Appendix Q

Preferred Operational Scenario with Martis Creek Reservoir Operational Analysis

TRUCKEE BASIN OPERATIONAL SCENARIO WITH MARTIS CREEK RESERVOIR OPERATIONAL

Analysis of an operational scenario of Truckee Basin Flood Operations with Martis Creek Reservoir fully operational for flood control purposes under the changes to the Water Control Manual (WCM) that are being proposed by the Truckee Basin Management Options Pilot (TBWMOP)

Abstract

The Truckee Basin Management Options Pilot proposes changes to the Truckee Basin Water Control Manual. This report analyzes how Martis Creek Reservoir being operational for flood control storage would impact the Preferred Operational Scenario water supply and flood operation objectives.

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1 Introduction

The Truckee Basin Water Management Options Pilot Study (TBWMOP) is an effort to study potential improvements to flood control operations on the Truckee River for the benefit of water management in the basin. The goal of the TBWMOP project is to develop a proposed revision to the 1985 United States Army Corps of Engineers (USACE) Truckee Basin Water Control Manual (WCM) (US Army Corps of Engineers, 1985) that governs management of flood control reservoirs in the Truckee Basin. The issues the TBWMOP aims to address are best summarized as follows (Department of Interior Bureau of Reclamation, 2021):

> "The [WCM] suffers from outdated rule curves, inflexible storage requirements, constrained reservoir release thresholds, and a constrained downstream regulation goal at Reno. It also does not reflect the Truckee River Operating Agreement (TROA), flood mitigation projects completed in Reno and Sparks since 1985, or the 2017 crest raise at Reclamation's Stampede Dam."

Stakeholders that contributed to addressing this set of issues include: the United States Bureau of Reclamation (USBR), Pyramid Lake Paiute Tribe (PLPT), the United States District Court Water Master (USWM), the California Department of Water Resources (CA DWR), the Truckee Meadows Water Authority (TMWA), Truckee River Flood Management Authority (TRFMA), California Nevada River Forecast Center (CNRFC), the National Weather Service (NWS) and USACE.

The 1985 WCM authorizes the use of Martis Creek Reservoir (Martis) to store water for flood control when flows at the Reno Gage reach 14,000 cfs; however, Martis Dam is currently following an interim flood control operation based on a 2008 dam safety risk screening that classified the project as high risk due to hydrologic (overtopping) and seepage deficiencies. These findings led to the requirement to leave the gates fully open at all times. A more rigorous risk assessment in 2015 found that the seepage would not lead to erosion of the foundation, and also that the probability of an overtopping flood event is lower than was previously assessed. Based on these updated findings, the dam is now categorized to have moderate risk. The interim flood control operation continues, with gates remaining fully open, until a test fill can be completed for Martis Creek Dam. The test fill is on hold and does not have a timeline determined (US Army Corps of Engineers, 2022).

The operational capacity of Martis was one of the primary concerns that were expressed during the stakeholder discussion of problems and opportunities with the 1985 WCM in the spring 2021 workshop. The stakeholders wanted to ensure that an updated WCM allowed for Martis to come back online in either a full or partial capacity. As such, the stakeholder group adopted the following statement as an objective for the TBWMOP: "allow flexibility for varying future operating conditions of Martis Creek Dam". This objective ensured that any alternatives considered contained flexibility for various operational states of Martis Creek Reservoir. Further stakeholder discussions decided that securing funding for USACE to conduct studies related to the potential dam safety improvements to rehabilitate Martis Creek Dam were outside the scope of the TBWMOP, however an analysis that accounts for effects of Martis Creek Dam being fully operational within the Preferred Operational Scenario would be completed as part of the TBWMOP (Bureau of Reclamation, 2021). This report will compare the results

of the Preferred Operational Scenario with and without Martis operational to the Baseline scenario which operates to the 1985 WCM without Martis being operational.

2 Impacts to Preferred Operational Scenario

The Preferred Operational Scenario includes a variety of changes including: updating the WCM with the latest available data, updating the downstream target to 7,000 cfs at Reno while ensuring flexibility for future changes in the downstream regulation target, allowing encroachment into flood space based on Forecast Informed Reservoir Operations (FIRO), adjusting the distribution of flood space between Boca and Stampede, and implementing flexibility for future operational states of Martis Creek Dam and Reservoir. The technical analysis that was used to inform selection of the Preferred Operational Scenario is discussed in detail in *Action and Alternative Modelling in the WMOP* (Noe, 2023) and the selection process is discussed in detail in *Preferred Operational Scenario Selection Process* (Gwynn & Noe, 2023).

The following report summarizes the attributes of the Preferred Operational Scenario that include built in flexibility for the operational or non-operational state of Martis. The TBWMOP first updated the Dynamic Storage Reservation Diagrams (dSRD) which are referred to as the Revised Guide Curves by the TBWMOP (Gwynn, 2022). The Preferred Operational scenario then allows encroachment into the flood space required by the Revised Guide Curves based on Forecast Informed Reservoir Operations (FIRO).

2.A Revised Guide Curves - dSRD

The dSRD analysis is based on 113 years of historical unregulated flow data for Reno including the releases from Lake Tahoe for 1909 through 2020 and the latest USACE criteria for developing dSRDs (NRCS, 1991; USACE, 2018; Lahde, et al., 2022). The daily average unregulated flow at Reno plus the releases from Lake Tahoe measured at Tahoe City[1] by day of year are illustrated in Figure 1 as well as the respective 1/50-year and 1/100-year flows that were also developed by Lahde, et al. This chart shows that unregulated flows exceeding the updated Reno flood target of 7,000 cfs have occurred no earlier in the year than mid-November and the few floods that have occurred in November had a peak unregulated flow of less than 15,000 cfs which could have been managed with a portion of the flood space (Gwynn, 2022).

[1] Lake Tahoe is a large natural lake at the headwaters of the Truckee River Basin with a dam that allows control of six feet of the lake level above the natural rim. TROA prescribes when release will be made to maintain the maximum elevation of 6,229.1' (Truckee River Operating Agreement, 2008). These releases can be up to 3,000 cfs when the lake is full and thus can make up over 40% of the 7,000 cfs flood target downstream at Reno. Because of this the releases from Lake Tahoe (measured at the Truckee River at Tahoe City) are included in the unregulated flow at Reno for computation of the Revised Guide Curve as it is a better indicator of the volume that would need to be stored in Truckee River flood control reservoirs to eliminate flooding (Gwynn, Revised Guide Curve Modeling, 2022).

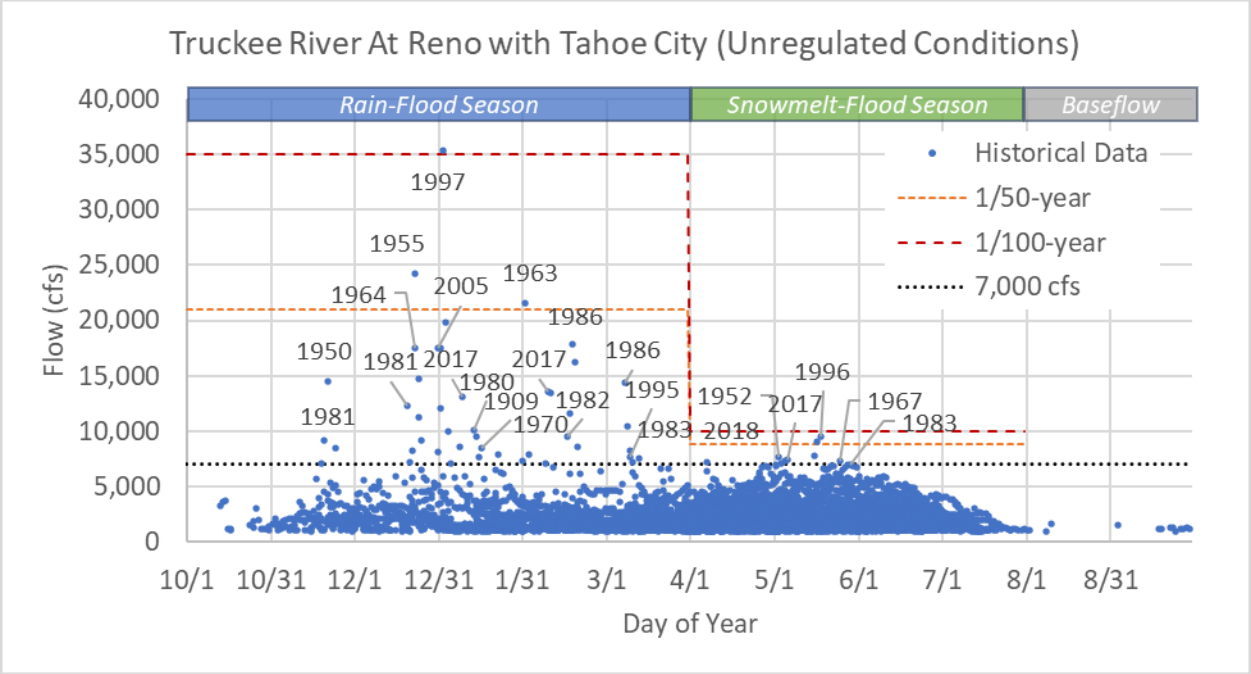

Figure 1: Summary of historical daily average Reno unregulated flows including Lake Tahoe releases measured at Tahoe City and established seasonal flow recurrence intervals. Flows less than 1,000 cfs were omitted.

The Revised Guide Curves with Martis operational extend the period when reservoirs can encroach into flood space for both the fall drawdown period and the spring fill period. As an example, the required Prosser flood space for a regulation target at Reno of 6,000 cfs in the Baseline[2], and 7,000 cfs in the Revised Guide Curve scenarios with and without Martis being operational for a dry, median and wet year are shown in Figure 2. The Revised Guide Curves have notable differences from the Baseline curves prescribed in the 1985 WCM because they were derived with additional data that has occurred since the WCM publication in 1985, updated guidance (NRCS, 1991; USACE, 2018), and a higher downstream target. As shown in Figure 1, only moderate floods have occurred in November and early December. Because of this, the Revised Guide Curves without Martis operational do not require all the Truckee Basin Flood Space until December 6th, 36-days later than the Baseline curves which require all the flood space to be reserved by November 1. If Martis' storage contributes to this basin total flood space requirement, then the date when all the flood space is required is pushed back 10 additional days to December 16th. Similarly, the latest observed unregulated flows near 7,000 cfs that have occurred in the snowmelt season are the end of May and the highest flows that have occurred in June are 6,000 cfs. These high summer flows occur in higher runoff years, so the Revised Guide Curves allow earlier encroachment into the Truckee Reservoir flood space if Martis' storage contributes to the basin food space than if Martis does not contribute to the basin flood space. In WY2000, a near median runoff year,

[2] The Baseline snowmelt parameter is based on the remaining April through July runoff while the Revised Guide Curve runoff parameter is based on the remaining water year forecast. The CNRFC Hindcast dataset was used to derive both quantities.

the first date that encroachment into flood space is permitted is March 24th without Martis operational and March 3rd with Martis operational compared to April 10th in the Baseline scenario.

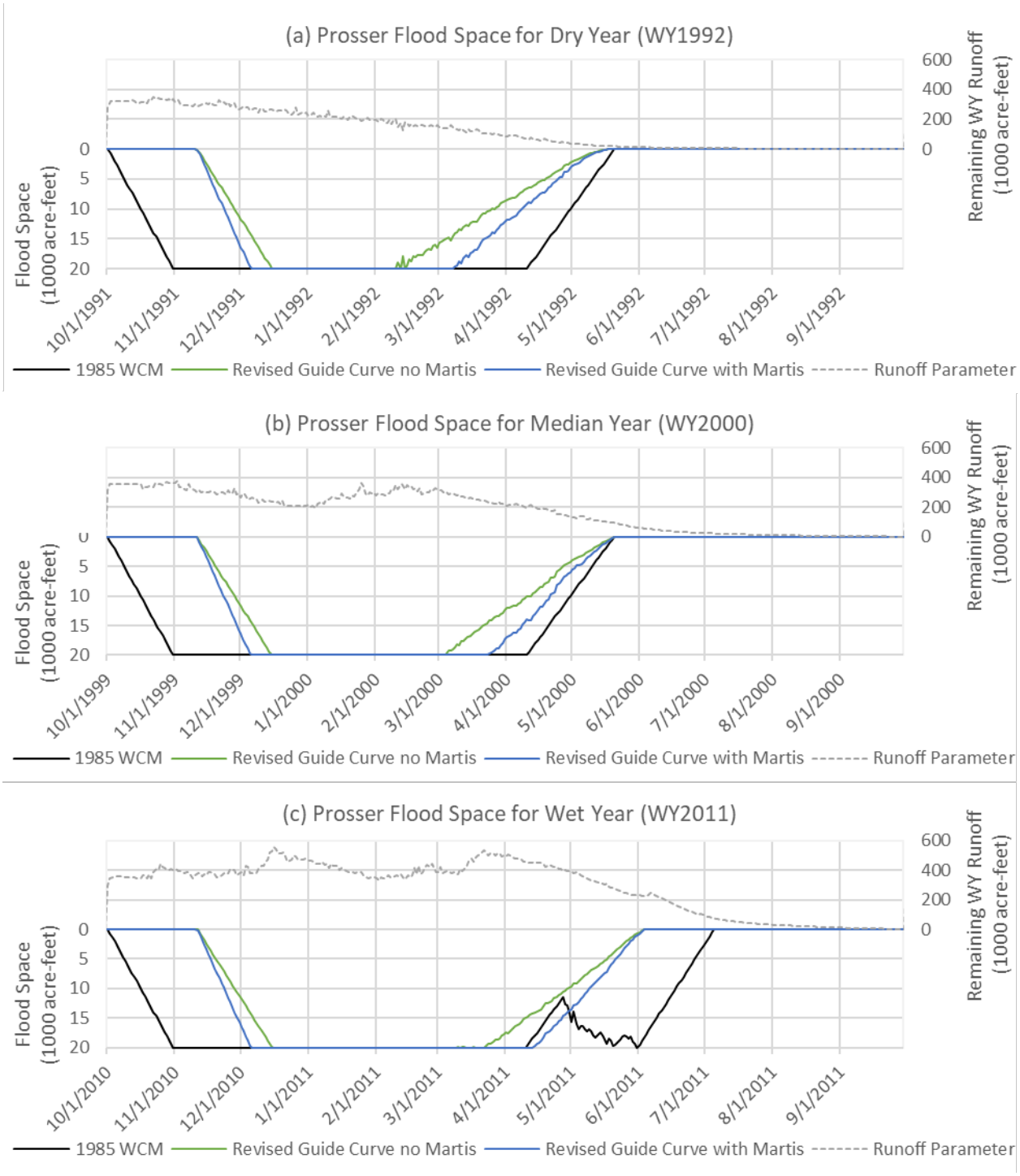

Figure 2: Comparison of the Prosser required flood space in the Baseline/1985 WCM, 7000 cfs Revised Guide Curve with and without Martis scenarios for (a) a dry (90% exceedance) year, (b) a median year and (c) a wet (10% exceedance) year. The forecasted remaining runoff is also shown.

2.B FIRO

The Preferred Operational scenario allows encroachment into the flood space required by the Revised Guide Curves based on Forecast Informed Reservoir Operations (FIRO). The FIRO specific method is based on the CNRFC Hydrologic Ensemble Forecasting System (HEFs) hindcasts that are used to determine the required basin flood space and is referred to as the By-a-Model method. The parameters used to determine the amount of flood space that is required by FIRO were optimized using a Multi-Objective Evolutionary Algorithm (MOEA) to adjust the study parameters to meet the study operational objectives while being within the study constraints[3]. The details of this process are summarized in the "Action and Alternative Modelling in the WMOP" report (Noe, 2023). The calculation of the dSRDs and the FIRO flood space are both based on similar computation of the required flood space in the Truckee Basin. The Revised Guide Curves are based on the amount of flood space that was required in historical years while FIRO uses an ensemble forecast of how much flood space may be required in the future. In both cases, the Basin Flood space was then distributed to the Truckee Basin reservoirs. The ratio used to distribute the Truckee Basin Flood space to the respective flood control reservoirs in each scenario is summarized in Table 1. One of the decision variables that was changed in both versions of the Preferred Operational Scenario (with and without Martis) is the distribution of the Little Truckee flood space between Boca and Stampede which was changed from reserving 73% of the flood space in Stampede to being distributed evenly between Boca and Stampede. Inclusion of the Martis flood space in the total Truckee Basin flood space reduces the portion of flood space that needs to be distributed to the other reservoirs. In periods when the total basin flood space requirement (by either the Revised Guide Curve or By-A-Model) is less than the total flood space reserved in the basin then the amount of flood space required in Prosser, Boca and Stampede will be less in the with Martis scenario than in the no Martis scenario.

Table 1: Summary of Truckee Basin Reservoir flood space reservations for each scenario

Reservoir	Baseline – no Martis		Preferred Operational Scenario – no Martis		Preferred Operational Scenario – with Martis	
	Flood Space	Percent of Total	Flood Space	Percent of Total	Flood Space	Percent of Total
Prosser	20,000 AF	40.0%	20,000 AF	40.0%	20,000 AF	28.6%
Martis	0 AF	0.0%	0 AF	0.0%	20,000 AF	28.6%
Little Truckee Total	30,000 AF	60.0%	30,000 AF	60.0%	30,000 AF	42.8%
• Boca • Stampede	• 8,000 AF • 22,000 AF	• 16.0% • 44.0%	• 15,000 AF • 15,000 AF	• 30.0% • 30.0%	• 15,000 AF • 15,000 AF	• 21.4% • 21.4%
Basin Total	50,000 AF	100.0%	50,000 AF	100.0%	70,000 AF	100.0%

Additionally, if Martis was operational in the Preferred Operational Scenario, flood event releases would be operated conjunctively with the releases of other flood control reservoirs to maintain the flows at Reno to the applicable Reno flood operations target (set to 7,000 cfs in the Preferred Operational Scenario). This differs from the operations prescribed by the 1985 WCM where Martis is operated to maintain 14,000 cfs while the other reservoirs are operated to maintain 6,000 cfs.

[3] The study objectives and constraints were defined by a stakeholder group (Bureau of Reclamation, 2021).

3 Impacts to Results

3.A Study Metrics

The TBWMOP developed metrics for the various basin objectives that were used by the MOEA and to facilitate screening of the initial MOEA results. The objectives that were used for this process are defined in Table 2 and will also be used to compare the results of Martis being operational.

Table 2: Summary of Quantifiable Objectives (Gwynn & Noe, 2023)

Objective Name	Calculation	Goal
Average Annual Volume for FR	Calculates the volume of Floriston Rate water within each of the 37 years of the planning model run and takes the average of these 37 years.	Maximize
Average Prosser Boca Stampede Storage	Calculates the average combined storage in Prosser, Boca, and Stampede over the model run.	Maximize
Average Annual Volume for Flow Regime	Calculates for each of the 37 years of the model run the average annual flow at Nixon limited the Flow Regime Target and then takes the average of these values. The flow regime target is computed within the planning model.	Maximize
RMS Flow over Flood Target	Using the historical dataset and the 100-year Scaled Hindcasts, the Square root of the sum of the squared hourly flows over 6500 cfs.	Minimize
Average Daily Increase in Flood Space Requirement	The average daily increase in the basin Flood Space requirement, limited to the days when the Flood Space requirement increases	Minimize

The results of these objectives with the Preferred Operational Scenario with and without Martis are summarized in Table 3. First, the Preferred Operational Scenario No Martis is compared to the Baseline No Martis to show the magnitude of the improvements attained in the Preferred Operational Scenario. The direct water supply objectives (Annual Average Volume for FR and Average Annual Volume for Flow Regime) showed modest improvements of 197 acre-feet/year and 956 acre-feet/year which represent less than a 1% improvement over the Baseline value. The Average Prosser Boca Stampede storage was increased by 6,534 acre-feet which is a 3.7% improvement over the Baseline value indicating that there would be more water in the reservoirs on average. The flooding objective, RMS Flow Over Flood Target, had the highest percentage benefit, decreasing flood impacts by 15,150 cfs or 9.5% of the Baseline value. The operational objective Average Daily Increase in Flood Space Requirement, which represents the magnitude of required flood space evacuations, is the only objective that is worse than Baseline in

the Preferred Operational Scenario. This objective is 18 acre-feet/day worse than the Baseline indicating that the FIRO approach requires larger flood space evacuations on average (generally occurring before a storm). The Preferred Operational Scenario is compared to the Baseline Scenario in more detail in the *Preferred Operational Scenario Selection Process* (Gwynn & Noe, 2023).

Comparison of the two versions of the Preferred Operational Scenario (with Martis and without Martis) showed the following. The direct water supply objectives (Annual Average Volume for FR and Average Annual Volume for Flow Regime) showed only 5 acre-feet/year of improvement in Floriston Rate and 1 acre-feet/year of reduction in Flow Regime under the Preferred Operational Scenario. The Average Prosser Boca Stampede storage was increased by 693 acre-feet, which is an additional 0.4% improvement over the without Martis scenario. This indicates having Martis operational results in more water in the other reservoirs on average even if Martis were only operational for flood control not water supply storage. The flooding objective RMS Flow Over Flood Target had the highest percentage benefit, decreasing by an additional 9,369 cfs or 5.9% of the Baseline value improvement from the without Martis scenario. The operational objective Average Daily Increase in Flood Space Requirement, which represents the magnitude of required flood space evacuations is better than the No Martis scenario by 9 acre-feet/day but still worse than the Baseline scenario.

Table 3: Comparison of Objectives with and without Martis Operational

Objective	Baseline – no Martis	Preferred Operational Scenario – no Martis	Preferred Operational Scenario – with Martis	Preferred Operational Scenario – no Martis vs Baseline – no Martis	Preferred Operational Scenario – no Martis vs with Martis
Average Annual Volume for FR (acre-feet)	263,079	263,277	263,282	197	5
Average Prosser Boca Stampede Storage (acre-feet)	175,024	181,559	182,252	6,534	693
Average Annual Volume for Flow Regime (acre-feet)	148,067	149,023	149,022	956	-1
RMS Flow Over Flood Target (cfs)	159,960	144,811	135,442	15,150	9,369
Average Daily Increase in Flood Space Requirement (acre-feet)	187	204	196	-18	9

3.B Water Supply Impacts

As noted in Table 3, the Average Prosser Boca Stampede Storage is the only water supply objective that was notably affected by Martis being operational. Figure 3 summarizes the change from the Baseline annual average Prosser, Boca, and Stampede combined storage in the Preferred Operational Scenario with and without Martis. In general, the Preferred Operational Scenario provides more water in storage than the Baseline scenario, with additional storage occurring in the with Martis scenario. Some years

where additional storage is accumulated in the with Martis scenario included 1993, 2003, 2011, 2017 and 2019 which were all above median runoff years that were preceded by dry periods.

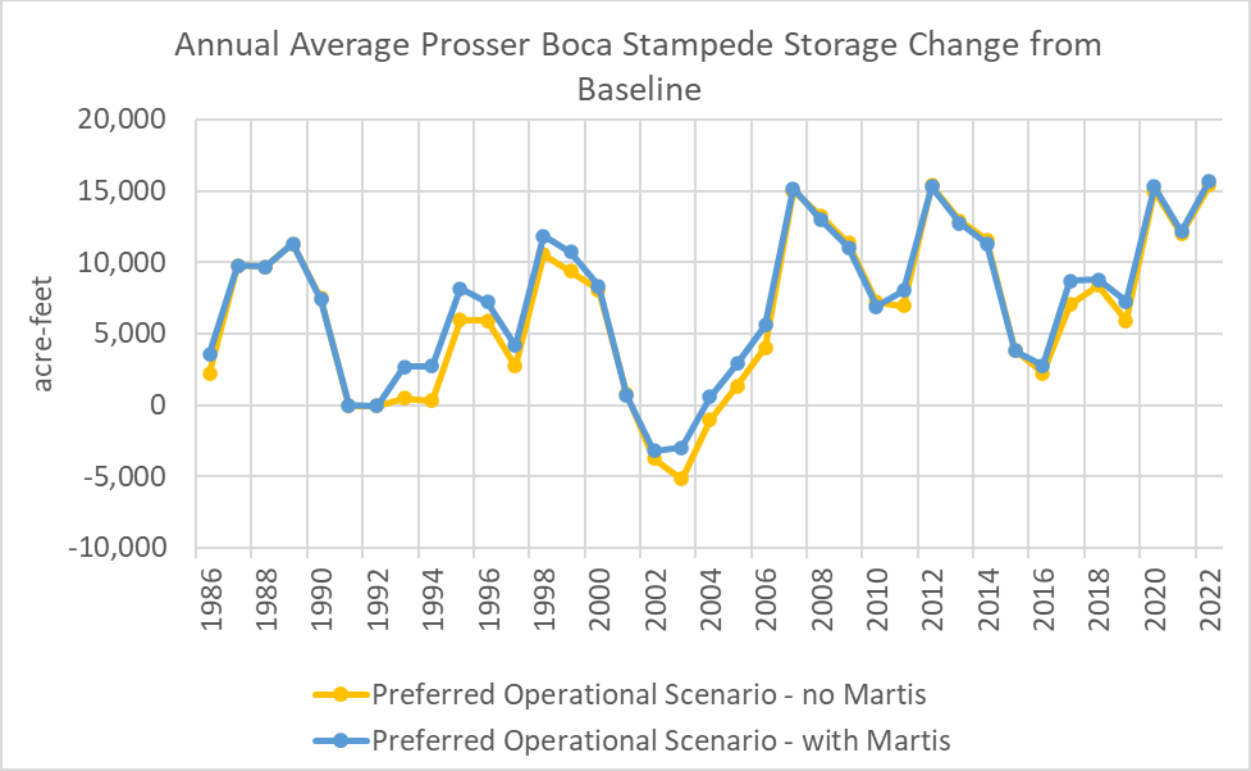

Figure 3: Summary of change from Baseline annual average combined Prosser Boca and Stampede storage

3.B.1 Spring Refill Impacts

Figure 4 compares the Prosser storage and required flood control capacity in the Baseline, and the Preferred Operational Scenarios with and without Martis in 1993. Hydrology in 1993 was a 26% exceedance runoff year (139% of average) that followed a severe drought. In this year, Martis' contribution to the spring flood space requirement allowed Prosser to retain water stored in March and fill at a slower rate ultimately reaching full on May 28th, the same date as the no Martis scenario. Both versions of the Preferred Operational Scenario (with and without Martis operational) can fill the reservoir unlike the Baseline scenario. Additionally, both versions of the Preferred Operational Scenario fill at a steady rate compared to the initial storage and later evacuation that occurs in the Baseline scenario. The fill seasons in 2011 (a 13% exceedance or 183% of average runoff year) and 2019 (a 18% exceedance or 162% of average runoff year) show similar improvements in the fill pattern.

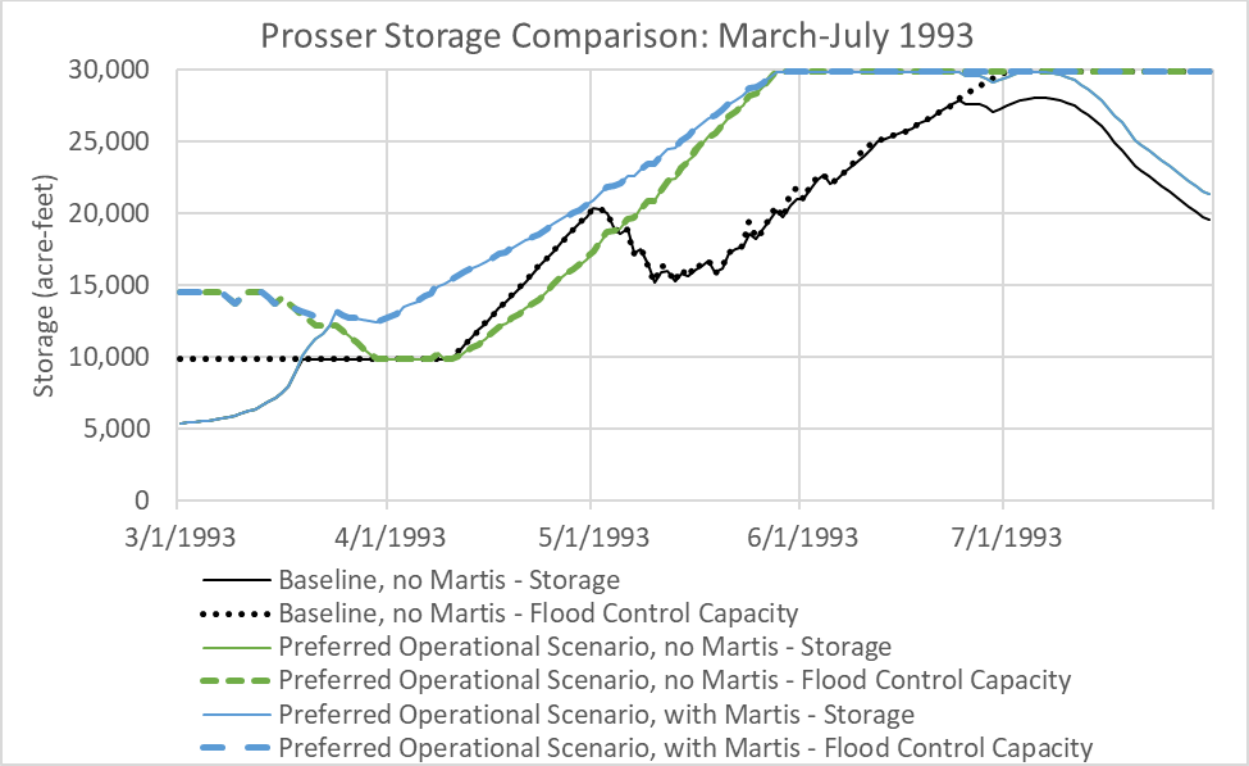

Figure 4: Comparison of Prosser spring operations in 1993

3.B.2 Fall Drawdown Impacts

Much of the water supply benefits that are gained by the TBWMOP scenarios are achieved by delaying the fall drawdown date and limiting the fall drawdown volume based on FIRO forecasts. These interactions are discussed in detail in the *Preferred Operational Scenario Selection Process* report (Gwynn & Noe, 2023). Martis's impact on fall operations will be discussed herein. 2017 is the largest runoff year in the dataset with 300% of the average water year runoff. This very large year, in the Martis operational scenario, allows for an increase of 16,400 acre-feet (6.7%) more carryover storage over Baseline the Prosser, Boca and Stampede storage. As shown in Figure 5 and Figure 6, the Martis operational scenario has a higher flood control capacity between November 11 and December 15. In 2017, there was sufficient storage to leverage Martis' additional capacity, delaying the drawdown in Stampede, and capturing more of the Stampede drawdown in Boca. The storage in both reservoirs converge after December 15th in the Preferred Operations Scenario with and without Martis, but delayed drawdown allows for releases that more closely mimic the inflows as shown in Figure 7. These releases that more closely mimic the natural inflows would be beneficial for native mountain white fish *(Prosopium williamsoni)* that spawn in the Truckee River and its tributaries in the fall (California Department of Water Resources; California Department of Fish and Wildlife, 2018). The operations with Martis are closer to the natural inflows than the no Martis scenario while both avoid the sudden drop in flows on November 1st in the Baseline scenario that could be detrimental to spawning.

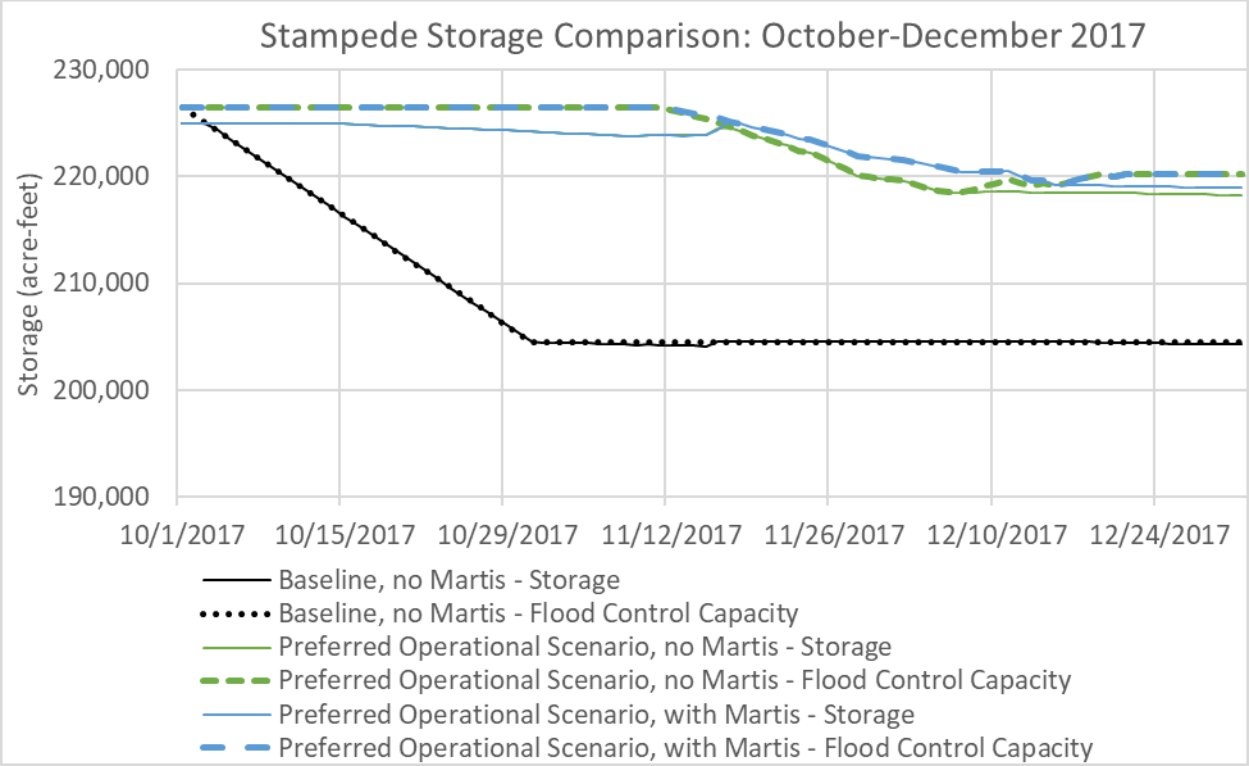

Figure 5: Comparison of Stampede fall drawdown operations in 2017

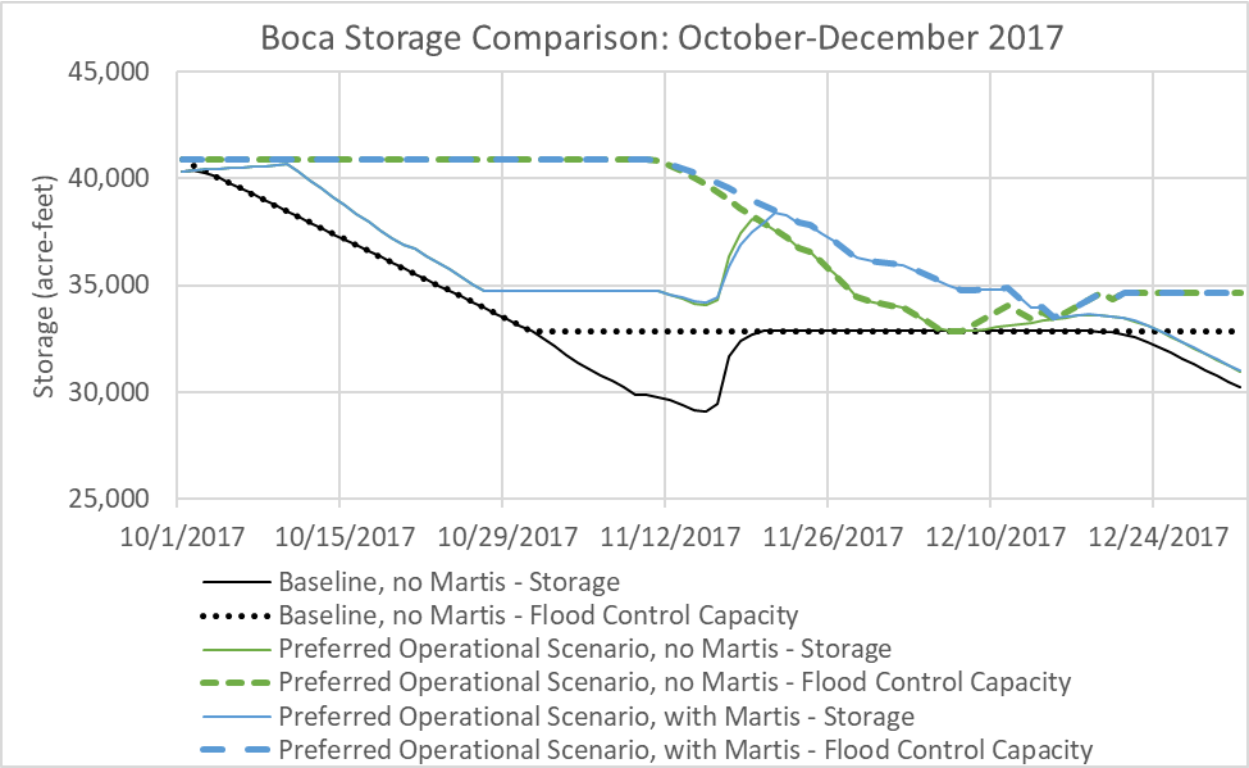

Figure 6: Comparison of Boca fall drawdown operations in 2017

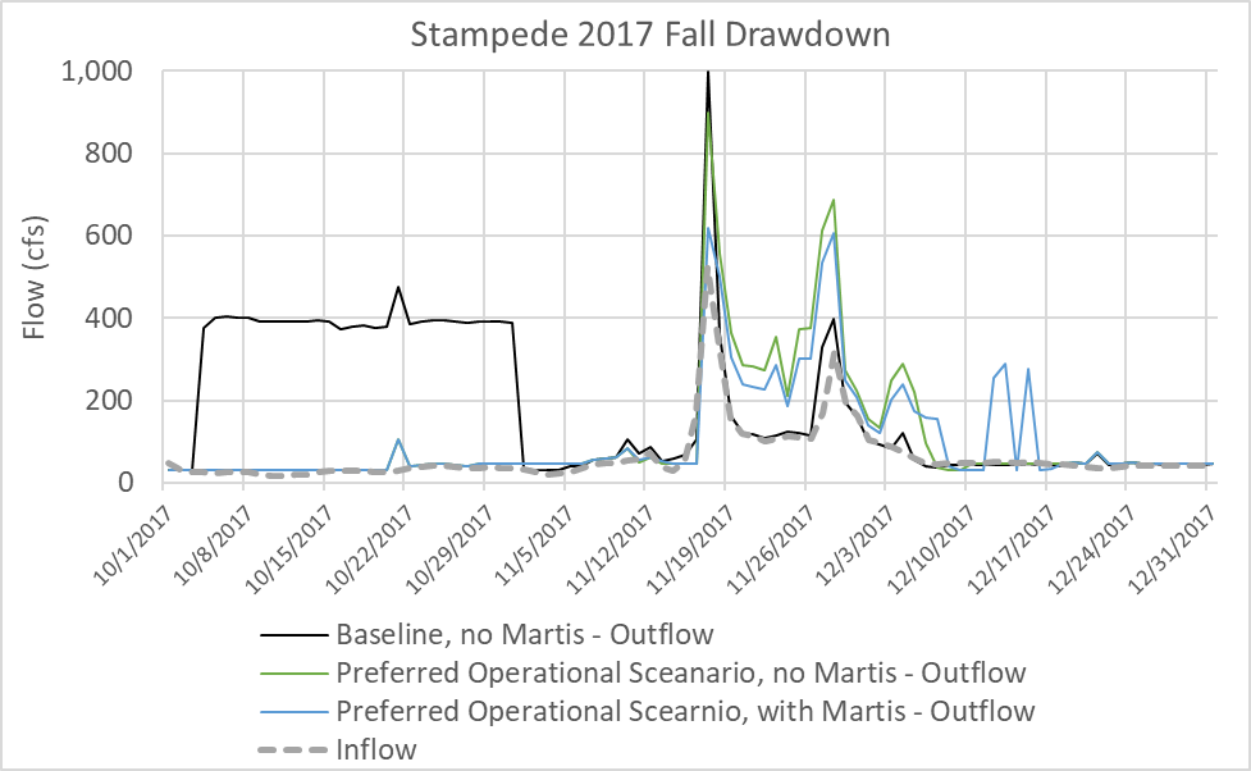

Figure 7: Stampede fall drawdown outflows in 2017

3.C Flood Routing Impacts

Table 2 shows that the Preferred Operational Scenario without Martis improves the RMS Flow Over Flood Target objective by 9.5% and Martis being operational further increases this improvement to 15.3%. Thus, the additional gains in the flooding metric by Martis being operational are nearly as significant as the gains from all other changes that are proposed by the Preferred Operational Scenario. Table 4 and Table 5 further examine the impacts of the Martis operational scenario. Table 4 examines the impacts of peak flow at Reno for each of the TBWMOP events where the Baseline scenario exceeded 7,000 cfs. Table 5 shows Martis' maximum storage during flood events. These historical events are named by the month(s) and year that the event occurred. The initial reservoir state was adjusted based on the projected operations under the relevant scenarios. The hourly inflows for these events are documented in *Technical Memorandum - Truckee River Basin Historical Hourly Data Development Methodologies: Water Years 1986 – 202*1 (Lawler, 2022b). CNRFC also produced scaled versions of two rain season events and two runoff season events where the precipitation forcings were increased such that the resultant runoff equaled the 1/100-yr, 1/200-yr and 1/500-yr recurrence intervals (Lahde, et al., 2022; Imgarten, 2022; Noe, 2023). These events are denoted by the historical month(s) and year followed by _NNNyr where NNN is the recurrence interval that the precipitation was scaled to achieve. Of these 13 events, the peak flow in the Preferred Operational Scenario no Martis is less than the Baseline in 6 events, within 0.1% of Baseline in six events and increased in the May1996_500yr event. Inclusion of Martis reduces the peak flow without Martis by more than 0.1% in 11 events. The peak flow in the May1996_500yr event is increased by an additional 1,200 cfs while the peak flow in the historical May 1996 event is 79 cfs higher than with Martis off, but still 700 cfs lower than the Baseline. The performance of select events will be discussed in the following sections.

Table 4: Summary of Reno peak flow in cfs for events where the Baseline exceeded 7,000 cfs at Reno

Event Name	Baseline – No Martis	Preferred Operational Scenario – no Martis	Preferred Operational Scenario – with Martis	Preferred Operational Scenario – no Martis vs Baseline	Preferred Operational Scenario – no Martis vs with Martis
DecMay2017_500yr	63,604	63,604	63,076	0	-528
Feb1986_500yr	57,247	50,414	49,801	-6,833	-613
DecJan1997_500yr	41,609	40,075	39,298	-1,534	-778
Feb1986_100yr	26,409	25,111	24,580	-1,298	-531
DecJan1997_100yr	19,215	15,245	14,656	-3,970	-590
DecMay2017_100yr	7,252	6,955	6,940	-297	-15
1997Flood	18,010	17,998	17,884	-12	-114
Jan2006	16,285	16,285	15,874	0	-411
May1996_500yr	15,657	15,944	17,145	287	1,201
Jan2017	12,275	12,284	11,792	10	-492
May1996_100yr	11,479	11,484	10,954	5	-530
Feb2017	10,305	10,318	9,780	13	-538
May1996	7,793	7,013	7,092	-780	79

Table 5: Martis maximum storage in acre-feet for events where the Baseline exceeded 7,000 cfs at Reno

Event Name	Baseline – No Martis	Preferred Operational Scenario – no Martis	Preferred Operational Scenario – with Martis	Preferred Operational Scenario – no Martis vs Baseline	Preferred Operational Scenario – no Martis vs With Martis
DecMay2017_500yr	17,314	17,314	20,401	0	3,087
Feb1986_500yr	19,689	19,689	24,184	0	4,495
DecJan1997_500yr	19,691	19,691	22,070	0	2,379
Feb1986_100yr	6,455	6,455	17,477	0	11,023
DecJan1997_100yr	8,246	8,246	13,570	0	5,323
DecMay2017_100yr	1,652	1,652	4,092	0	2,440
1997Flood	4,466	4,466	11,310	0	6,844
Jan2006	2,656	2,656	3,694	0	1,038
May1996_500yr	5,013	5,013	11,641	0	6,627
Jan2017	2,604	2,604	3,604	0	1,000
May1996_100yr	1,924	1,924	6,055	0	4,130
Feb2017	3,190	3,190	5,649	0	2,459
May1996	989	989	2,356	0	1,367

3.C.1 1/500 yr Event Differences

The 1/500 yr scaled events provide a stress test for the Preferred Operational Scenario that evaluates how it would behave for events that significantly exceed those present in the historical record. The daily average 500-year unregulated flow is 83,000 cfs, over three times the largest flow in the historical dataset (Lahde, et al., 2022). Analysis shows that events of this scale are more than sufficient to fill all the flood space in the reservoirs and would very likely cause severe damage downstream. Reductions of the peak flow in these events will likely reduce the area that is inundated. The most significant difference at Reno occurs in the Feb1986_500yr event where the peak flow at Reno is reduced by 6,800 cfs in the Preferred Operational Scenario compared to Baseline. This improvement is attributable to the increased portion of the Little Truckee flood space that is reserved in Boca. As shown in Figure 8 and Figure 9, Boca reaches full several hours later in the Preferred Operational Scenario with and without Martis which (after accounting for travel time) allows capture of Boca inflows during the peak flow at Reno on February 18th. Similarly, Martis being operational allows Martis to store 600 cfs during this timeframe before Martis reaches its full storage on February 19th (Figure 10). If Martis were operational it would reach or exceed the top of the spillway (20,391 acre-feet) in all 1/500-year events while the Baseline peak storage nearly reaches this value in the Feb1986 and DecJan1997 rain season 500-year events (see Table 5).

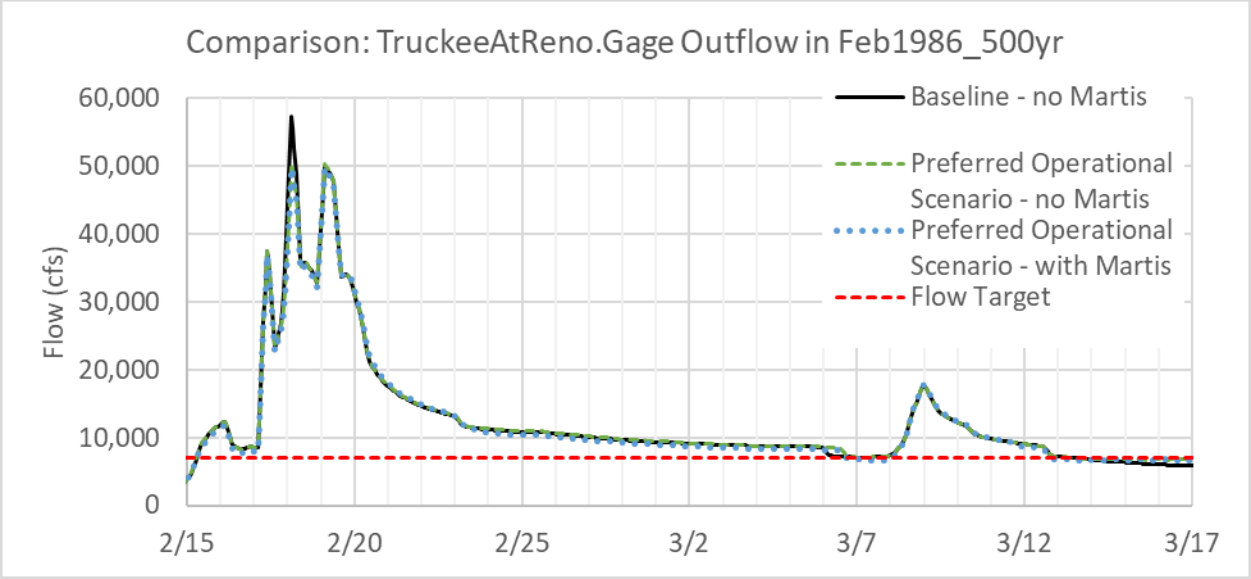

Figure 8: Truckee River At Reno in the February 1986 500 yr scaled event

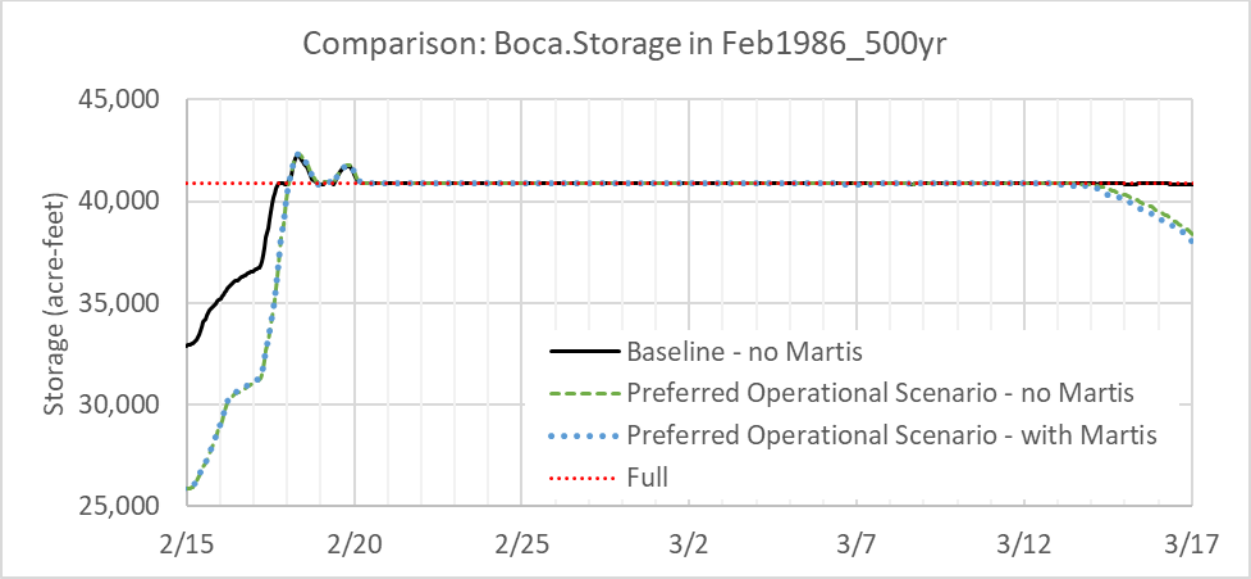

Figure 9: Boca Storage in the February 1986 500 yr scaled event.

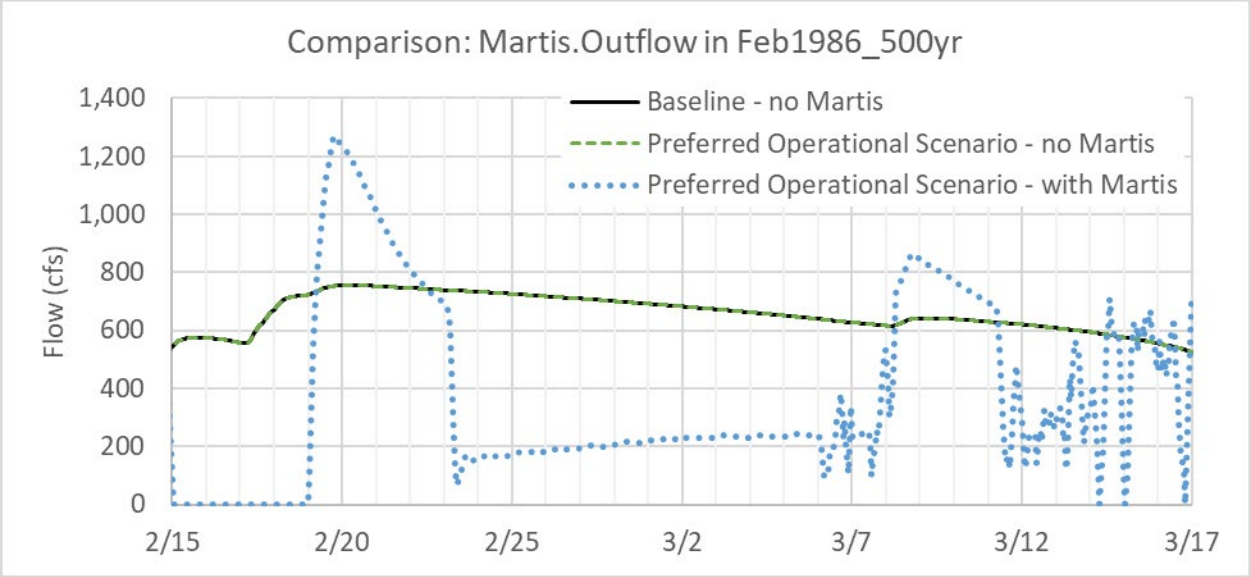

Figure 10: Martis outflow in the February 1986 500-yr scaled event

The May1996_500yr event has a 1-day peak Reno unregulated flow of 25,000 cfs. This scaled event is 2.5 times the snowmelt seasonal 500-year flow and falls between the 2/100 year and 1/100-year flows for the rainy season (Lahde, et al., 2022). Similarly, the May1996_100yr event had a peak flow of 14,000 cfs which is about double the 1/100-year snowmelt 1-day peak flow. The goal of these events was to match the 1-day peak snowmelt peak flow for the respective recurrence intervals. However, the unregulated flow ended up being much larger. While these events still supply a stress test of the Preferred Operational Scenario, they are more extreme than indicated by the stated recurrence intervals.

The May 1996 scaled 1/500-year event shows a 287 cfs increase in the Reno peak flow in the Preferred Operational Scenario without Martis and an additional 1,200 cfs increase with Martis. Reno flows in the 1/500 year scaled May 1996 event are shown in Figure 11. This shows that the Preferred Operational Scenario with Martis has a higher flow in the May 17th peak while the Preferred Operational Scenario no Martis has a higher peak flow in the May 18th peak. The main reason for the increase in the peak flow at Reno is that the reservoirs have higher initial storage prior to the event as shown in Figure 12. In all scenarios the reservoirs reach their maximum capacity prior to the peak flow and begin passing inflows through the reservoirs. The higher storages in the Preferred Operational Scenario's led to more flow over the unregulated spillways in Prosser (Figure 14) and Stampede (Figure 13). In the May 1996 1/500-yr event, these increased spills are due to the higher initial storages in Boca, Stampede and Prosser exceeding the effect of Martis storing its inflow in the with Martis scenario.

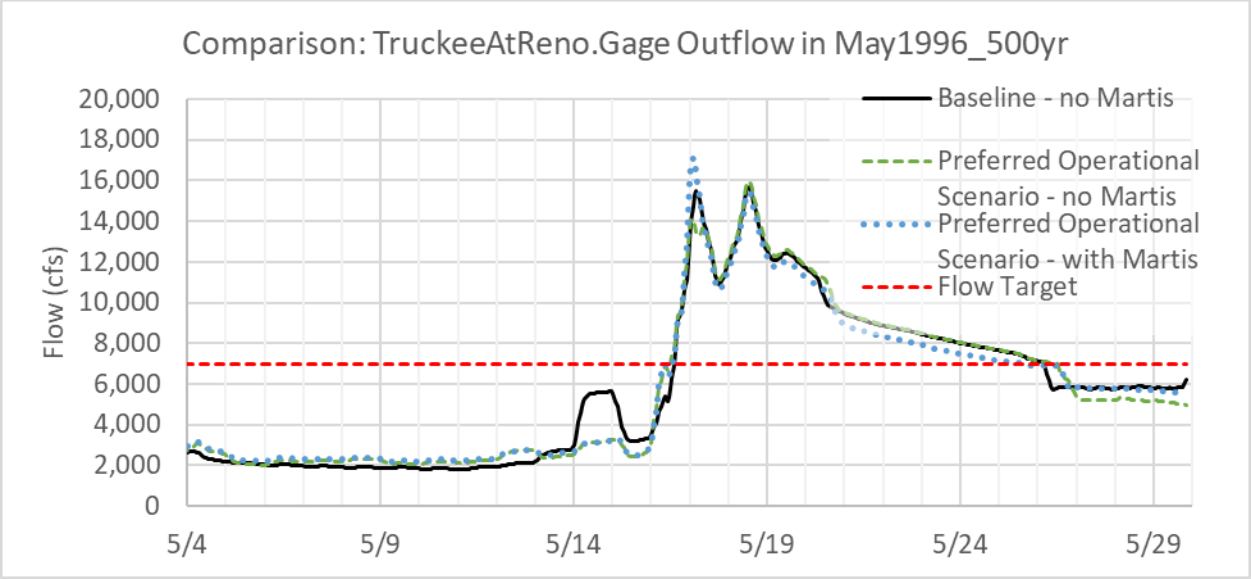

Figure 11: Truckee At Reno flow in the May 1996 1/500 yr scaled event

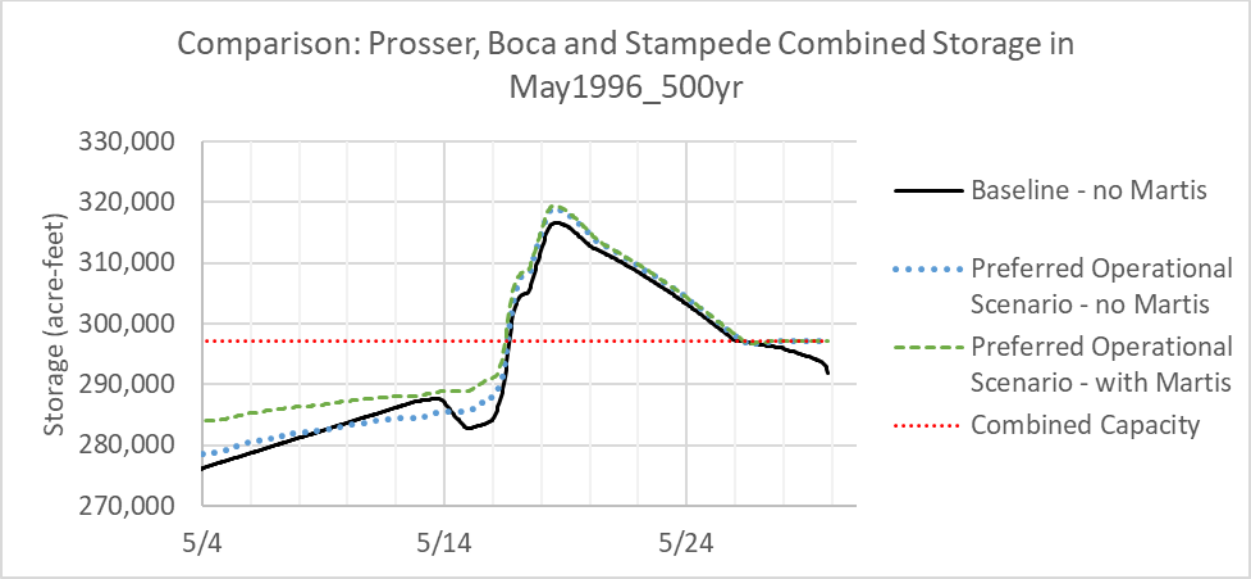

Figure 12: Prosser, Boca and Stampede combined storage in the May 1996 1/500-yr scaled event

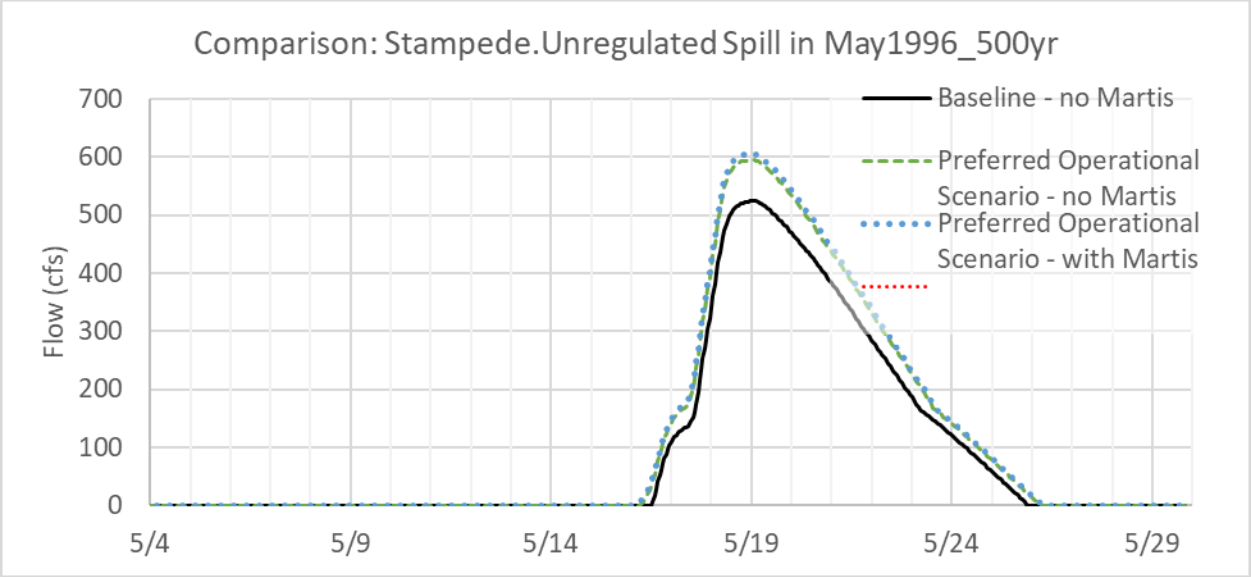

Figure 13: Stampede unregulated spillway flow in May 1996 1/500-yr event

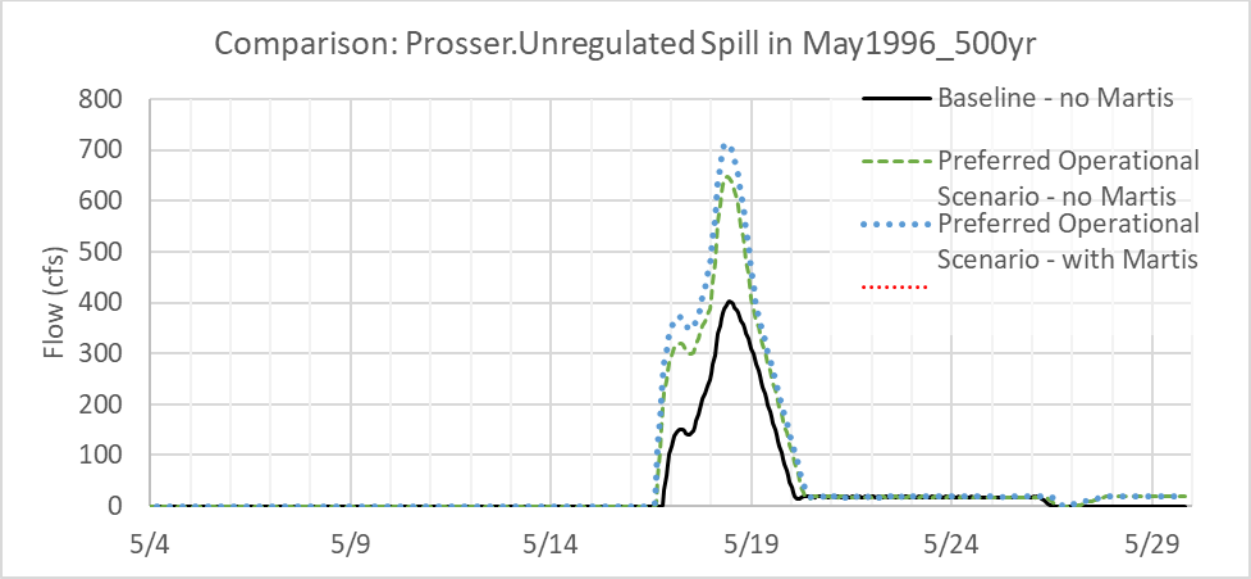

Figure 14: Prosser unregulated spillway flow in May 1996 1/500-yr event

3.C.2 1/100 yr Event Differences

The 1/100 year scaled events provide additional test cases for events that are within or slightly exceeding the historical record. All the 1/100-yr scaled events have reductions in the Reno peak flow, but the largest improvement occurs in the DecJan1997_100yr event. As shown in Figure 15, the Preferred Operational Scenario reduces the 5 AM peak January 3rd such that the peak flow at Reno is the 3 AM peak on January 2nd for these scenarios. Similar to the Feb1986_500yr event, this is achieved through maintenance of additional flood space in Boca, so that Boca does not reach full until 10 AM on January 3rd. Martis being operational reduces the peak flow an additional 590 cfs and reduces the flow the entire period when the 7,000 cfs target is exceeded by a similar amount. This is achieved by storing to a peak storage of 13,500 acre-feet or 67% of capacity (Figure 17).

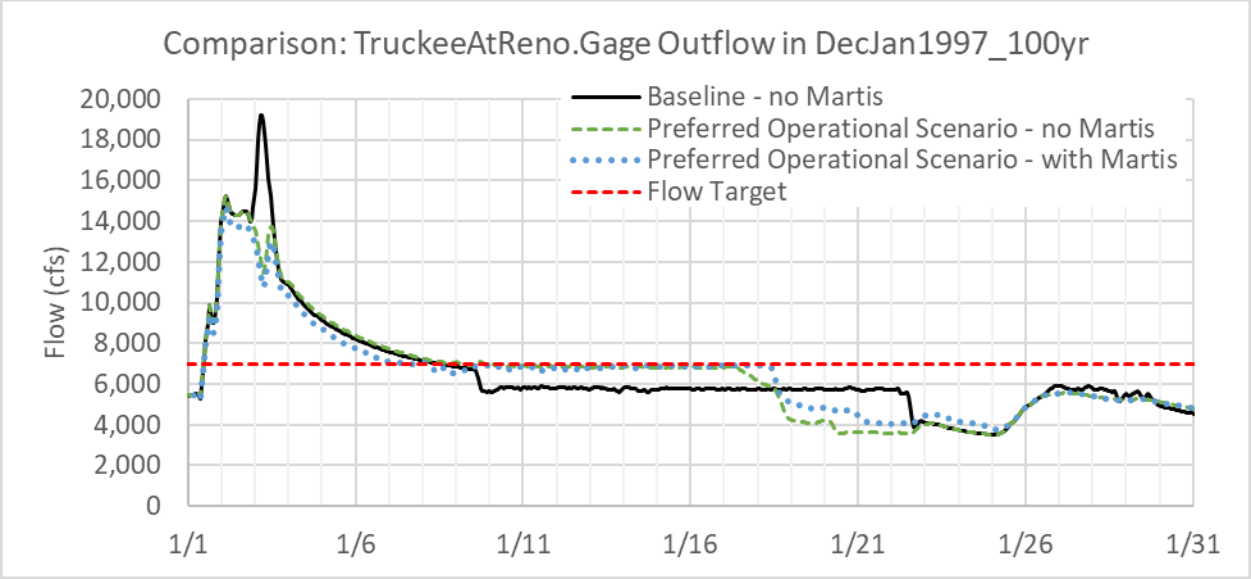

Figure 15: Truckee At Reno flow in the December and January 1997 100-yr scaled event

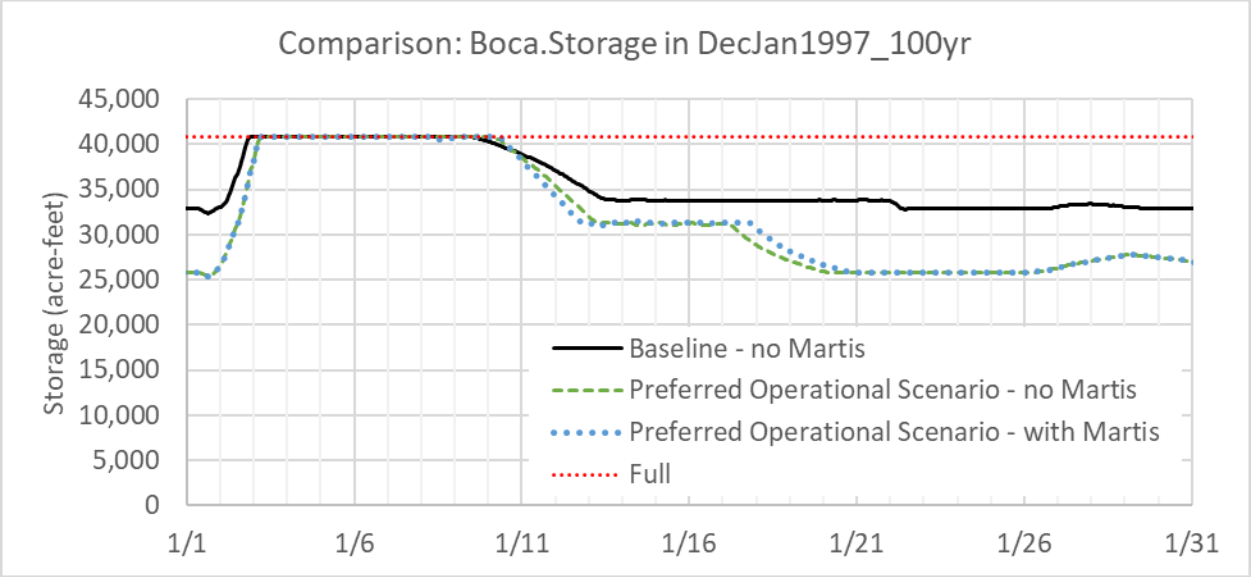

Figure 16: Boca storage in the December and January 1997 100-yr scaled event

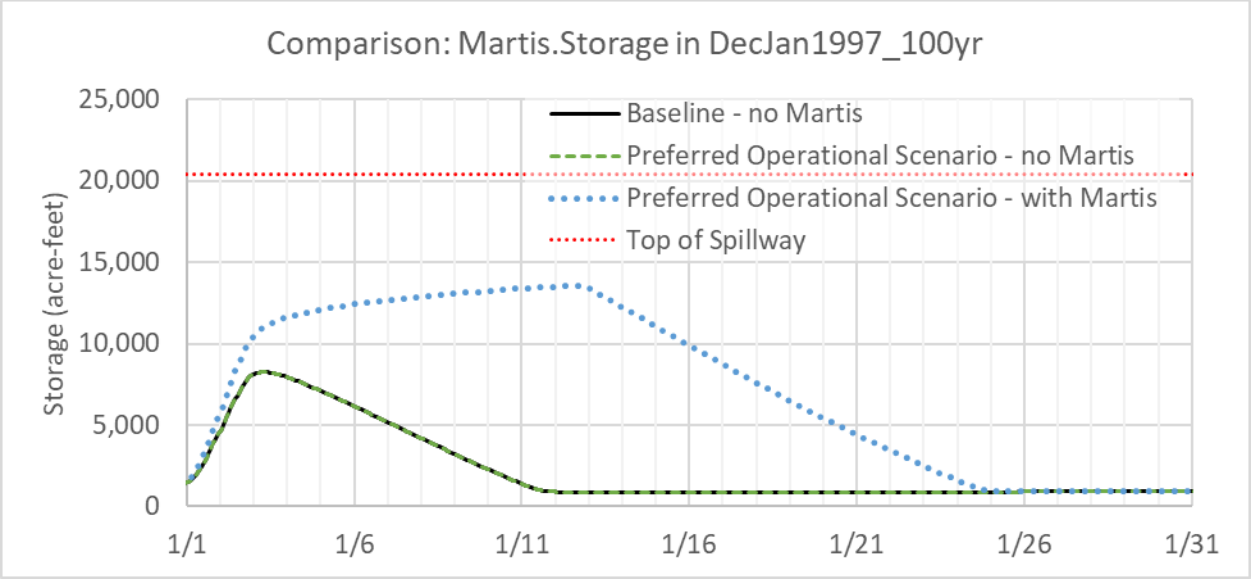

Figure 17: Martis storage in December and January 1997 100-yr scaled event

3.C.3 Historical Events

For all the historical events, except the May 1996 event, the Reno Peak flow in the Preferred Operational Scenario no Martis is within a few cfs of the Baseline peak flow (Table 4). However, in the with Martis scenario, the peak flow at Reno is reduced by as much as 500 cfs. The impacts in the flows at Reno for February 2017 are shown in Figure 18 where the peak flow reduced. An additional improvement that comes from the increased flow target of 7,000 cfs vs 6,000 cfs in the Baseline is that the Preferred Operational Scenarios are in flood operations for 3 days compared to 6 days in the Baseline scenario.

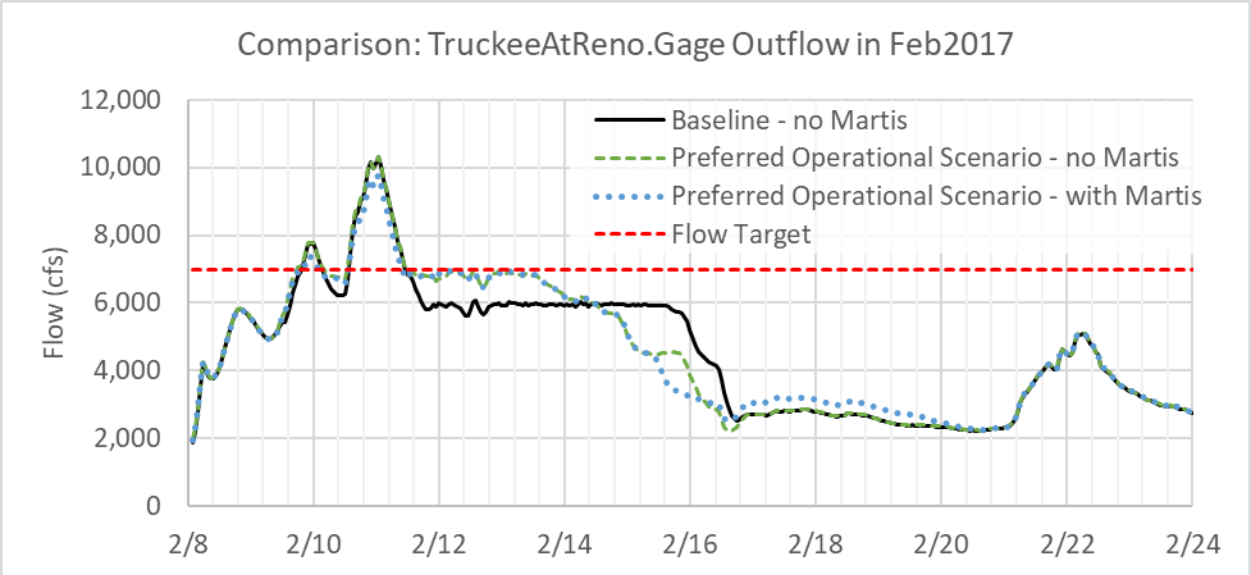

Figure 18: Truckee At Reno flow in the February 2017 historical event

4 Conclusion

The Preferred Operational Scenario from the Truckee Basin Water Management Options Pilot study includes built in flexibility for various operational states of Martis Creek reservoir including continuing to be inoperable, being fully operational, or any condition in between. If Martis were fully operational, then it would benefit the Truckee Basin's water supply and further increase flood mitigation protection.

The water supply benefits are centered on operations in the late spring and early fall when only small historical floods have occurred. In the spring, inclusion of Martis in the flood space requirement for the basin allows the other flood control reservoirs Prosser, Boca and Stampede to begin filling earlier and fill at a slower rate. These benefits over the Baseline scenario are most evident in moderately above average years such as 1993, 2011 and 2019. In the fall, Martis would allow slower drawdown of the flood space. In 2017, the largest runoff year in the dataset, the additional flood space allowed with Martis operational allows for drawdown releases more conducive for native fish spawning as prescribed in the California Guidelines (California Department of Water Resources; California Department of Fish and Wildlife, 2018).

Flood events were examined from the historical period of record, as well as events where the precipitation was scaled to produce 1/100-year unregulated inflows and 1/500-year unregulated inflows at Reno. The only event where the peak flow was substantially increased with the Preferred Operational Scenario with Martis is the May 1996 scaled 1/500-year event. However, this event has a 1-day inflow 2.5 times larger than the snowmelt season 1/500-year flow, so it is considerably more extreme than indicated by the stated recurrence interval. In all other events, the Preferred Operational Scenario with Martis being operational has a lower simulated peak flow than both the Preferred Operational Scenario without Martis and the Baseline scenarios. The average reduction in peak flow by Marits being operational is 467 cfs. The RMS flow over Flood Target metric that evaluates the magnitude and duration that the flood target is exceeded was reduced an additional 5.9% with Martis operational in addition to the 9.5% improvement from the Preferred Operational Scenario without Martis operational. In these events, Martis only reaches its maximum capacity of 20,391 acre-feet in the 1/500-year scaled events indicating that much of these flood improvements could be achieved if Martis were only able to store a portion of to its full capacity.

An additional study is recommended to (1) evaluate the potential water supply benefits of Martis Creek reservoir being used for conservation storage and/or Credit Water Operations as allowed by TROA (Truckee River Operating Agreement, 2008) in the Preferred Operational Scenario and to (2) evaluate the necessary actions to permit Martis Creek reservoir to operate to in any capacity up to its initial maximum design storage of 20,391 acre-feet.

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