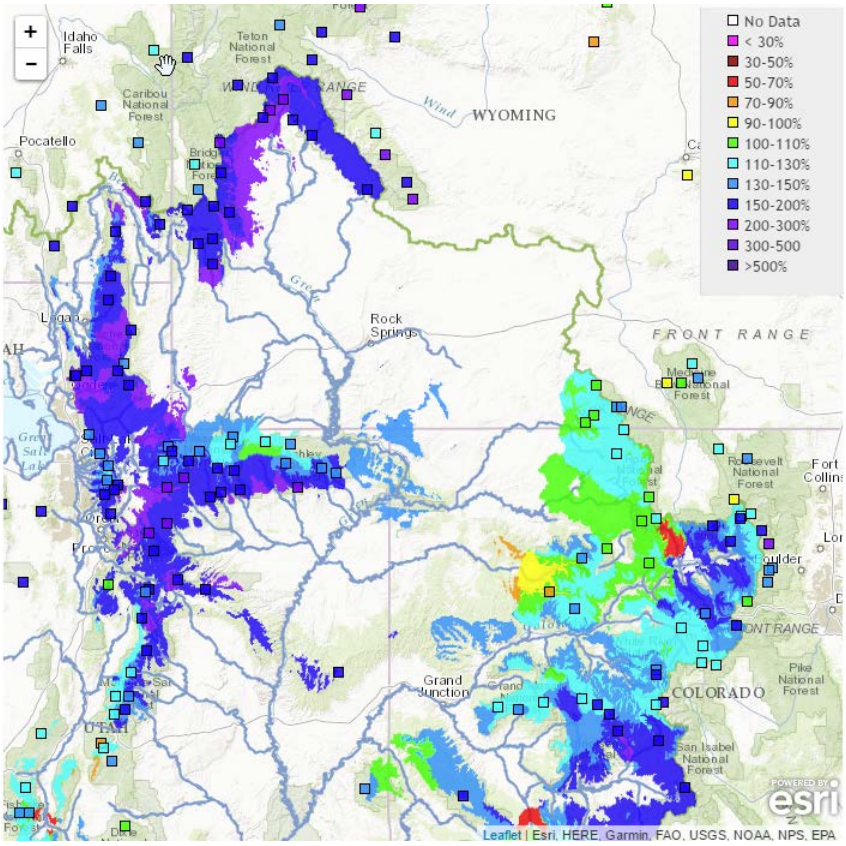

FIGURE 7. Yampa River Basin modeled SWE significant areas as of March 7, 2016.

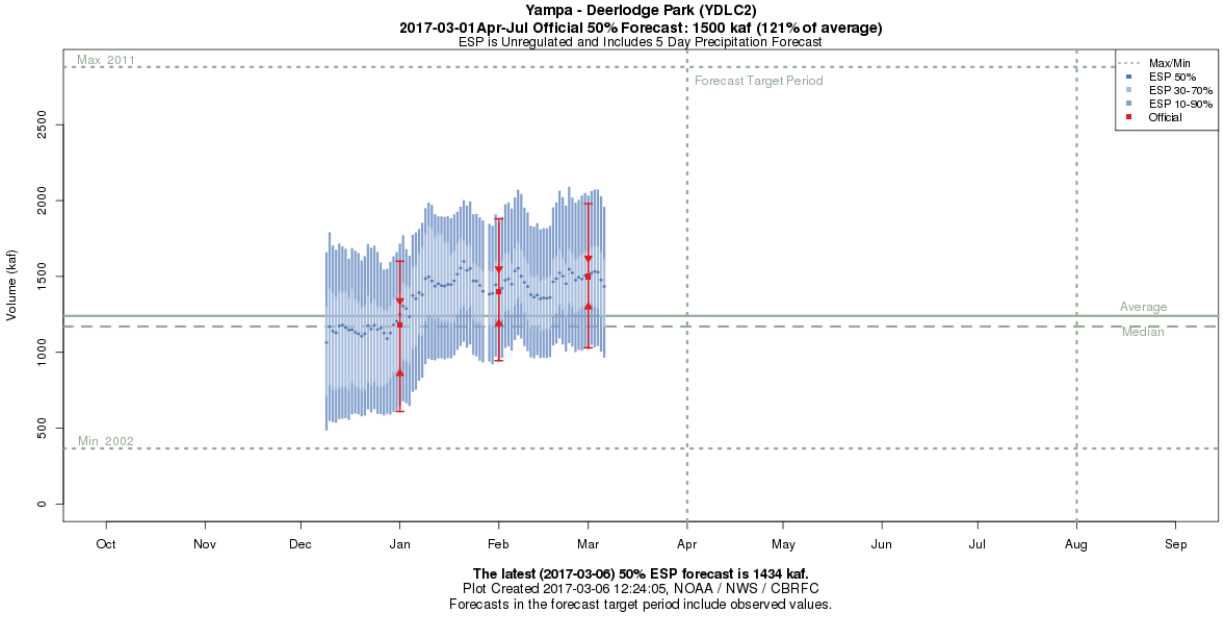

FIGURE 8. Yampa – Deerlodge Park Water Supply Forecast as of March 7, 2016.

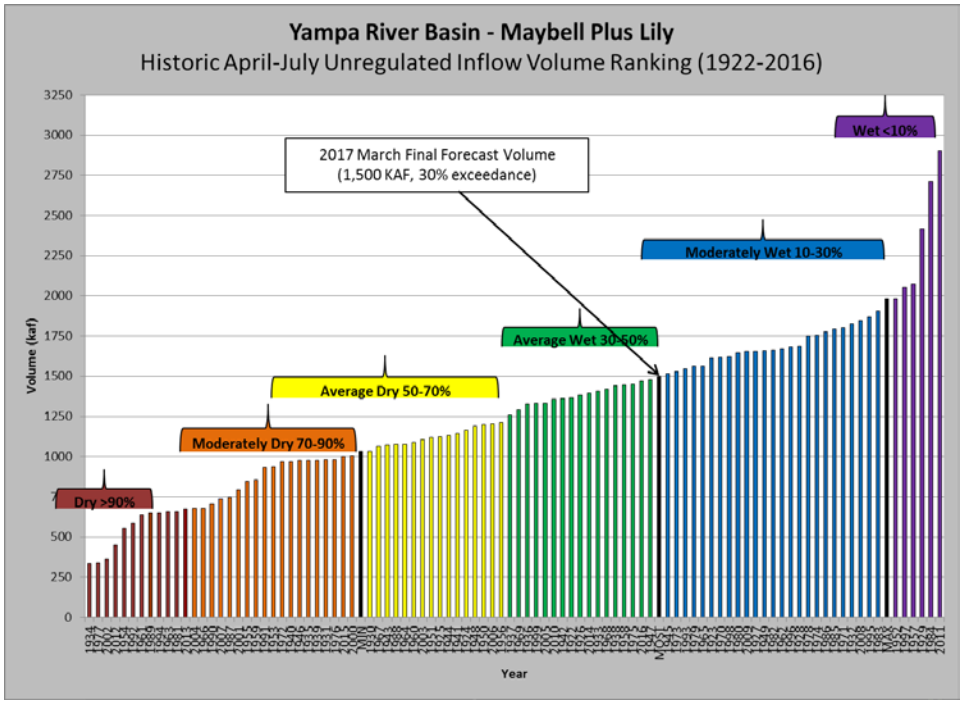

FIGURE 9. Yampa River Basin (Maybell plus Lily) March forecast and ranked April-July unregulated inflow volume for years 1922-2016

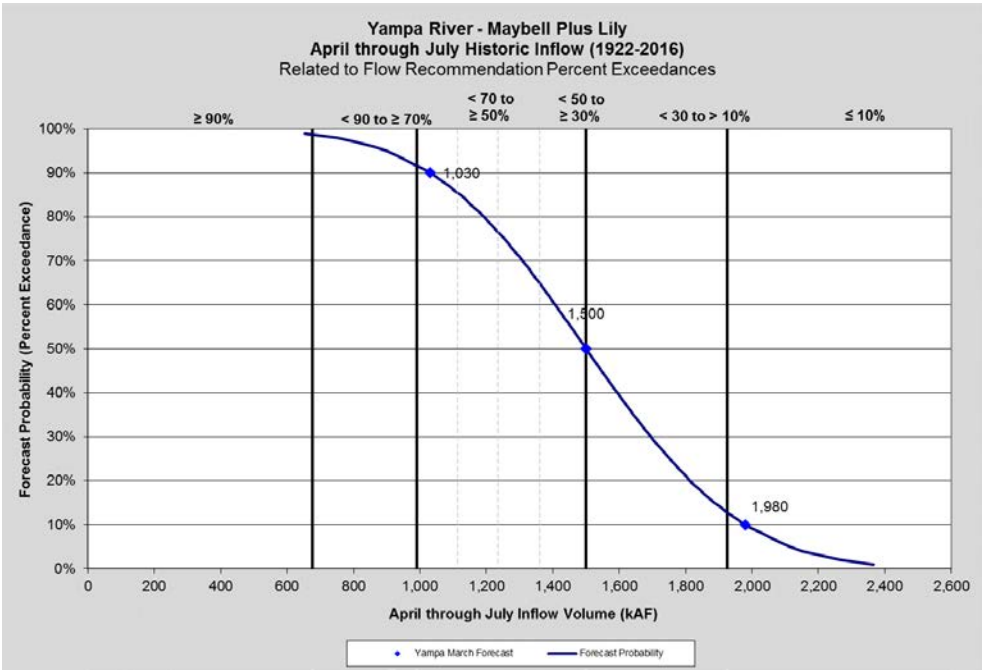

FIGURE 10. Yampa River – Maybell Plus Lily March final forecast probability (percent exceedance) and historic April-July unregulated inflow volume for years 1963-2016

Probabilities of Flow Events for Spring 2017

The Flaming Gorge unregulated inflow and Yampa River forecasts are wet and average (above median), respectively, and trending wetter. An analysis was completed to assist in the determination of appropriate flow objectives for spring and summer 2017. The Flaming Gorge forecast is so high that ten similar between the minimum and maximum forecasts are unavailable. The ten most similar historic years for the Yampa River Basin (Maybell plus Lily) compared to the current forecast (Table 1) were analyzed assuming a normal distribution.

Table 2 presents the percent exceedance of cumulative days greater than or equal to various flow levels at Yampa River (Maybell plus Lily). The current analysis indicates that it is likely Yampa River flows above 20,000 cfs will not be achieved this year.

Table 1
Yampa River (Maybell plus Lily) – April through July Unregulated Volume
Ten Similar Years to the March 1, 2017 Forecast
Thousand Acre-Feet (KAF)

Year	April-July Unreg Inflow Volume (KAF)
MIN	1,030
1938	1,439
1958	1,443
1975	1,450
2016	1,468
1947	1,479
MOST	1,500
1945	1,514
1973	1,527
1993	1,543
1979	1,562
1965	1,564
MAX	1,980

Table 2
Spring 2017 – Days above Specific Flow Thresholds in the Yampa River
(Maybell plus Lily)
Based on the March 1, 2017 Forecast
Percent Exceedance (%)

March 1, 2017 Forecast	% Exceed	Days above 6000 cfs	Days above 8000 cfs	Days above 10000 cfs	Days above 12000 cfs	Days above 14000 cfs	Days above 16000 cfs	Days above 18000 cfs
YAMPA	25%	58	41	26	19	10	6	0
	50%	53	38	23	14	7	3	0
	75%	51	34	21	13	6	1	0
	90%	43	31	17	10	5	0	0

Colorado Basin River Forecast Center Yampa River Analysis

The Colorado Basin River Forecast Center (RFC) calculates percent exceedance based on thirty years of historic temperature and precipitation data (1981-2010) using a modified Monte Carlo method to provide projections of flow. The RFC provides projections based upon (1) strict observance to the historic dataset and (2) incorporation of the ten-day quantitative precipitation forecast (QPF). QPF is the expected amount of melted precipitation over the ten-day climate forecast period.

The RFC provides a synopsis of the current seasonal outlook for the Yampa River at Deerlodge. This synopsis is provided below:

> *This outlook is based on flows from ESP with model states as of March 6. Water year precipitation is slightly above average in the Yampa River Basin at 115 percent of normal. Precipitation was above average for the month of January followed by near average precipitation in February. February precipitation was 97 percent of average. The current snow water equivalent as of March 1 is 115 percent of median in the Yampa River Basin.*
>
> *The Yampa River basin is expected to be under a zonal flow through at least Friday. This will result in dry conditions and a modest warming trend. Models are currently indicating a slight chance for precipitation Friday into Saturday before a ridge of high pressure reestablishes providing more dry weather. 10 day streamflow forecasts are suggesting some increases due to low elevation snowmelt by days 9-10 of the forecast period.*

The RFC provides updated Yampa River April through July seasonal exceedance probabilities for both the river flows and daily maximum peak flow. Table 3 presents the RFC projections based on current information. Figures 11 and 12 illustrate the probabilities of the Yampa River at Deerlodge river flows exceeding certain thresholds and exceedance probabilities over the April through July spring period.

Table 3
Maximum Peak Daily Flow on the Yampa River at Deerlodge
Based on the March 6, 2017, RFC Analysis
Percent Exceedance (%)

CBRFC March 1, 2017 Projections	% Exceed	Maximum Daily Peak (cfs)	Number of Days to Peak from 04/01/17	Number of Days Above 10,000 cfs	Number of Days above 14,000 cfs	Number of Days above 16,000 cfs
YAMPA	10%	22,648	73	44	24	15
	25%	16,146	66	33	11	1
	50%	14,221	55	22	1	0
	75%	12,067	48	10	0	0
	90%	10,525	39	1	0	0

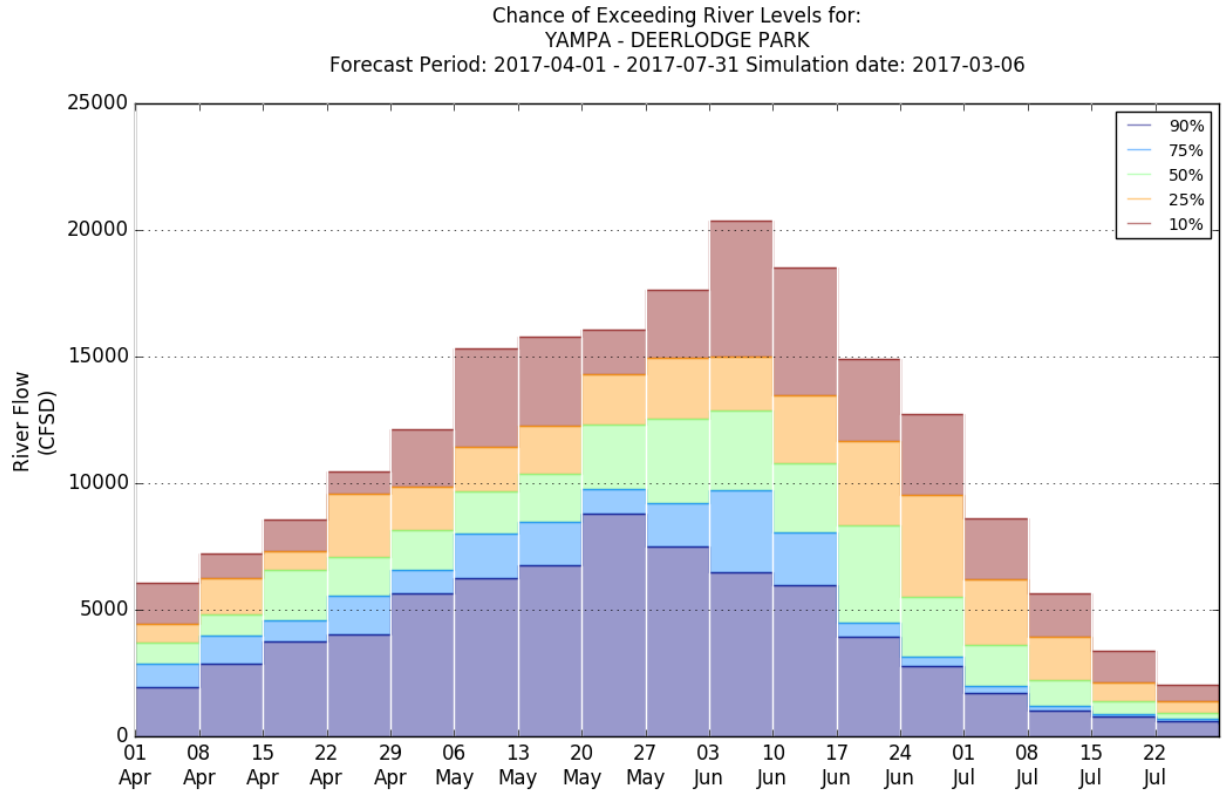

FIGURE 11. RFC March 6, 2017 projection of Yampa River at Deerlodge flows exceeding thresholds for various percent exceedance for the 2017 April through July spring period.

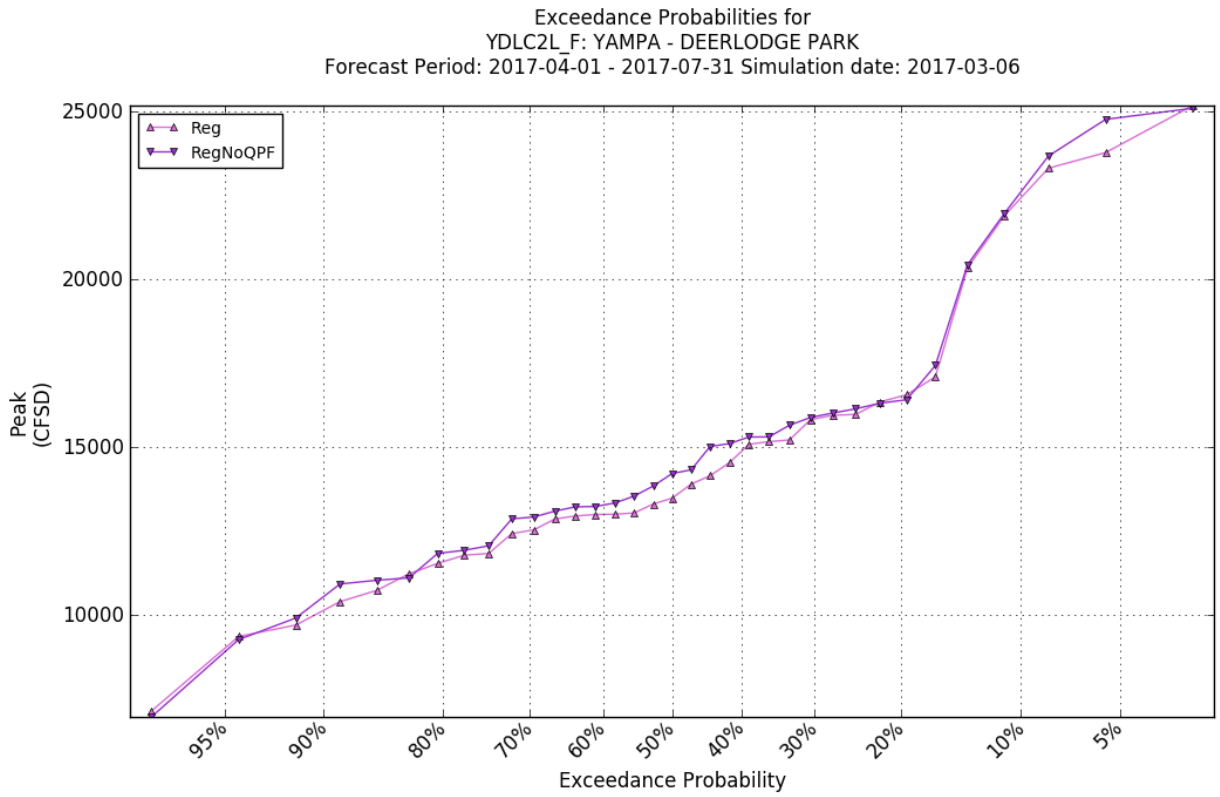

FIGURE 12. RFC March 6, 2017 projection of Yampa River at Deerlodge flow exceeding thresholds for based on the historic observed, simulation of historic climate with current initial conditions and simulation of historic climate including the ten-day QPF with initial conditions.