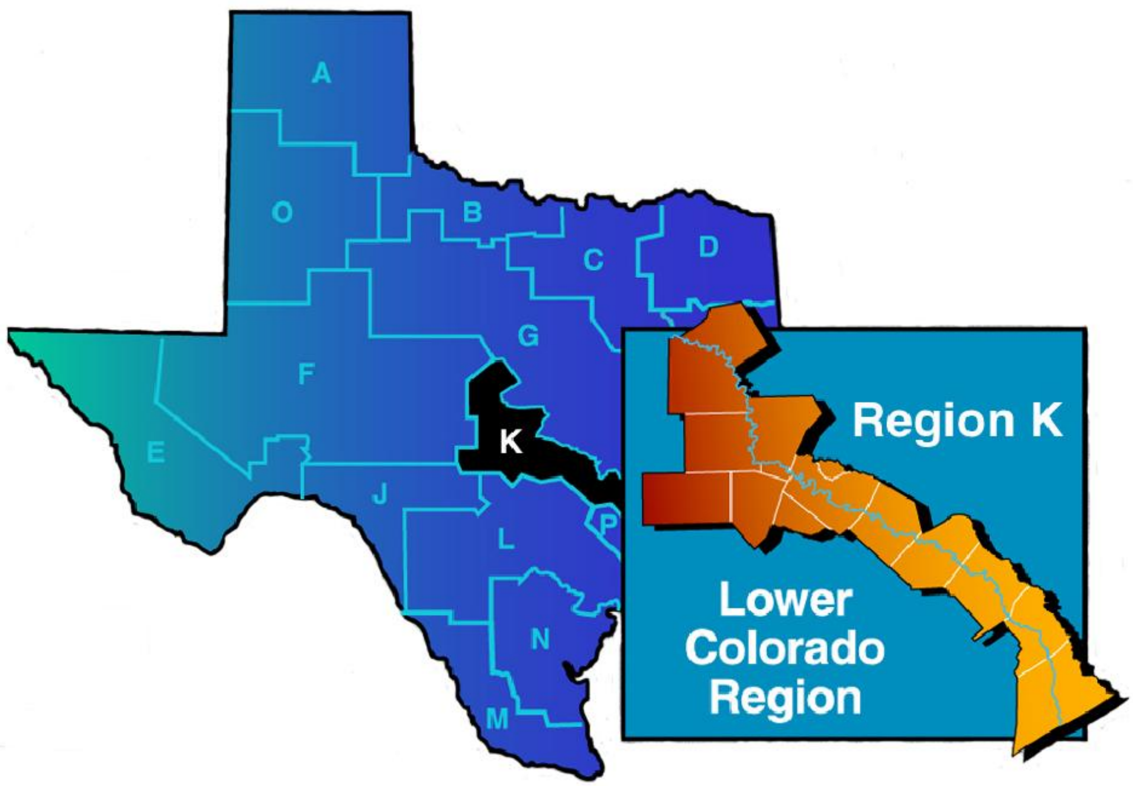
LCRWPG 2011 WATER PLAN
FIRST BIENNIUM STUDIES

ENVIRONMENTAL IMPACTS OF WATER MANAGEMENT STRATEGIES STUDY

for the

Lower Colorado Regional Water Planning Group



prepared by
Lower Colorado Regional Water Planning Group
with funding assistance from the Texas Water Development Board

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with assistance from
AECOM USA Group, Inc.
TBPE Reg. No. F-3082

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EXECUTIVE SUMMARY

Purpose of Study

The purpose of this study was to conduct a quantitative evaluation of the potential environmental impacts of the proposed water management strategies for the 2006 Lower Colorado Regional Water Plan as related to instream flows and freshwater inflows to Matagorda Bay. During the initial development of the Plan, each strategy was evaluated qualitatively in sufficient detail to address its potential overall impact on wildlife and general natural resources; however, the water availability assumptions which were incorporated into the model for the 2006 Plan did not allow for practical model adjustments needed to obtain information on environmental flow impacts. Therefore, the quantitative analyses included a large amount of uncertainty with regard to simulated changes in instream and bay and estuary flows. As a part of the studies for the 2011 Lower Colorado Regional Water Plan, the TWDB provided additional funding for this study to conduct these further analyses in order to better quantify the potential changes to these flows which may result over time as a result of the various strategies contained in the 2006 Plan. If, as a result of this study, a particular water management strategy is determined to create changes to the historical flow regimes, the Lower Colorado Regional Water Planning Group (LCRWPG) may consider other strategies during the 2011 phase of planning.

Methodology

The WAM Run 3 Cutoff Model (cutoff model) was used for the surface water availability modeling in other tasks completed under this phase of the planning program. A description of the model is provided in *Appendix A*. Please see the task report entitled *Draft LCRWPG 2011 Water Plan, First Biennium Studies, Surface Water Availability Modeling Study*, for further explanation of this cutoff model and the results of the availability modeling. In order to use the cutoff model for analysis of the environmental flow impacts, a few adjustments were required, including:

1. turning off the environmental flow caps ("caps" are upper limits on the amount of flow released – turning them off allows more water to be released to the environment, if available) ,
2. using the 2006 FINS Criteria for the bay and estuary inflow requirements (the supply model used the 1997 FINS),
3. using weather-variable irrigation demands for the run-of-river irrigation rights, owned by LCRA
4. using the curtailment of LCRA interruptible water to satisfy LCRA municipal and industrial firm demands, and
5. using projected decadal demands versus authorized demands.

The adjusted Region K WAM Run 3 Cutoff model is used in this study to quantifiably measure the impact that certain water management strategies could potentially have on the Colorado River and its major tributaries, as well as Matagorda Bay, by comparing the regulated stream flow in the base model without the strategy to the regulated stream flow in the model with the strategy in place. The instream flow results were also compared to the seven-day, two-year low-flow (7Q2 flows) obtained from the *Texas Administrative Code (TAC) 307.10(2) – Appendix B – Low Flow Criteria*. It should be noted that the 7Q2 flow information is provided simply as information and should not be used to determine whether or not a strategy is reasonable based on whether the strategy causes the instream flows to go above or below a particular value. Again, the main comparison for this study is the flow with and without the strategy implemented. The bay and estuary inflow results were also compared to the target and critical bay and estuary monthly inflows as presented in the 2006 Matagorda Bay Freshwater Inflow Needs Study. The frequency of the flows meeting the target and critical levels at certain control points were analyzed for each strategy, as well as duration and flow volume statistics in order to provide a more complete picture of the impacts of each strategy. Thirteen proposed water management strategies from the 2006 Region K Plan were chosen as potentially impacting the Colorado River or its major tributaries in a way that could be quantifiably determined using the adjusted Region K WAM Run 3 Cutoff model. The strategies were analyzed for the years 2010 and 2060 if they were expected to be implemented by 2010, as dictated by the 2006 Plan. If a strategy was expected to be implemented after 2010, it was analyzed only for 2060.

The thirteen proposed water management strategies are as follows:

1. Transfer/allocation/purchase water from Water User Groups (WUGs) with surplus. (Sections 4.6.1.4 and 4.7.3 in 2006 Region K Plan)
2. Treated water purchase from Canyon Lake Water Supply. (Section 4.8.2 in 2006 Region K Plan)
3. Guadalupe-Blanco River Authority (GBRA) Hays County Pipeline. (Section 4.8.3 in 2006 Region K Plan)
4. Recharge Edwards BFZ Aquifer with Onion Creek recharge structure. (Section 4.8.4 in 2006 Region K Plan)
5. Construct Goldthwaite channel dam. (Section 4.8.7 in 2006 Region K Plan)
6. Construct additional Goldthwaite off-channel reservoir. (Section 4.8.6 in 2006 Region K Plan)
7. HB 1437. (Section 4.8.8 in 2006 Region K Plan)
8. Desalination of seawater or brackish groundwater. (Section 4.13.3.1in 2006 Region K Plan)
9. LCRA-SAWS Water Sharing Project (LSWP). (Section 4.6.1.9 in 2006 Region K Plan)
10. City of Austin return flows for downstream needs. (Section 4.5.1.1 in 2006 Region K Plan)
11. City of Austin reuse. (Section 4.6.2.2 in 2006 Region K Plan)
12. Amendment of LCRA irrigation water rights. (Section 4.6.1.3 in 2006 Region K Plan)
13. LCRA excess flows permit and off-channel storage. (Section 4.6.1.8 in 2006 Region K Plan)

The strategies were also all combined into a comprehensive model to determine the overall effects of all of the strategies together. This one is referred to as:

14. Comprehensive model containing all of the strategies.

Each strategy was compared to a base model run (without the strategy in place) at six different control points downstream of the strategy location. Five of the control points are for comparing instream flows, and the sixth control point is M10000, which compares the bay and estuary freshwater inflows. Many of the control points chosen for analysis are the same for all of the strategies, but depending on the location of the strategy, some of the control points differ in order to analyze the impacts immediately downstream of each strategy.

The methodology for Strategy 3 (GBRA Hays County Pipeline Strategy) is shown below as an example:

The GBRA has constructed a treated water transmission pipeline in the I-35 Corridor that extends to the City of Buda. The City of Buda has a commitment with GBRA for 1,120 ac-ft/yr of treated water from the pipeline. An additional 1,680 ac-ft/yr of treated water is available through the pipeline and is allocated to the Region K portion of Hays County-Other for a total of 2,800 ac-ft/yr through 2050. By

2060, this total is increased to 2,982 ac-ft/yr of additional supply to meet projected increased need for the City of Buda.

To determine the impacts of this strategy on both the environment and on existing water rights, a constant inflow card was used to insert the simulated return flows from this strategy. The Buda WWTP is located on Onion Creek, which contributes to the Colorado River Basin. A constant inflow was inserted at Control Point J40120 (Onion Creek) in the model. For the 2010 model, an assumed 60 percent return flow was calculated from the City of Buda portion of strategy (1,120 ac-ft/yr in 2010) to be 672 ac-ft/yr. For the 2060 model, an assumed 60 percent return flow was also calculated for the City of Buda portion of the strategy (1,302 ac-ft/yr in 2060) which amounts to 702 ac-ft/yr. Because there are no existing permitted discharge locations for the Hays County-Other portion of the strategy, it was assumed that these municipal/domestic supplies will be disposed of through individual on-site sewage facilities (OSSF) and therefore there are no return flows that were modeled for the 1,680 ac-ft/yr allocated to it.

The model output was used to determine the change in regulated stream flow (instream flows and bay and estuary inflows) at certain control points within the river basin. Control Points J40060 (Onion Creek), I10000 (Austin), J10000 (Colorado County), K20000 (Wharton County), and K10000 (Matagorda County) were used to evaluate the impact on the instream flows downstream of the strategy, and Control Point M10000 (Entrance to Matagorda Bay) was used to evaluate the impact on the bay and estuary inflow.

Results

The water management strategies that can show quantitative environmental impacts to instream flows and bay and estuary freshwater inflows by comparing the water availability model with and without the strategy are discussed with tabular and graphic results. If the strategy is expected to be implemented throughout the planning period, then a comparison is shown for both 2010 and 2060. If the strategy is not needed throughout the entire planning period, then the comparison is only made for the year 2060. The tables of results for each strategy show a comparison of the 10th percentile flows, meaning that the flows shown are larger than 10 percent of all the monthly results for the years 1940 through 1998, as calculated by the model. This percentile was chosen because the strategies are likely to be incorporated during periods of drought, and therefore the 10th percentile was a more likely representation of the proposed situation than the median flows.

The flows are compared for a model run with and without the strategy and show the percent change, either positive if the strategy has a positive effect on the downstream regulated streamflows, or negative if the strategy has a negative effect on the downstream regulated streamflows. Tables showing the frequency that target and critical instream flow and freshwater inflow levels are met are provided, as well as tables showing duration and volume statistics related to occurrences where the instream flows and freshwater inflows fall below the target and critical levels. Graphs showing the results at Control Point M10000 (Entrance to Matagorda Bay) are also provided for each strategy.

Figure ES.1 below shows a graphic of the locations of several of the control points along the Colorado River that were analyzed as part of this study.

Figure ES.1 Location of Selected Control Points

The majority of the strategies had modeled impacts that can be considered minimal. The following *Table ES.1* is a summary of the strategy results for both 2010 and 2060 (see page ES-2 for strategy names). It includes the results for the bay and estuary inflows, as well as the average result for the instream flow control points analyzed for each strategy. The numbers shown in the table are the percent difference from the model run without the strategy, or in other words, the percent impact the strategy has on the environmental flows. Strategies with no numerical results were either not applicable to the decade being modeled, or the strategy itself was not able to be modeled. A negative number means that the instream flows or freshwater inflows decreased as a result of incorporating the strategy. A positive number means that the instream flows or freshwater inflows increased as a result of incorporating the strategy. **In some cases, the results can be attributed to other strategies as well, which is explained in more detail on pages ES-7 and ES-9**.

Table ES.1 Summary of Strategy Results Showing Percent Difference as Compared to Base Model

	2010						2060					
	Instream Flow			Bay and Estuary Inflow			Instream Flow			Bay and Estuary Inflow		
Strategy #	Monthly High (%)	Monthly Low (%)	Annual Average (%)	Monthly High (%)	Monthly Low (%)	Annual Average (%)	Monthly High (%)	Monthly Low (%)	Annual Average (%)	Monthly High (%)	Monthly Low (%)	Annual Average (%)
1	0	-0.3	0	0	0	0	13.8	-18.4	-0.3	3.1	-17.6	0.1
2	-	-	-	-	-	-	-	-	-	-	-	-
3	0.5	-0.3	0.1	2.1	-0.9	0.2	0.7	-0.5	0.2	4.1	-0.6	0.2
4	-	-	-	-	-	-	24.4	-6.9	-0.1	469.3	-2.7	0.2
5	2.7	0	0.1	1.4	0	0	1.4	-0.5	0.1	1.2	-0.1	0.3
6	2.1	-14.7	-0.5	6.5	-9.1	0.6	1.5	-0.1	0.1	300	0	0.5
7	0	-0.3	0	0	-0.2	0	0.5	-0.8	0	0.1	-0.7	-0.3
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	902.9	-37.2	36.3	156,039	6.1	138.1
10	79.9	-15.8	15.9	385.8	-27.6	23	123.8	0.5	42.5	5,776	-57.4	82.7
11	9.3	-24.7	-2.6	17.5	-28.1	-3.8	20.8	-18	-6.3	202.3	-58.3	-6.7
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	0.5	-0.5	-0.1	1.1	-0.1	0.1
14 (Comp)	-	-	-	-	-	-	939	-37.6	36.7	156,499	6.2	139.1

The City of Austin reuse strategy (Strategy 11) shows a downward bias in environmental flows at the control points below the reuse diversion point. However, further investigation is warranted to determine if the impacts of downstream reuse are being balanced by other changes in the model, such as increased upstream storage which would otherwise have been released to meet the downstream demands, or by a change in the long term frequency of the river being managed in target instream flow mode. Reusing a portion of the wastewater effluent reduces the amount of water that can be returned to the river, but also offsets an equal amount of water that would otherwise have been consumed from upstream storage. *Table ES.2A* shows an example of the instream flow impact results at CP J10000 for the City of Austin reuse strategy.

Table ES.2A Strategy 11 (COA Reuse) Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	18,081	22,501	22,207	-1.3	28,432	26,531	-6.7
FEB	18,081	22,459	22,379	-0.4	28,869	27,424	-5.0
MAR	18,081	30,275	30,275	0.0	32,554	31,374	-3.6
APR	18,081	34,962	34,318	-1.8	33,269	30,570	-8.1
MAY	18,081	70,354	69,131	-1.7	53,021	50,670	-4.4
JUN	18,081	75,969	75,612	-0.5	57,235	54,093	-5.5
JUL	18,081	55,512	54,427	-2.0	40,141	39,942	-0.5
AUG	18,081	42,948	43,479	1.2	35,985	29,885	-17.0
SEP	18,081	40,001	38,187	-4.5	34,686	33,754	-2.7
OCT	18,081	27,269	26,854	-1.5	28,561	24,076	-15.7
NOV	18,081	21,994	21,820	-0.8	27,909	25,975	-6.9
DEC	18,081	24,190	24,091	-0.4	29,343	28,201	-3.9
Annual	216,972	468,433	462,781	-1.2	430,005	402,495	-6.4

Table ES.2B shows an example of the bay and estuary freshwater inflow impact results at CP M10000 for the City of Austin reuse strategy.

Table ES.2B Strategy 11 (COA Reuse) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2010 and 2060

Month	Target B&E	Critical B&E	2010			2060		
			Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	205,600	36,000	21,388	21,388	0.0	27,830	25,894	-7.0
FEB	194,500	36,000	22,030	21,388	-2.9	30,903	29,575	-4.3
MAR	63,200	36,000	23,976	23,956	-0.1	28,148	27,013	-4.0
APR	60,400	36,000	9,810	9,167	-6.6	14,721	12,782	-13.2
MAY	255,400	36,000	18,976	13,652	-28.1	7,196	8,660	20.3
JUN	210,500	36,000	5,018	5,301	5.6	3,078	1,284	-58.3
JUL	108,400	36,000	2,851	3,284	15.2	479	1,447	202.3
AUG	62,000	36,000	2,358	2,772	17.5	714	1,465	105.1
SEP	61,900	36,000	1,331	1,392	4.6	881	668	-24.2
OCT	71,300	36,000	10,737	10,002	-6.8	13,466	9,092	-32.5
NOV	66,500	36,000	21,388	21,350	-0.2	25,648	24,184	-5.7
DEC	68,000	36,000	21,524	21,524	0.0	27,824	26,697	-4.1
Annual	1,427,700	432,000	161,388	155,175	-3.8	180,887	168,760	-6.7

Table ES.2C Strategy 11 (COA Reuse) Frequency of Meeting Target and Critical Needs for 2060

Month	COA Reuse Strategy at CP J10000 (Colorado County)						COA Reuse Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	20.3%	20.3%	0.0%	81.4%	79.7%	-1.7%
FEB	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	23.7%	23.7%	0.0%	84.7%	84.7%	0.0%
MAR	94.9%	91.5%	-3.4%	94.9%	91.5%	-3.4%	49.2%	47.5%	-1.7%	79.7%	79.7%	0.0%
APR	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	49.2%	47.5%	-1.7%	69.5%	66.1%	-3.4%
MAY	93.2%	89.8%	-3.4%	100.0%	98.3%	-1.7%	23.7%	23.7%	0.0%	79.7%	79.7%	0.0%
JUN	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	30.5%	30.5%	0.0%	69.5%	67.8%	-1.7%
JUL	100.0%	98.3%	-1.7%	100.0%	100.0%	0.0%	18.6%	16.9%	-1.7%	40.7%	39.0%	-1.7%
AUG	100.0%	98.3%	-1.7%	100.0%	100.0%	0.0%	10.2%	8.5%	-1.7%	37.3%	27.1%	-10.2%
SEP	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	32.2%	28.8%	-3.4%	59.3%	59.3%	0.0%
OCT	93.2%	89.8%	-3.4%	100.0%	100.0%	0.0%	39.0%	35.6%	-3.4%	72.9%	69.5%	-3.4%
NOV	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	47.5%	45.8%	-1.7%	81.4%	81.4%	0.0%
DEC	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	49.2%	47.5%	-1.7%	83.1%	83.1%	0.0%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	44.1%	40.7%	-3.4%	79.7%	79.7%	0.0%

Table ES.2C above demonstrates the impacts the City of Austin Reuse strategy has on the frequency of meeting target and critical instream flows and freshwater inflows. The table does not show the frequency of years in which Lakes Travis and Buchanan are engaged in Critical or Target environmental flow mode in accordance with LCRA's Water Management Plan. The reuse strategy is compared to the full return flow strategy.. The impacts are generally less than four percent, although the largest impact occurs at the Matagorda Bay control point where the frequency of meeting the critical freshwater inflows decreases by 10 percent for the month of August.

Table ES.2D Strategy 11 (COA Reuse) Flow Duration Below Target and Critical Needs for 2060

Condition	COA Reuse Strategy at CP J10000 (Colorado County)			COA Reuse Strategy at CP M10000 (Matagorda Bay)		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
Number of Times Flow Falls Below **Target** Level	14	20	6	94	92	-2
Maximum Duration Below **Target** Level (months)	1	3	2	39	39	0
Total Duration Below **Target** Level (months)	14	22	8	476	486	10
Average Duration Below **Target** Level (months)	1	1	0	5	5	0
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	4,402	5,024	623	407,864	432,524	24,660
Number of Times Flow Falls Below **Critical** Level	3	6	3	72	77	5
Maximum Duration Below **Critical** Level (months)	1	1	0	11	11	0
Total Duration Below **Critical** Level (months)	3	6	3	213	226	13
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	469	3,117	2,648	64,654	66,304	1,650

Table ES.2D above provides statistics related to the instream flow and freshwater inflow falling below their respective target and critical levels over the 58-year period of record. Information on the number of times the flow falls below the target/critical level, the longest amount of time in months that the flow is below the target/critical level, the total amount of time in months that the flow is below the target/critical level, the average amount of time in months per occurrence that the flow is below the target/critical level, and the average volume of flow for each occurrence of the flow falling below target/critical levels is provided. The information is looked at both with and without the strategy, and the difference between the two is shown. In this table, a negative value in the Difference column means that the strategy causes fewer or shorter occurrences below the target/critical level than without the strategy.

Table ES.2D shows that the reuse strategy increases the number of times the instream flows fall below target and critical levels, the number of times freshwater inflows fall below critical levels, the maximum duration below the target level for the instream flows, the total duration below the target and critical levels for the instream flows and freshwater inflows, and the average volume of flow per occurrence for the instream flows and freshwater inflows. The reuse strategy is compared to the full return flow strategy (Strategy 10), at control points below the reuse diversion point. Effects of retaining stored water upstream in lieu of a release to meet downstream demands are not explored here.

The strategy result with the largest positive impact was the LSWP strategy (Strategy 9). Although at CP I10000, immediately downstream of Austin, the impacts on the instream flows are negative, at control points further downstream, the strategy causes large increases to the instream flows and bay and estuary freshwater inflows. This result is due to a decrease in the amount of water being released downstream, but conservation measures taken by irrigation farmers in the lower portion of the basin mean less water is taken out of the river at the downstream control points, thus allowing for a positive impact in the lower part of the basin. It should be noted that the City of Austin and LCRA reuse agreement, as detailed in their 2007 Settlement Agreement, is a part of the LSWP model used in this study to analyze the LSWP strategy, and may contribute to the positive impact as well. The City of Austin anticipates proposing to the Region K Planning Group an updated reuse strategy for consideration in the 2011 Region K Plan. This updated reuse strategy is expected to be considerably different than Strategy 11, which is presented in this study and is included in the approved 2006 Region K Plan.

Table ES.3A shows the negative impact results from the LSWP strategy at CP I10000 (Austin), while *Table ES.3B* shows the positive impact results further downstream at CP K10000 (Matagorda County).

Table ES.3A Strategy 9 (LSWP) Comparison of 10th Percentile Flows at CP I10000 (Austin) for 2060

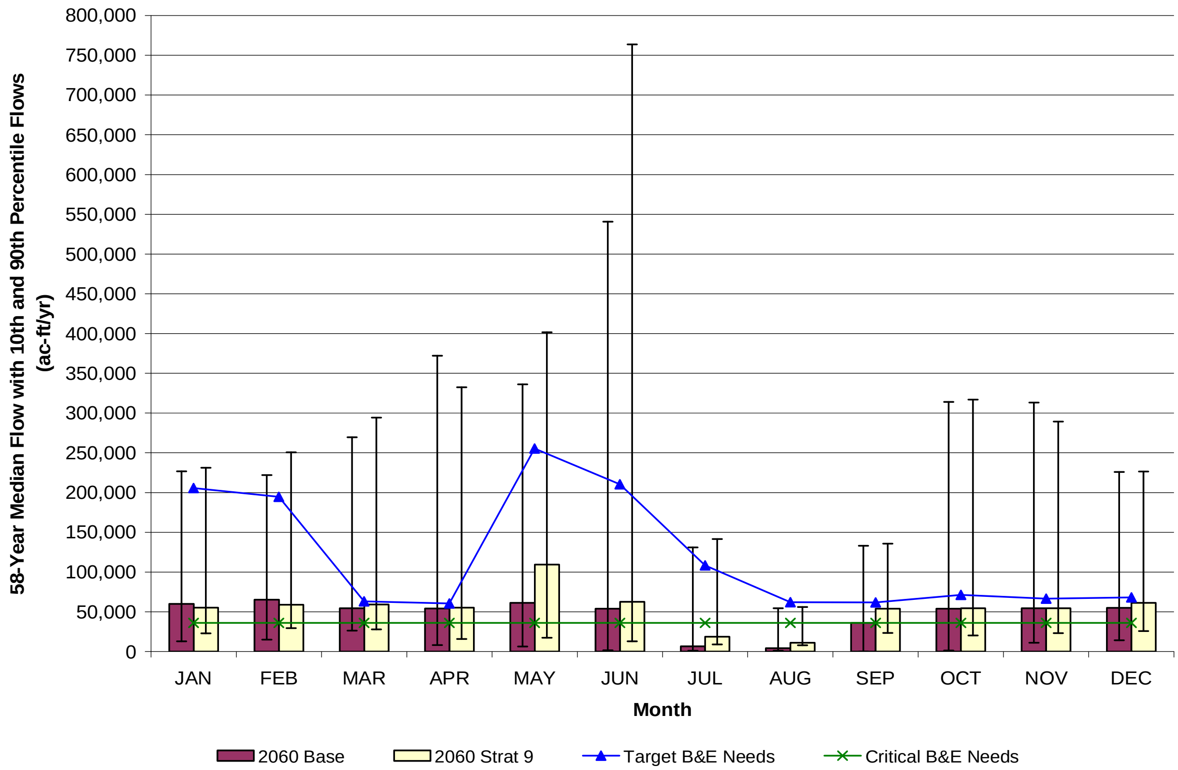
Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	11,547	8,785	8,125	-7.5
FEB	11,547	8,886	8,775	-1.2
MAR	11,547	17,696	13,851	-21.7
APR	11,547	19,782	13,643	-31.0
MAY	11,547	31,805	32,530	2.3
JUN	11,547	26,996	28,167	4.3
JUL	11,547	20,204	17,021	-15.8
AUG	11,547	27,245	20,718	-24.0
SEP	11,547	17,181	10,784	-37.2
OCT	11,547	12,000	13,011	8.4
NOV	11,547	9,409	10,654	13.2
DEC	11,547	10,382	10,889	4.9
Annual	138,564	210,371	188,168	-10.6

Table ES.3B Strategy 9 (LSWP) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	12,374	15,015	30,299	101.8
FEB	12,374	18,782	35,112	86.9
MAR	12,374	32,712	30,107	-8.0
APR	12,374	12,388	19,234	55.3
MAY	12,374	10,349	24,785	139.5
JUN	12,374	6,701	17,113	155.4
JUL	12,374	4,063	12,830	215.8
AUG	12,374	4,205	10,962	160.7
SEP	12,374	2,694	27,015	902.9
OCT	12,374	11,468	25,898	125.8
NOV	12,374	16,617	29,067	74.9
DEC	12,374	18,127	30,078	65.9
Annual	148,488	153,121	292,500	91.0

Figure ES.2 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without the LSWP strategy at CP M10000 (Entrance to Matagorda Bay) for 2060, along with the target and critical bay and estuary freshwater inflows.

Figure ES.2 Strategy 9 (LSWP) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)



The comprehensive strategy model combines all of the individual strategies into a single model, to determine the overall impact on the flows in the Colorado River. Because the LSWP model (used in the LSWP strategy analysis - Strategy 9) contains several strategies that have large impacts, the results for the comprehensive strategy model are very similar to the results shown for the LSWP strategy, in this report.

Conclusions

A major goal of the regional water planning process is planning for future water supplies while protecting the State's environmental, agricultural, and natural resources. This goal has been considered throughout the planning process by the LCRWPG when selecting strategies to meet water needs for the future. One of the specific objectives of this study was to determine if the impacts of the water management strategies are reasonable, consistent with protection of environmental flows, and consistent with long-term protection of the state's water resources, natural resources, and agricultural resources. Comparisons of the predicted environmental instream flows and bay and estuary flows for basin conditions both with and without water management strategies are but one tool used by the LCRWPG to accomplish these goals. However, these comparisons also provide additional insight into the impacts of these strategies and allow additional future consideration of operational and design modifications for those strategies which might better mitigate any identified undesirable consequences.

Overall, based upon the modeling assumptions developed as a part of this study, the individual water management strategies evaluated appear reasonable and consistent with the long-term protection of the state's water resources, natural resources, and agricultural resources. Likewise, the cumulative impacts of all of these strategies are generally within expected ranges and are similar to the results generated by the LSWP model, which contains the LSWP strategy along with other strategies, which have larger positive impacts on the basin than the rest of the strategies. The LCRWPG will continue to consider all of these strategies in further detail during future regional water planning updates, as well as examine potential alternative strategies for selected areas and for changed conditions.

The results of this study have also created concern among planning group members that freshwater inflows to Matagorda Bay are meeting the Critical amounts detailed in the 2006 Matagorda Bay Freshwater Inflow Needs Study only 76 percent of the time, even prior to the implementation of any strategy. This is an area that the planning group may want to evaluate in future studies to determine whether the frequency of the freshwater inflows meeting the Critical level can be increased towards 100 percent.

Note: The Modeling and Environmental Flows Committees of the Lower Colorado Regional Water Planning Group reviewed the draft Task 2 Report. While the work was performed to the limits of the scope of work, the planning group members were concerned that they were not aware of how the results would be presented in the report when the scoping was done. Upon review of the report some committee members expressed concern that the comparisons of the predicted environmental flows for basin conditions both with and without water management strategies contained inherent inconsistencies that jeopardize the report's usefulness for drawing conclusions about the viability of each strategy for accomplishing the long-term protection of the state's water resources, natural resources, and agricultural resources. Some adjustments were made to the Draft Final Task 2 Report that improved the overall report; however, it was agreed that the concerns could not be fully addressed due to scheduling and budgetary constraints. It was further agreed that this note would be added as a qualifier to underscore the need for additional refinements on this section in a future plan.

Please see *Appendix D* for the types of concerns that members of the regional planning group had in relation to the Task 2 Report.

1.0 PURPOSE OF STUDY

The purpose of this study was to conduct a quantitative evaluation of the potential environmental impacts of the proposed water management strategies for the 2006 Lower Colorado Regional Water Plan as related to instream flows and freshwater inflows to Matagorda Bay. During the initial development of the Plan, each strategy was evaluated qualitatively in sufficient detail to address its potential overall impact on wildlife and general natural resources; however, the water availability assumptions which were incorporated into the model for the 2006 Plan did not allow for practical model adjustments needed to obtain information on environmental flow impacts. Therefore, the quantitative analyses included a large amount of uncertainty with regard to simulated changes in instream and bay and estuary flows. As a part of the studies for the 2011 Lower Colorado Regional Water Plan, the TWDB provided additional funding for this study to conduct these further analyses in order to better quantify the potential changes to these flows which may result over time as a result of the various strategies contained in the 2006 Plan. If, as a result of this study, a particular water management strategy is determined to create changes to the historical flow regimes, the Lower Colorado Regional Water Planning Group (LCRWPG) may consider other strategies during the 2011 phase of planning.

The scope of work for this study was outlined as follows within the study plan approved under the contract dated August 8, 2007, between LCRA and TWDB.

a. Perform a quantitative impact analysis of the proposed water management strategies for instream flows at five designated control points on the Colorado River and its major tributaries.

b. Perform a quantitative impact analysis of the water management strategies for freshwater inflows into Matagorda Bay.

c. Research information on any new environmental criteria in any amendment to an existing water right or such criteria in any new water right or any agreements between parties, since publication of the January 2006 Regional Plans, for inclusion in the model.

d. Prepare tabular comparisons for each strategy of the impacts to land and water resources.

e. Determine if the impacts are reasonable, consistent with protection of environmental flows, and consistent with long-term protection of the state's water resources, natural resources, and agricultural resources.

f. Utilize the LCRA Water Management Plan guidelines when evaluating freshwater inflows impacts and instream flow impacts. Incorporate information from the most recent studies conducted by LCRA on bay and estuary inflows, as well as instream flows.

g. Coordinate with LCRA regarding incorporation of information from LSWP impact studies.

h. Present information to LCRWPG and discuss results.

i. Assist LCRWPG in determining long-term viability of projects and water management strategies analyzed, and present results at a LCRWPG meeting.

j. For any strategies that are determined to have unreasonable impacts, develop a scope and budget for investigation of new strategies to replace the ones with unreasonable impacts. This scope and budget will be for the second biennium of the third planning round.

2.0 METHODOLOGY

During this phase of planning, the LCRWPG evaluated various alternative surface water availability models for the Colorado River, and subsequently chose the model that appeared to most appropriately reflect the actual and historical operating conditions and existing contractual agreements between LCRA and certain upper basin water right holders. The model chosen is referred to as the Region K WAM (Water Availability Model) Run 3 Cutoff Model, and it is believed to more accurately reflects the conditions of the Colorado River than either the current TCEQ WAM or the "No Call" WAM developed for the 2006 Region K Plan. The Region K WAM Run 3 Cutoff Model's use was approved by TWDB on March 11, 2008.

The Region K WAM Run 3 Cutoff Model (cutoff model) was used for the surface water availability modeling in other tasks completed under this phase of the planning program. A description of the cutoff model is provided in *Appendix A*. Please see the task report entitled *Draft LCRWPG 2011 Water Plan, First Biennium Studies, Surface Water Availability Modeling Study*, for further explanation of this cutoff model and the results of the availability modeling. In order to use the cutoff model for analysis of the environmental flow impacts, a few adjustments were required, including:

1. turning off the environmental flow caps ("caps" are upper limits on the amount of flow released – turning them off allows more water to be released to the environment, if available),

2. using the 2006 FINS Criteria for the bay and estuary inflow requirements (the supply model used the 1997 FINS),

3. using weather-variable irrigation demands for the run-of-river irrigation rights, owned by LCRA,

4. using the curtailment of LCRA interruptible water to satisfy LCRA municipal and industrial firm demands, and

5. using projected decadal demands versus authorized demands.

Some of these adjustments were made as a result of scoping requirements, and others were made because the LCRA-SAWS Water Project (LSWP) model obtained from LCRA for the purpose of determining the impacts of the LSWP already contained these adjustments, and the Region K Water Modeling Committee agreed that the base model for all of the strategies should contain the same adjustments as a way of keeping conditions consistent among the comparative models. A table containing a summary of the modeling assumptions used for the supply and strategy models is located in *Appendix A*.

The adjusted Region K WAM Run 3 Cutoff Model is used in this study to quantifiably measure the impact that certain water management strategies could potentially have on the Colorado River and its major tributaries, as well as Matagorda Bay, by comparing the regulated stream flow in the base model without the strategy to the regulated stream flow in the model with the strategy in place. Regulated flow represents physical flow at a location, some or all of which may be required to meet water rights requirements (Wurbs 2008). The instream flow results were also compared to the seven-day, two-year low-flow (7Q2 flows) obtained from the *Texas Administrative Code (TAC) 307.10(2) – Appendix B – Low Flow Criteria*. 7Q2 flows are defined as "-- the lowest average stream flow for seven consecutive days with a recurrence interval of two years, as statistically determined from historical data," and were determined to be a good measure of low-flow conditions. It should be noted that the 7Q2 flow information is provided simply as information and should not be used to determine whether or not a strategy is reasonable based on whether the strategy causes the instream flows to go above or below a particular value. Again, the main comparison for this study is the flow with and without the strategy implemented. The bay and estuary inflow results were also compared to the target and critical bay and estuary monthly inflows as determined in the 2006 Matagorda Bay Freshwater Inflow Needs Study. Thirteen proposed water management strategies from the 2006 Region K Plan were chosen as potentially impacting the Colorado River or its major tributaries in a way that could be quantifiably determined using the adjusted Region K WAM Run 3 Cutoff model. The strategies were analyzed for the years 2010 and 2060 if they were expected to be implemented by 2010, as dictated by the 2006 Plan. If a strategy was expected to be implemented after 2010, it was analyzed only for 2060.

The thirteen proposed water management strategies are as follows:

1. Transfer/allocation/purchase water from Water User Groups (WUGs) with surplus. (Sections 4.6.1.4 and 4.7.3 in 2006 Region K Plan)
2. Treated water purchase from Canyon Lake Water Supply. (Section 4.8.2 in 2006 Region K Plan)
3. Guadalupe-Blanco River Authority (GBRA) Hays County Pipeline. (Section 4.8.3 in 2006 Region K Plan)
4. Recharge Edwards BFZ Aquifer with Onion Creek recharge structure. (Section 4.8.4 in 2006 Region K Plan)
5. Construct Goldthwaite channel dam. (Section 4.8.7 in 2006 Region K Plan)
6. Construct additional Goldthwaite off-channel reservoir. (Section 4.8.6 in 2006 Region K Plan)
7. HB 1437. (Section 4.8.8 in 2006 Region K Plan)
8. Desalination of seawater or brackish groundwater. (Section 4.13.3.1in 2006 Region K Plan)
9. LCRA-SAWS Water Sharing Project (LSWP). (Section 4.6.1.9 in 2006 Region K Plan)
10. City of Austin return flows for downstream needs. (Section 4.5.1.1 in 2006 Region K Plan)
11. City of Austin reuse. (Section 4.6.2.2 in 2006 Region K Plan)
12. Amendment of LCRA irrigation water rights. (Section 4.6.1.3 in 2006 Region K Plan)
13. LCRA excess flows permit and off-channel storage. (Section 4.6.1.8 in 2006 Region K Plan)

The strategies were also all combined into a comprehensive model to determine the overall effects of all of the strategies together. This one is referred to as:

14. Comprehensive model containing all of the strategies.

Each strategy was compared to a base model run (without the strategy in place) at six different control points downstream of the strategy location. Five of the control points are for comparing instream flows, and the sixth control point is M10000, which compares the bay and estuary freshwater inflows. Many of the control points chosen for analysis are the same for all of the strategies, but depending on the location of the strategy, some of the control points differ in order to analyze the impacts immediately downstream of each strategy. An exhibit showing the location of all of the control points discussed in this study is located in *Appendix B*.

The modeling approach for each strategy is described below.

Strategy 1. Transfer/allocation/purchase water from Water User Groups (WUGs) with surplus

Significant shortages and surpluses appear for several WUGs within the Region K planning area. This strategy allows for three variations of transferring water from areas of surplus and providing it to areas of shortage. The first two variations, transfer and allocation, involve extremely small amounts of water that would not have any statistically significant impact on the instream flows and bay and estuary flows in the basin, and therefore were not modeled. The third variation involves the expansion of current contracts with LCRA to meet specific municipal and industrial demands. The 2006 Region K Plan shows that these contract amendments would amount to 4,688 ac-ft/yr in 2010, and would increase to 11,394 ac-ft/yr in 2060. Because these amounts are already included as projected demands in their respective base models, the effort was made to compare the impacts as if the strategy did not occur. To make this comparison, the respective amounts were subtracted from the firm "uncommitted" or "other" water rights in the model, and the same amounts were shown as an increase for the LCRA interruptible water rights.

The model output was used to determine the change in regulated stream flow (instream flows and bay and estuary flows) at certain control points within the river basin. Control Points I10000, J30000, J10000, K20000, and K10000 were used to evaluate the impact on the instream flows downstream of the strategy, and Control Point M10000 was used to evaluate the impact on the bay and estuary flow. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study.

Strategy 2. Treated water purchase from Canyon Lake Water Supply

The City of Blanco has contracted with the Canyon Lake Water Supply Corporation (WSC) to supply water from its regional system. The project involves construction of an approximately 10.5 mile pipeline from US 281 and SH 306 to the City of Blanco and includes a booster pump station and ground storage tank. The project would provide 600 ac-ft/yr of municipal water supplies to the City of Blanco as it is needed. Goforth WSC is the only water user group (WUG) that would use the water from Canyon Lake WSC and it would provide service in the Colorado River Basin. However, neither Goforth WSC nor other entities provide wastewater treatment services with return flows from their service areas into the Colorado River Basin.

The strategy to supply the City of Blanco with treated water from Canyon Lake WSC does not withdraw flows from, nor return treated wastewater flows to, the Colorado River Basin. Therefore, the strategy to supply the City of Blanco is not included in the model. Similarly, the Goforth WSC would supply a portion of Travis County in the Colorado River Basin; however, neither Goforth WSC nor other entities have established wastewater treatment plants in the service area that would provide treated wastewater return flows to the Colorado River. Therefore, this water management strategy cannot be accounted for in the model.

Strategy 3. Guadalupe-Blanco River Authority (GBRA) Hays County Pipeline

The GBRA has constructed a treated water transmission pipeline in the I-35 Corridor that extends to the City of Buda. The City of Buda has a commitment with GBRA for 1,120 ac-ft/yr of treated water from the pipeline. An additional 1,680 ac-ft/yr of treated water is available through the pipeline and is allocated to the Region K portion of Hays County-Other for a total of 2,800 ac-ft/yr through 2050. By 2060, there is an increase to 2,982 ac-ft/yr of additional supply to meet projected increased need for the City of Buda.

To determine the impacts of this strategy on both the environment and on existing water rights, a constant inflow card was used to insert the simulated return flows from this strategy. The Buda WWTP is located on Onion Creek, which contributes to the Colorado River Basin. A constant inflow was inserted at Control Point J40120 in the model. For the 2010 model, an assumed 60% return flow was calculated from the City of Buda portion of this strategy (1,120 ac-ft/yr in 2010) to be 672 ac-ft/yr. For the 2060 model, an assumed 60% return flow was also calculated for the City of Buda portion of the strategy (1,302 ac-ft/yr in 2060) which amounts to 702 ac-ft/yr. Because there are no existing permitted discharge locations for the Hays County-Other portion of the strategy, it was assumed that these municipal/domestic supplies will be disposed of through individual on-site sewage facilities (OSSF) and therefore there are no return flows that were modeled for the 1,680 ac-ft/yr allocated to it.

The model output was used to determine the change in regulated stream flow (instream flows and bay and estuary inflows) at certain control points within the river basin. Control Points J40060, I10000, J10000, K20000, and K10000 were used to evaluate the impact on the instream flows downstream of the strategy, and Control Point M10000 was used to evaluate the impact on the bay and estuary inflow. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study.

Strategy 4. Recharge Edwards BFZ Aquifer with Onion Creek recharge structure

This strategy would involve the construction of two channel dams across Onion Creek to temporarily retain runoff during periods of higher flow. The strategy objective is to convert surface water instream flows to groundwater recharge by retarding water during periods of high flow, and releasing it at a slower rate, thus allowing a greater amount of infiltration to occur downstream.

This strategy was modeled with an on-channel reservoir which makes releases for stream recharge purposes. The on-channel dam allows the bypass of low flow events. The naturalized 10th percentile at Control Point J40160 is approximately 250 ac-ft/month, and was used as the low flow criteria. Refill should also be curtailed, probably to a greater extent, by the priority date of the water right. A junior priority date (12/30/3000) was assigned to this water right which would only allow for refill during peak flow events. The on-channel dam will impound flows in excess of the low flow criteria. The reservoir makes releases from stored water to enhance the recharge on the reaches of Onion Creek below the dam. An assumed release rate of 1800 ac-ft/month was determined by using the naturalized 50th percentile at Control Point J40160.

The model output was used to determine the change in regulated streamflow (instream flows and bay and estuary inflows) at certain control points within the river basin. Control Points J40150, J40060, J10000, K20000, and K10000 were used to evaluate the impact on the instream flows downstream of the strategy, and Control Point M10000 was used to evaluate the impact on the bay and estuary inflow. This strategy was only evaluated for 2060, because the strategy is not needed in 2010. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study.

Strategy 5. Construct Goldthwaite channel dam

The City of Goldthwaite has an existing right to divert water from the Colorado River; however, the quantities that are available will not meet its demands through the fifty-year planning period. The City of Goldthwaite would exhaust its limited supply of stored water if the flow in the Colorado River ceased for an extended period of time. Even with a decrease in the City's demand for water through applied conservation, there are still shortages over the entire planning period. For this reason, a strategy involving the construction of a new channel dam below the City's existing diversion structure was selected in the 2006 RWP.

For this strategy, a channel dam below the City's existing diversion structure would be constructed on the Colorado River. The low dam structure would be located approximately 300 feet downstream of the existing structure. The channel dam would be 10 feet high so that it would provide a larger and more reliable source of water for the City's diversion pumps, allowing the City to continue providing service for a longer period without flow in the river. As a part of the strategy, it was assumed that the water impounded behind the dam would provide 400 ac-ft/yr of additional supply.

This strategy was modeled with an on-channel reservoir. The on-channel dam allows the bypass of low flow events. The naturalized 10th percentile at Control Point F10780 is approximately 8,900 ac-ft/month, and was used as the low flow criteria. The junior priority date (12/30/3000) should only allow for refill during peak flow events. The on-channel dam will impound flows in excess of the low flow criteria. The reservoir makes releases at an assumed rate of 27,000 ac-ft/month, determined by using the naturalized 50^{th} percentile at Control Point F10780.

The model output was used to determine the change in regulated stream flow (instream flows and bay and estuary inflows) at certain control points within the river basin. Control Points F10000, I10000, J10000, K20000, and K10000 were used to evaluate the impact on the instream flows downstream of the strategy, and Control Point M10000 was used to evaluate the impact on the bay and estuary inflow. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study.

Strategy 6. Construct additional Goldthwaite off-channel reservoir

The City of Goldthwaite has an existing right to divert water from the Colorado River; however, the quantities that are available will not meet its demands through the fifty-year planning period. The City of Goldthwaite would exhaust its limited supply of stored water if the flow in the Colorado River ceased for an extended period of time. Even with a decrease in the City's demand for water through applied conservation, there are still shortages over the entire planning period. For this reason, a strategy involving the construction of a new off-channel reservoir adjacent to the City's existing reservoir on the San Saba Highway was selected in the 2006 RWP. An additional 350 ac-ft/yr of storage could be added at this off-channel site to increase the City's total storage capacity, and therefore its ability to survive extended dry periods.

To determine the impacts of the strategy on the environment, a water right associated with the new reservoir was added to reflect the proposed yield of the reservoir at Control Point F10780. The water right was assigned the most junior priority date in the basin (12/31/3000). The model output was used to determine the change in regulated streamflow (instream flows and bay and estuary inflows) at certain control points within the river basin. Control Points F10000, I10000, J10000, K20000, and K10000 were used to evaluate the impact on the instream flows downstream of the strategy, and Control Point M10000 was used to evaluate the impact on the bay and estuary inflow. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study.

Strategy 7. HB 1437

The HB 1437 strategy is a Region G strategy that provides a transfer of up to an additional 25,000 ac-ft/yr from the Colorado River Basin to new customers within the Brazos River Basin in Williamson County.

The legislation is now codified in Texas Water Code § 222.029. The strategy is a conservation strategy in which improvements are made on farms and in the irrigation divisions that reduce agricultural use of the surface water. The legislation allows transfer only if there is “no net loss” to the Colorado River Basin and requires adverse effects of the transfer to be mitigated. The Agricultural Water Conservation Fund (Ag Fund) was established to pay for the mitigation and is funded through a conservation surcharge (set by the LCRA Board) collected from Williamson County HB 1437 customers.

The strategy is for Region G and is already included in the strategy base model. Therefore, the strategy actually had to be removed in order to provide a comparison for purposes of this analysis. The 25,000 ac-ft/yr water right (WRID 11405730001) was identified at Control Point I20000 on Lake Travis. The LCRA “uncommitted card” (WRID 61405482001C) was increased to account for the change. The demand was modeled as 25,000 ac-ft/yr for the year 2060 and 14,854 ac-ft/yr for the year 2010. To determine the impacts of the strategy on the environment, the water right associated with the strategy was set to zero in order to provide the scenario of the strategy not being implemented. Control Points I10540, I10000, J10000, K20000, and K10000 were used to evaluate the impact on the instream flows downstream of the strategy, and Control Point M10000 was used to evaluate the impact on the bay and estuary inflow. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study.

Strategy 8. Desalination of seawater or brackish groundwater

Desalination of seawater or brackish groundwater is a strategy for expanding the option of available supplies for the STP Nuclear Operating Company (STPNOC) water demands in Matagorda County. STPNOC proposes to generate 26.4 million gallons per day (MGD) of fully treated desalinated water on its existing site (either from seawater or brackish groundwater). To produce the 26.4 MGD, STPNOC would need a raw water source with a capacity between 40 and 50 MGD, depending on the quality of the raw water.

Modeling the strategy is not applicable under the following assumptions:

1. The desalination waste stream would not be included as a return flow in the model because
    a. it is not freshwater, and
    b. the discharge location has not yet been determined, but would most likely be deep well injection or off shore disposal.
2. Water from the desalination process would be produced only after all current surface rights are exhausted (i.e., there is no reason for STPNOC to used desalination until its existing, cheaper water has been exhausted).
3. Water from desalination would be used as make-up water for cooling purposes and that would be 100% consumptive use with no return flows.

Under the above assumptions, modeling of this strategy for this environmental flows analysis is not applicable. Because of the coastal location of the STPNOC and the extreme downstream location within the river basin, any future increased return flows from the plant would not be expected to have a substantial impact on water rights or instream flow. Increased return flows could have an impact on freshwater bay and estuary flows; however, that impact may be all or partially offset by the waste stream disposal location. Until the strategy is further developed, potential impacts to freshwater bay and estuary flows cannot be determined as a part of this analysis.

Strategy 9. LCRA-SAWS Water Sharing Project (LSWP)

The 2002 State Water Plan included a proposal to temporarily transfer up to 150,000 ac-ft/yr of water from the lower Colorado River Basin to the Region L water planning area. The objective of this proposal was and is to satisfy long-term water shortages in both Region K and Region L. In 2001, the Region K planning group also considered and adopted a strategy element that set out a nine-point policy to be considered by the regional planning group in evaluating the proposed interbasin transfer of this water to Region L. That policy is included in this plan under Section 8.2.1.

In 2004, LCRA entered into an agreement with the San Antonio Water System (SAWS) to effectuate this proposal. This project is now referred to as the LCRA-SAWS Water Project (LSWP). Prior to finalizing the agreement with SAWS, specific legislation was enacted that imposes several restrictions and requirements on the LSWP (Texas Water Code § 222.030). Specifically, the LCRA Board must find that the contract:

1. Protects and benefits the lower Colorado River watershed and the authority's water service area, including municipal, industrial, agricultural, recreational, and environmental interests
2. Is consistent with regional water plans filed with the Texas Water Development Board on or before January 5, 2001
3. Ensures that the beneficial inflows remaining after any water diversions will be adequate to maintain the ecological health and productivity of the Matagorda Bay system
4. Provides for in-stream flows no less protective than those included in the authority's WMP for the Lower Colorado River Basin, as approved by the commission
5. Ensures that, before any water is delivered under the contract, the municipality has prepared a drought contingency plan and has developed and implemented a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the municipality
6. Provides for a broad public and scientific review process designed to ensure that all information that can be practicably developed is considered in establishing beneficial inflow and instream flow provisions
7. Benefits stored water levels in the authority's existing reservoirs

These and additional requirements contained in the legislation and final agreement between LCRA and SAWS mirror many of those contained in the nine-point policy of the 2001 Plan. For example, the transfer is temporary; it benefits both regions by substantially reducing projected water shortages in Region K and meeting municipal shortages in Region L; the system operation necessary for the project maximizes use of inflows available below Austin; and the goal is to design a project that will have minimal detrimental environmental, social, economic and cultural impacts and that will provide benefits to lake recreation over what would occur without the project.

For this study, and because of the complexity of the LSWP strategy, the time that would be required to develop the code within the model would not be possible with the state funds available under this regional water planning program. Instead, as a part of the LSWP, LCRA has created a model specifically for the project that is compatible with the Region K WAM Run 3 Cutoff Model and can be used for comparison purposes; therefore, it is more efficient to use the LCRA's already developed LSWP model. It should be noted that the LSWP model does contain several of the other strategies within it, which do contribute to the overall results. These strategies were already embedded in the model, and it was too difficult to remove them. The strategies include the 2007 Settlement Agreement between the City of Austin and the LCRA, as well as the Amendment of LCRA irrigation water rights (Strategy 12) and the LCRA excess flows permit and off-channel storage (Strategy 13). It is likely that the incorporation of the Settlement Agreement in the LSWP model will create the appearance of more positive impact results than if it was not included, as it is not for the other strategy comparisons. This should be considered when comparing the results. As the LSWP strategy will not be used in 2010, only a 2060 comparison of the impacts was performed using this existing model.

Control Points I10540, I10000, J10000, K20000, and K10000 were used to evaluate the impact on the instream flows downstream of the strategy, and Control Point M10000 was used to evaluate the impact on the bay and estuary inflow. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study.

Strategy 10. City of Austin return flows for downstream needs

The City of Austin currently returns approximately 60 percent of its water used to the Colorado River as wastewater discharges. Currently, as an interim strategy, these return flows from the City of Austin wastewater treatment plants can be used as a temporary water management strategy to meet projected water supply shortages within Region K. In order to demonstrate the impacts of this strategy, the return flow cards for the City of Austin were turned on in the model and used to determine the change in regulated streamflow (instream flows and bay and estuary flows) as compared to the model with zero return flows from the City. Control Points J30490, J30000, J10000, K20000, and K10000 were used to evaluate the instream flows downstream of the strategy, and Control Point M10000 was used to evaluate bay and estuary flow. This strategy is used only to provide interim supplies and is eventually supplanted by the next strategy as outlined further below. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study.

Strategy 11. City of Austin reuse

The City of Austin has developed a long-term reuse water strategy which includes construction of future water distribution systems to provide reclaimed water to meet non-potable water demands within the City's service area. As the level of authorized reclaimed water use in the City of Austin increases, the amount of flow it returns to the Colorado River will decrease accordingly. By 2090, the City of Austin may achieve full utilization (zero return flow).

To determine the impacts of the strategy on the environmental flows, an assumed return flow factor of 60.6 percent was assumed for the City of Austin water rights. The following strategies were then subtracted from the total return flow:

- direct reuse for municipal and manufacturing (33,537 ac-ft in 2060)
- indirect reuse for Fayette (27,411 ac-ft in 2060)
- direct reuse for Travis (13,690 ac-ft in 2060)

The remaining return flows are available for use downstream,. For comparison purposes, this strategy used a base model containing full City of Austin return flows, in order to appropriately determine the impact of the reuse. Control points J30490, J30000, J10000, K20000, and K10000 were used to evaluate the flows downstream of the strategy, and control point M10000 was used to evaluate bay and estuary flow. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study.

Strategy 12. Amendment of LCRA irrigation water rights

This strategy is a necessary component of the LSWP strategy, and thus was not modeled separately from the LSWP strategy. Please see Strategy 9 above for that methodology.

Strategy 13. LCRA excess flows permit and off-channel storage

LCRA has pending an application to appropriate the additional remaining flows (beyond the LSWP flows) in the lower part of the Colorado River Basin for storage in additional off-channel reservoirs. Subject to potential or pending litigation, LCRA intends to capture these flows and use them in conjunction with other water supplies available to it as part of its system operation. This water may ultimately be used to meet firm demands or mitigate environmental impacts of the LSWP, or to meet other demands in the Colorado River Basin. Water available under this permit will depend on the conditions imposed on the permit for purposes of protecting environmental flows. As a very conservative measure, this analysis included an assumption that target instream flow and freshwater bay and estuary inflow requirements would be imposed on this junior water right before diversions would occur.

This strategy used two reservoirs, one in Matagorda County at Control Point M10020, and one in Colorado County at Control Point K20080. Both water right diversions were given junior priority dates of 12/31/3000. The target bay and estuary inflows from the 2006 Matagorda Bay Freshwater Inflow Needs Study (FINS) and the target instream flows identified in the LCRA 2003 Water Management Plan were used as the bay and estuary and instream flow requirements with a more senior priority date of 12/30/3000. This strategy is only needed in 2060, and therefore, was only modeled for 2060.

Control Points K20080, K20000, K10090, K10000, and M10050 were used to evaluate the impact on the instream flows downstream of the strategy, and Control Point M10000 was used to evaluate the impact on the bay and estuary inflow. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study.

Strategy 14. Comprehensive model containing all of the strategies

In order to see the impact of all of the strategies occurring at the same time, a strategy model was created containing all of the appropriate strategies, and a base model was created that contained none of those strategies, as further elaborated here. The comprehensive strategy model began by using the LSWP model provided by LCRA (Strategy 9). The LSWP model, within itself, contains Strategies 9, 10, 11, 12, and 13. It should be noted that in this case, the City of Austin strategies (Strategy 10 and 11) are modeled as they are discussed in the 2007 COA/LCRA Settlement Agreement. This agreement is not a part of the other strategy comparisons because it occurred after the 2006 Plan was adopted by the Lower Colorado Regional Water Planning Group. The City of Austin anticipates proposing an updated reuse strategy for consideration in the 2011 Plan.

To the LSWP model, the language code was added for Strategy 3 (GBRA pipeline), Strategy 4 (Onion Creek recharge), and Strategies 5 and 6 (Goldthwaite). Because of the makeup of the strategies, Strategy 1 (LCRA contract expansion) and Strategy 7 (HB 1437) are already in the model.

For the comprehensive base model, Strategy 1 (LCRA contract expansion) and Strategy 7 (HB 1437) were removed from the base model used for all of the individual strategies.

Control Points F10000, I10000, J10000, K20000, and K10000 were used to evaluate the impact on the instream flows downstream of the strategy, and Control Point M10000 was used to evaluate the impact on the bay and estuary inflow. Please see the exhibit in Appendix B showing the location of all control points analyzed in this study. Only the 2060 model was used for this comparison.

3.0 RESULTS

The water management strategies that can show quantitative environmental impacts to instream flows and bay and estuary freshwater inflows by comparing the water availability model with and without the strategy are discussed in this section with tabular and graphic results. If the strategy is expected to be implemented throughout the planning period, then a comparison is shown for both 2010 and 2060. If the strategy is not needed throughout the entire planning period, then the comparison is only made for the year 2060. The tables of results for each strategy show a comparison of the 10^{th} percentile flows, meaning that the flows shown are larger than 10 percent of all the monthly results for the years 1940 through 1998, as calculated by the model. This percentile was chosen because the strategies are likely to be incorporated during periods of drought, and therefore the 10^{th} percentile was a more likely representation of the proposed situation than the median flows.

The flows are compared for a model run with and without the strategy and show the percent change, either positive if the strategy has a positive effect on the downstream regulated streamflows, or negative if the strategy has a negative effect on the downstream regulated streamflows. The results at the control points other than M10000 are also compared with the 7Q2 flows, which are considered to be low-flow conditions. The results at Control Point M10000 are compared to both the target and critical bay and estuary freshwater inflows, as determined in the 2006 Matagorda Bay Freshwater Inflow Needs Study. Tables showing the frequency that target and critical instream flow and freshwater inflow levels are met are provided, as well as tables showing duration and volume statistics related to occurrences where the instream flows and freshwater inflows fall below the target and critical levels. Graphs showing the results at Control Point M10000 are also provided for each strategy. Please refer to *Appendix B* for definitions and information related to the Results section of the report. An exhibit showing the location of all of the control points discussed in this study is also provided in *Appendix B*. For some strategies, additional control points were analyzed in addition to the ones discussed in this section. Please refer to *Appendix C* for graphic impact comparisons for the control points for each strategy.

Figure 3.1 below shows a graphic of the locations of the various control points discussed in this section.

Figure 3.1 Location of Selected Control Points

Strategy 1. Transfer/allocation/purchase water from Water User Groups (WUGs) with surplus

This strategy involves the expansion of LCRA contracts to meet shortages. The increase in contract amounts should decrease interruptible supplies, and therefore, regulated streamflows downstream of the strategy. The base model (Region K WAM Run 3) inherently contains both Strategy 1 (Expand Contract) and Strategy 7 (HB 1437), so for this analysis, Strategy 1 had to be removed from the base model in order to show the "without strategy" condition. See page 2-3 for more explanation. Impacts are compared at Control Points I10000, J10000, K20000, K10000, and M10000. *Table 3.1A* shows the comparison at Control Point I10000. *Table 3.1B* shows the comparison at Control Point J10000. *Table 3.1C* shows the comparison at Control Point K20000. *Table 3.1D* shows the comparison at Control Point K10000. *Table 3.1E* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations.

Table 3.1A Strategy 1 (Expand Contract) Comparison of 10th Percentile Flows at CP I10000 (Austin) for 2010 and 2060

Month	7Q2 Flow ac-ft	2010 Base Model ac-ft	2010 Strategy ac-ft	2010 % Change	2060 Base Model ac-ft	2060 Strategy ac-ft	2060 % Change
JAN	11,547	10,073	10,073	0.0	8,923	8,785	-1.5
FEB	11,547	8,188	8,188	0.0	8,886	8,886	0.0
MAR	11,547	22,124	22,124	0.0	17,696	17,696	0.0
APR	11,547	22,119	22,119	0.0	19,782	19,782	0.0
MAY	11,547	32,388	32,388	0.0	31,803	31,805	0.0
JUN	11,547	36,552	36,552	0.0	30,600	26,996	-11.8
JUL	11,547	33,454	33,454	0.0	20,204	20,204	0.0
AUG	11,547	37,812	37,812	0.0	27,245	27,245	0.0
SEP	11,547	18,060	18,060	0.0	17,181	17,181	0.0
OCT	11,547	13,673	13,673	0.0	11,711	12,000	2.5
NOV	11,547	11,197	11,197	0.0	9,377	9,409	0.3
DEC	11,547	10,672	10,672	0.0	10,196	10,382	1.8
Annual	138,564	256,314	256,314	0.0	213,603	210,371	-1.5

At Control Point (CP) I10000, the strategy of contract expansion overall has a small negative impact on the annual 10th percentile instream flows for 2060 and no impact in 2010. There is a fairly significant impact during the historical period for the months of June using the 2060 conditions with a more than 10% reduction for the low-flow conditions. However, the 10th percentile flows in this month are well above the 7Q2 flows.

Table 3.1B Strategy 1 (Expand Contract) Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2010 and 2060

Month	7Q2 Flow ac-ft	2010 Base Model ac-ft	2010 Strategy ac-ft	2010 % Change	2060 Base Model ac-ft	2060 Strategy ac-ft	2060 % Change
JAN	18,081	17,518	17,518	0.0	13,467	12,916	-4.1
FEB	18,081	14,691	14,691	0.0	12,901	12,901	0.0
MAR	18,081	30,275	30,275	0.0	31,475	32,006	1.7
APR	18,081	31,476	31,476	0.0	30,338	30,281	-0.2
MAY	18,081	60,646	60,646	0.0	51,567	51,525	-0.1
JUN	18,081	70,621	70,621	0.0	54,177	53,258	-1.7
JUL	18,081	52,845	52,845	0.0	37,175	36,001	-3.2
AUG	18,081	40,740	40,628	-0.3	28,807	27,029	-6.2
SEP	18,081	37,639	37,639	0.0	30,164	29,694	-1.6
OCT	18,081	22,361	22,361	0.0	15,923	16,942	6.4
NOV	18,081	14,588	14,588	0.0	13,672	13,672	0.0
DEC	18,081	17,822	17,822	0.0	14,991	16,264	8.5
Annual	216,972	411,223	411,110	0.0	334,658	332,488	-0.6

The annual impacts caused by the LCRA contract expansions are still small farther downstream at CP J10000 for both 2010 and 2060, and can be considered negligible. For the purposes of this study, impacts of less than one percent can be considered negligible.

Table 3.1C Strategy 1 (Expand Contract) Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	23,613	20,996	20,996	0.0	16,140	14,599	-9.5
FEB	23,613	19,465	19,465	0.0	17,188	17,368	1.0
MAR	23,613	30,746	30,746	0.0	33,101	33,690	1.8
APR	23,613	18,450	18,450	0.0	20,816	21,167	1.7
MAY	23,613	30,092	30,092	0.0	27,546	27,977	1.6
JUN	23,613	28,298	28,298	0.0	20,624	20,518	-0.5
JUL	23,613	22,939	22,939	0.0	15,157	15,053	-0.7
AUG	23,613	16,170	16,170	0.0	11,617	11,617	0.0
SEP	23,613	13,945	13,945	0.0	11,702	11,875	1.5
OCT	23,613	12,307	12,302	0.0	8,952	9,708	8.4
NOV	23,613	19,736	19,736	0.0	15,596	16,617	6.6
DEC	23,613	20,704	20,704	0.0	16,400	17,041	3.9
Annual	283,356	253,849	253,844	0.0	214,840	217,230	1.1

The impacts on the instream flows from the contract expansion strategy at CP K20000 for 2060 are still fairly small, with the largest negative impact occurring in January.

Table 3.1D Strategy 1 (Expand Contract) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	12,374	20,205	20,205	0.0	18,402	15,015	-18.4
FEB	12,374	21,826	21,826	0.0	17,507	18,782	7.3
MAR	12,374	28,665	28,665	0.0	32,540	32,712	0.5
APR	12,374	9,294	9,294	0.0	12,140	12,388	2.0
MAY	12,374	11,743	11,743	0.0	10,349	10,349	0.0
JUN	12,374	8,204	8,204	0.0	5,886	6,701	13.8
JUL	12,374	6,264	6,264	0.0	4,340	4,063	-6.4
AUG	12,374	4,846	4,846	0.0	4,205	4,205	0.0
SEP	12,374	2,985	2,985	0.0	2,608	2,694	3.3
OCT	12,374	7,867	7,867	0.0	10,105	11,468	13.5
NOV	12,374	19,396	19,396	0.0	16,199	16,617	2.6
DEC	12,374	21,105	21,105	0.0	17,747	18,127	2.1
Annual	148,488	162,401	162,401	0.0	152,028	153,121	0.7

At CP K10000, further downstream, the annual instream flow impacts are negligible except for the month of January which shows a significant decrease of 18.4 percent for the 2060 model. The impact of the strategy does not cause the instream flows to fall below the level of the 7Q2 flow.

Table 3.1E Strategy 1 (Expand Contract) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2010 and 2060

Month	Target B&E	Critical B&E	2010			2060		
			Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	205,600	36,000	16,939	16,939	0.0	12,939	12,939	0.0
FEB	194,500	36,000	19,941	19,941	0.0	14,988	14,988	0.0
MAR	63,200	36,000	23,842	23,842	0.0	26,324	26,337	0.0
APR	60,400	36,000	6,947	6,947	0.0	8,131	8,192	0.8
MAY	255,400	36,000	10,971	10,971	0.0	6,375	6,375	0.0
JUN	210,500	36,000	6,223	6,223	0.0	1,595	1,582	-0.8
JUL	108,400	36,000	3,476	3,476	0.0	1,292	1,122	-13.2
AUG	62,000	36,000	3,259	3,259	0.0	1,154	951	-17.6
SEP	61,900	36,000	1,048	1,048	0.0	15	15	0.0
OCT	71,300	36,000	2,210	2,210	0.0	1,334	1,334	0.0
NOV	66,500	36,000	17,501	17,501	0.0	11,010	11,010	0.0
DEC	68,000	36,000	18,829	18,829	0.0	13,749	14,181	3.1
Annual	1,427,700	432,000	131,186	131,186	0.0	98,908	99,028	0.1

CP M10000 is considered the entrance to Matagorda Bay, and thus, the flows are compared to the target and critical bay and estuary freshwater flows. As is shown in *Table 3.1E*, the 10th percentile monthly flows are far below both the target and the critical flows as identified in the 2006 Matagorda Bay Freshwater Inflow Needs Study. The annual impacts of the strategy are negligible, although the summer months for the 2060 model are negatively impacted with significant statistical reductions in July and August.

Figure 3.2 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without Strategy 1 at CP M10000 for 2010, along with the target and critical bay and estuary freshwater inflows. *Figure 3.3* below shows a similar comparison for 2060.

Figure 3.2 Strategy 1 (Expand Contract) 2010 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

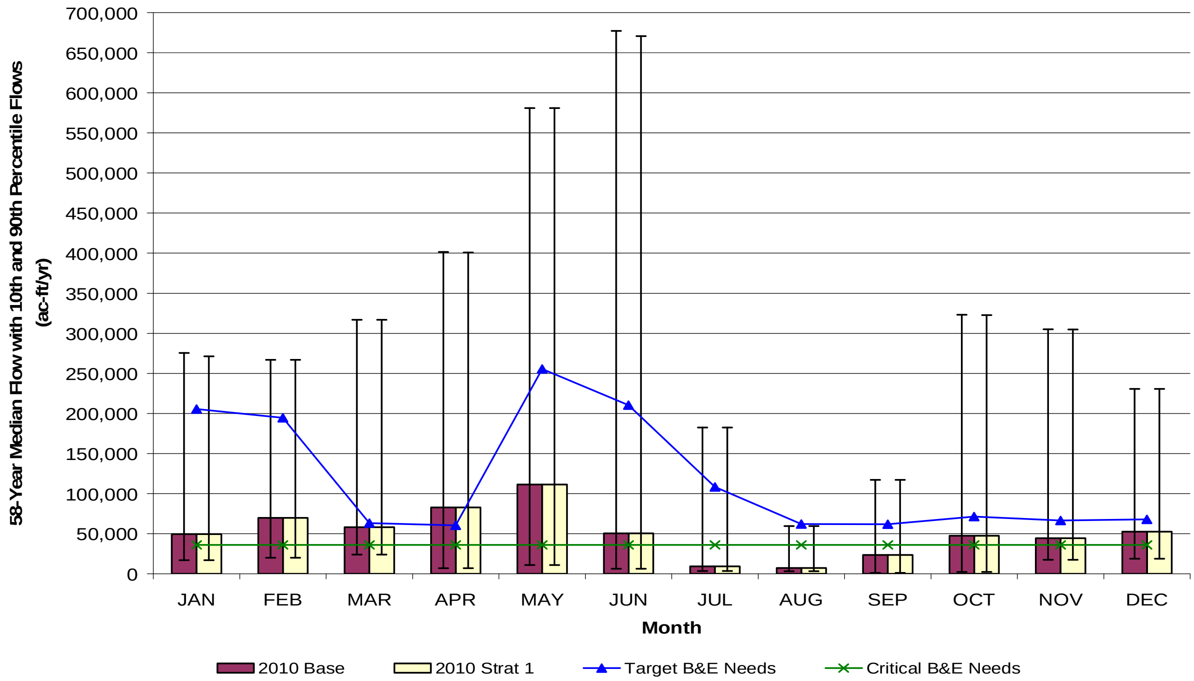


Figure 3.3 Strategy 1 (Expand Contract) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

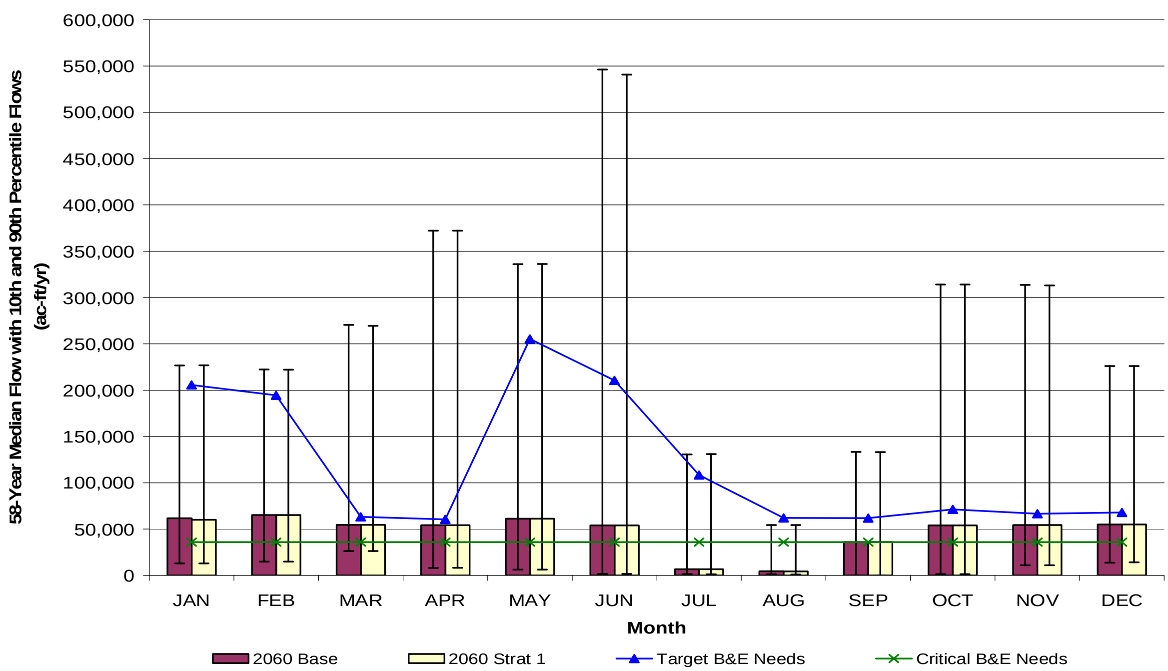


Table 3.1F Strategy 1 (Expand Contract) Frequency of Meeting Target and Critical Needs for 2060

Month	Expand Contract Strategy at CP J10000 (Colorado County)						Expand Contract Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	81.4%	81.4%	0.0%	100.0%	98.3%	-1.7%	18.6%	18.6%	0.0%	71.2%	71.2%	0.0%
FEB	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	18.6%	18.6%	0.0%	76.3%	76.3%	0.0%
MAR	91.5%	93.2%	1.7%	91.5%	93.2%	1.7%	42.4%	42.4%	0.0%	74.6%	76.3%	1.7%
APR	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	45.8%	45.8%	0.0%	62.7%	62.7%	0.0%
MAY	89.8%	89.8%	0.0%	98.3%	100.0%	1.7%	22.0%	22.0%	0.0%	78.0%	78.0%	0.0%
JUN	94.9%	96.6%	1.7%	100.0%	100.0%	0.0%	30.5%	30.5%	0.0%	64.4%	64.4%	0.0%
JUL	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	13.6%	13.6%	0.0%	37.3%	39.0%	1.7%
AUG	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	8.5%	8.5%	0.0%	23.7%	23.7%	0.0%
SEP	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	25.4%	25.4%	0.0%	59.3%	59.3%	0.0%
OCT	74.6%	74.6%	0.0%	100.0%	100.0%	0.0%	32.2%	32.2%	0.0%	66.1%	66.1%	0.0%
NOV	83.1%	84.7%	1.7%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	67.8%	67.8%	0.0%
DEC	84.7%	84.7%	0.0%	98.3%	98.3%	0.0%	45.8%	45.8%	0.0%	72.9%	72.9%	0.0%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	76.3%	76.3%	0.0%

Table 3.1F above demonstrates how frequently (by month and year) the target or critical needs are met at a particular control point, both with and without the strategy. The months where a target is met less frequently due to the strategy being implemented are highlighted in gray. The two control points analyzed for this table are CP J10000 (Colorado County) and CP M10000 (Entrance to Matagorda Bay). Please refer to the Definitions pages of *Appendix B* for the target and critical flow values for each control point.

Table 3.1G Strategy 1 (Expand Contract) Flow Duration Below Target and Critical Needs for 2060

Condition	Expand Contract Strategy at CP J10000 (Colorado County)			Expand Contract Strategy at CP M10000 (Matagorda Bay)		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
Number of Times Flow Falls Below **Target** Level	39	38	-1	85	85	0
Maximum Duration Below **Target** Level (months)	6	6	0	51	51	0
Total Duration Below **Target** Level (months)	71	68	-3	506	506	0
Average Duration Below **Target** Level (months)	2	2	0	6	6	0
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	10,699	10,659	-39	503,851	504,744	893
Number of Times Flow Falls Below **Critical** Level	7	6	-1	92	93	1
Maximum Duration Below **Critical** Level (months)	1	1	0	11	11	0
Total Duration Below **Critical** Level (months)	7	6	-1	263	261	-2
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	3,815	5,068	1,253	67,893	66,999	-894

Table 3.1G above provides statistics related to the instream flow and freshwater inflow falling below their respective target and critical levels over the 58-year period of record. Information on the number of times

the flow falls below the target/critical level, the longest amount of time in months that the flow is below the target/critical level, the total amount of time in months that the flow is below the target/critical level, the average amount of time in months per occurrence that the flow is below the target/critical level, and the average volume of flow for each occurrence of the flow falling below target/critical levels is provided. The information is looked at both with and without the strategy, and the difference between the two is shown. For this table, a negative value in the Difference column means that the strategy causes fewer or shorter occurrences below the target/critical level than without the strategy.

Strategy 2. Treated water purchase from Canyon Lake Water Supply

This strategy should not have an impact on the instream flows and freshwater inflows in the Colorado River Basin.

Strategy 3. Guadalupe-Blanco River Authority (GBRA) Hays County Pipeline

This strategy involves supplying Hays County and the City of Buda with GBRA water from Canyon Reservoir to meet shortages in the Colorado basin. The increase in water to the City of Buda should increase the return flows to Onion Creek and eventually to the Colorado River. For the analysis, the Region K WAM Run 3 Cutoff Model, which inherently contains Strategy 1 (Expand Contract) and Strategy 7 (HB 1437), was used for the base condition. Impacts are compared at Control Points I10000, J10000, K20000, K10000, and M10000. *Table 3.2A* shows the comparison at Control Point I10000. *Table 3.2B* shows the comparison at Control Point J10000. *Table 3.2C* shows the comparison at Control Point K20000. *Table 3.2D* shows the comparison at Control Point K10000. *Table 3.2E* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations.

Table 3.2A Strategy 3 (GBRA Pipeline) Comparison of 10th Percentile Flows at CP I10000 (Austin) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
	ac-ft	Base Model ac-ft	Strategy ac-ft	% Change	Base Model ac-ft	Strategy ac-ft	% Change
JAN	11,547	10,073	10,073	0.0	8,785	8,785	0.0
FEB	11,547	8,188	8,188	0.0	8,886	8,850	-0.4
MAR	11,547	22,124	22,077	-0.2	17,696	17,696	0.0
APR	11,547	22,119	22,109	0.0	19,782	19,782	0.0
MAY	11,547	32,388	32,335	-0.2	31,805	31,749	-0.2
JUN	11,547	36,552	36,493	-0.2	26,996	26,983	-0.1
JUL	11,547	33,454	33,454	0.0	20,204	20,204	0.0
AUG	11,547	37,812	37,794	0.0	27,245	27,224	-0.1
SEP	11,547	18,060	18,001	-0.3	17,181	17,181	0.0
OCT	11,547	13,673	13,673	0.0	12,000	12,000	0.0
NOV	11,547	11,197	11,197	0.0	9,409	9,399	-0.1
DEC	11,547	10,672	10,635	-0.3	10,382	10,382	0.0
Annual	138,564	256,314	256,030	-0.1	210,371	210,234	-0.1

Table 3.2B Strategy 3 (GBRA Pipeline) Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	18,081	17,518	17,518	0.0	12,916	12,969	0.4
FEB	18,081	14,691	14,698	0.1	12,901	12,910	0.1
MAR	18,081	30,275	30,275	0.0	32,006	32,006	0.0
APR	18,081	31,476	31,476	0.0	30,281	30,275	0.0
MAY	18,081	60,646	60,646	0.0	51,525	51,514	0.0
JUN	18,081	70,621	70,681	0.1	53,258	53,250	0.0
JUL	18,081	52,845	52,811	-0.1	36,001	36,008	0.0
AUG	18,081	40,628	40,629	0.0	27,029	27,065	0.1
SEP	18,081	37,639	37,639	0.0	29,694	29,763	0.2
OCT	18,081	22,361	22,420	0.3	16,942	17,011	0.4
NOV	18,081	14,588	14,632	0.3	13,672	13,724	0.4
DEC	18,081	17,822	17,868	0.3	16,264	16,274	0.1
Annual	216,972	411,110	411,295	0.0	332,488	332,768	0.1

Table 3.2C Strategy 3 (GBRA Pipeline) Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	23,613	20,996	21,005	0.0	14,599	14,653	0.4
FEB	23,613	19,465	19,504	0.2	17,368	17,414	0.3
MAR	23,613	30,746	30,746	0.0	33,690	33,702	0.0
APR	23,613	18,450	18,444	0.0	21,167	21,173	0.0
MAY	23,613	30,092	30,140	0.2	27,977	27,958	-0.1
JUN	23,613	28,298	28,297	0.0	20,518	20,510	0.0
JUL	23,613	22,939	22,927	-0.1	15,053	15,071	0.1
AUG	23,613	16,170	16,149	-0.1	11,617	11,688	0.6
SEP	23,613	13,945	13,945	0.0	11,875	11,948	0.6
OCT	23,613	12,302	12,303	0.0	9,708	9,777	0.7
NOV	23,613	19,736	19,782	0.2	16,617	16,660	0.3
DEC	23,613	20,704	20,741	0.2	17,041	17,041	0.0
Annual	283,356	253,844	253,982	0.1	217,230	217,596	0.2

Table 3.2D Strategy 3 (GBRA Pipeline) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	12,374	20,205	20,251	0.2	15,015	15,068	0.4
FEB	12,374	21,826	21,834	0.0	18,782	18,828	0.2
MAR	12,374	28,665	28,665	0.0	32,712	32,551	-0.5
APR	12,374	9,294	9,304	0.1	12,388	12,348	-0.3
MAY	12,374	11,743	11,741	0.0	10,349	10,346	0.0
JUN	12,374	8,204	8,197	-0.1	6,701	6,692	-0.1
JUL	12,374	6,264	6,264	0.0	4,063	4,042	-0.5
AUG	12,374	4,846	4,872	0.5	4,205	4,191	-0.3
SEP	12,374	2,985	2,977	-0.3	2,694	2,694	0.0
OCT	12,374	7,867	7,879	0.1	11,468	11,482	0.1
NOV	12,374	19,396	19,434	0.2	16,617	16,660	0.3
DEC	12,374	21,105	21,152	0.2	18,127	18,170	0.2
Annual	148,488	162,401	162,570	0.1	153,121	153,072	0.0

Table 3.2E Strategy 3 (GBRA Pipeline) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2010 and 2060

Month	Target B&E	Critical B&E	2010			2060		
			Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	205,600	36,000	16,939	16,985	0.3	12,939	12,993	0.4
FEB	194,500	36,000	19,941	19,979	0.2	14,988	15,034	0.3
MAR	63,200	36,000	23,842	23,842	0.0	26,337	26,338	0.0
APR	60,400	36,000	6,947	6,985	0.6	8,192	8,182	-0.1
MAY	255,400	36,000	10,971	10,971	0.0	6,375	6,362	-0.2
JUN	210,500	36,000	6,223	6,216	-0.1	1,582	1,573	-0.6
JUL	108,400	36,000	3,476	3,446	-0.9	1,122	1,117	-0.5
AUG	62,000	36,000	3,259	3,248	-0.3	951	949	-0.3
SEP	61,900	36,000	1,048	1,041	-0.6	15	15	0.0
OCT	71,300	36,000	2,210	2,257	2.1	1,334	1,389	4.1
NOV	66,500	36,000	17,501	17,538	0.2	11,010	11,021	0.1
DEC	68,000	36,000	18,829	18,875	0.2	14,181	14,234	0.4
Annual	1,427,700	432,000	131,186	131,384	0.2	99,028	99,207	0.2

Overall, the impacts at the various control points are relatively small, with an impact of less than one percent most of the time, and can be considered negligible. The results are generally consistent with the expected slightly positive impact due to the increased return flows from the City of Buda.

Figure 3.4 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without Strategy 3 at CP M10000 for 2010, along with the target and critical bay and estuary freshwater inflows. *Figure 3.5* below shows a similar comparison for 2060.

Figure 3.4 Strategy 3 (GBRA Pipeline) 2010 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

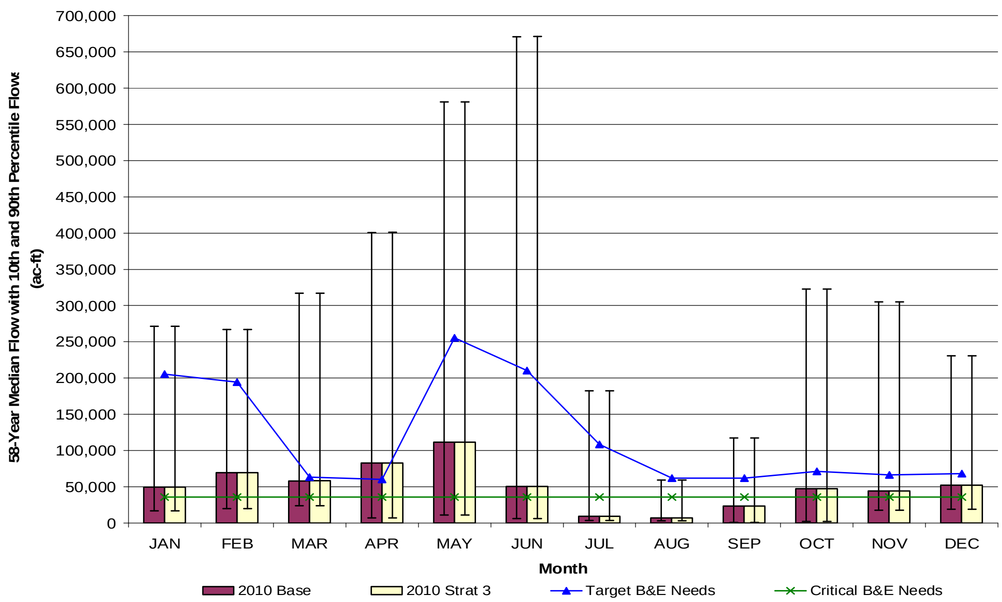


Figure 3.5 Strategy 3 (GBRA Pipeline) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

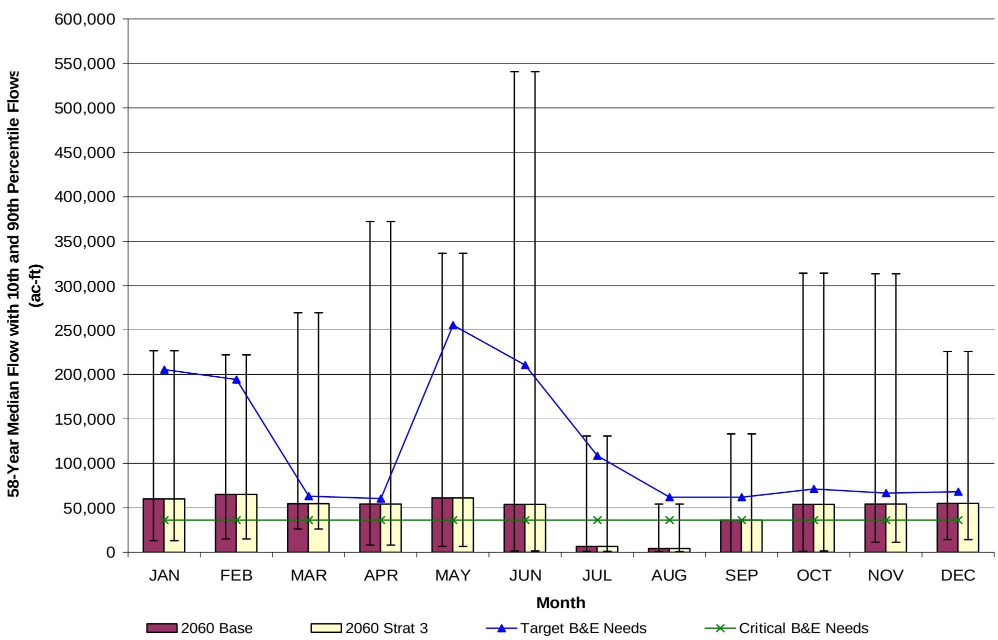


Table 3.2F Strategy 3 (GBRA Pipeline) Frequency of Meeting Target and Critical Needs for 2060

	GBRA Pipeline Strategy at CP J10000 (Colorado County)						GBRA Pipeline Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
Month	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	81.4%	81.4%	0.0%	98.3%	98.3%	0.0%	18.6%	18.6%	0.0%	71.2%	71.2%	0.0%
FEB	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	18.6%	18.6%	0.0%	76.3%	76.3%	0.0%
MAR	93.2%	93.2%	0.0%	93.2%	93.2%	0.0%	42.4%	42.4%	0.0%	76.3%	76.3%	0.0%
APR	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	45.8%	45.8%	0.0%	62.7%	62.7%	0.0%
MAY	89.8%	89.8%	0.0%	100.0%	100.0%	0.0%	22.0%	22.0%	0.0%	78.0%	78.0%	0.0%
JUN	96.6%	96.6%	0.0%	100.0%	100.0%	0.0%	30.5%	30.5%	0.0%	64.4%	64.4%	0.0%
JUL	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	13.6%	15.3%	1.7%	39.0%	39.0%	0.0%
AUG	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	8.5%	8.5%	0.0%	23.7%	23.7%	0.0%
SEP	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	25.4%	25.4%	0.0%	59.3%	59.3%	0.0%
OCT	74.6%	74.6%	0.0%	100.0%	100.0%	0.0%	32.2%	32.2%	0.0%	66.1%	66.1%	0.0%
NOV	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	67.8%	67.8%	0.0%
DEC	84.7%	84.7%	0.0%	98.3%	98.3%	0.0%	45.8%	45.8%	0.0%	72.9%	72.9%	0.0%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	76.3%	76.3%	0.0%

Table 3.2F above shows that the GBRA Pipeline strategy does not cause the instream flows and freshwater inflows to meet their target and critical flow levels any less often than if the strategy is not implemented.

Table 3.2G Strategy 3 (GBRA Pipeline) Flow Duration Below Target and Critical Needs for 2060

	GBRA Pipeline Strategy at CP J10000 (Colorado County)			GBRA Pipeline Strategy at CP M10000 (Matagorda Bay)		
Condition	**Without Strategy**	**With Strategy**	**Difference**	**Without Strategy**	**With Strategy**	**Difference**
Number of Times Flow Falls Below **Target** Level	38	38	0	85	85	0
Maximum Duration Below **Target** Level (months)	6	6	0	51	51	0
Total Duration Below **Target** Level (months)	68	68	0	506	505	-1
Average Duration Below **Target** Level (months)	2	2	0	6	6	0
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	10,659	10,602	-57	504,744	504,654	-90
Number of Times Flow Falls Below **Critical** Level	6	6	0	93	93	0
Maximum Duration Below **Critical** Level (months)	1	1	0	11	11	0
Total Duration Below **Critical** Level (months)	6	6	0	261	261	0
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	5,068	5,050	-18	66,999	66,975	-24

Table 3.2G above demonstrates that the GBRA Pipeline strategy has very little impact on whether the instream flow or freshwater inflow falls below its target/critical level. For this table, a negative value in the Difference column means that the strategy causes shorter occurrences or less volume below the target/critical level than without the strategy.

Strategy 4. Recharge Edwards BFZ Aquifer with Onion Creek recharge structure

This strategy involves the construction of two channel dams across Onion Creek in order to hold back excess flows and release them at a slower rate, allowing for greater infiltration and groundwater recharge downstream of the dams. This strategy was only modeled for 2060, as the strategy is not expected to be implemented in 2010. It should be noted that this strategy's effectiveness has been questioned and an alternative to this strategy will be considered during the next phase of planning. For the analysis, the Region K WAM Run 3 Cutoff Model, which inherently contains Strategy 1 (Expand Contract) and Strategy 7 (HB 1437), was used for the base condition.

Impacts are compared at Control Points J10000, K20000, K10000, and M10000. *Table 3.3A* shows the comparison at Control Point J10000. *Table 3.3B* shows the comparison at Control Point K20000. *Table 3.3C shows* the comparison at Control Point K10000. *Table 3.3D* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations. Please see Appendix C (pages C-27 through C-33) for impact analysis results of control points not discussed in this section.

Table 3.3A Strategy 4 (Onion Creek) Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	18,081	12,916	13,869	7.4
FEB	18,081	12,901	12,901	0.0
MAR	18,081	32,006	30,589	-4.4
APR	18,081	30,281	30,368	0.3
MAY	18,081	51,525	48,557	-5.8
JUN	18,081	53,258	53,587	0.6
JUL	18,081	36,001	36,002	0.0
AUG	18,081	27,029	27,097	0.3
SEP	18,081	29,694	29,808	0.4
OCT	18,081	16,942	16,942	0.0
NOV	18,081	13,672	13,709	0.3
DEC	18,081	16,264	15,145	-6.9
Annual	216,972	332,488	328,574	-1.2

Table 3.3B Strategy 4 (Onion Creek) Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	23,613	14,599	16,219	11.1
FEB	23,613	17,368	17,263	-0.6
MAR	23,613	33,690	32,983	-2.1
APR	23,613	21,167	21,184	0.1
MAY	23,613	27,977	27,928	-0.2
JUN	23,613	20,518	20,463	-0.3
JUL	23,613	15,053	15,119	0.4
AUG	23,613	11,617	11,692	0.6
SEP	23,613	11,875	12,052	1.5
OCT	23,613	9,708	9,708	0.0
NOV	23,613	16,617	16,617	0.0
DEC	23,613	17,041	16,448	-3.5
Annual	283,356	217,230	217,678	0.2

Table 3.3C Strategy 4 (Onion Creek) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	12,374	15,015	18,672	24.4
FEB	12,374	18,782	17,526	-6.7
MAR	12,374	32,712	31,459	-3.8
APR	12,374	12,388	12,350	-0.3
MAY	12,374	10,349	10,349	0.0
JUN	12,374	6,701	6,724	0.3
JUL	12,374	4,063	4,303	5.9
AUG	12,374	4,205	4,463	6.2
SEP	12,374	2,694	2,726	1.2
OCT	12,374	11,468	11,534	0.6
NOV	12,374	16,617	16,617	0.0
DEC	12,374	18,127	17,747	-2.1
Annual	148,488	153,121	154,471	0.9

The negative impacts on the instream flows at the various downstream control points for this strategy are small and can be considered negligible. There are some positive impacts that could be attributed to the slower release rate from the dam that allows increased downstream flows during times when there wouldn't be as much water, otherwise. There are concerns regarding the water quality aspect with this strategy, which is one of the reasons an alternative will be considered in the upcoming phase of planning.

Table 3.3D Strategy 4 (Onion Creek) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2060

Month	Target B&E ac-ft	Critical B&E ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	205,600	36,000	12,939	13,088	1.2
FEB	194,500	36,000	14,988	15,076	0.6
MAR	63,200	36,000	26,337	26,343	0.0
APR	60,400	36,000	8,192	8,195	0.0
MAY	255,400	36,000	6,375	6,375	0.0
JUN	210,500	36,000	1,582	1,658	4.8
JUL	108,400	36,000	1,122	1,253	11.6
AUG	62,000	36,000	951	1,013	6.5
SEP	61,900	36,000	15	85	469.3
OCT	71,300	36,000	1,334	1,353	1.4
NOV	66,500	36,000	11,010	11,010	0.0
DEC	68,000	36,000	14,181	13,799	-2.7
Annual	1,427,700	432,000	99,028	99,248	0.2

Overall, the Onion Creek recharge strategy has little impact on the freshwater inflows to Matagorda Bay. The impacts are mainly positive, with the December monthly 10th percentile inflows showing the only negative impact.

Figure 3.6 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without Strategy 4 at CP M10000 for 2060, along with the target and critical bay and estuary freshwater inflows. The graph shows that the strategy has very little impact overall.

Figure 3.6 Strategy 4 (Onion Creek) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

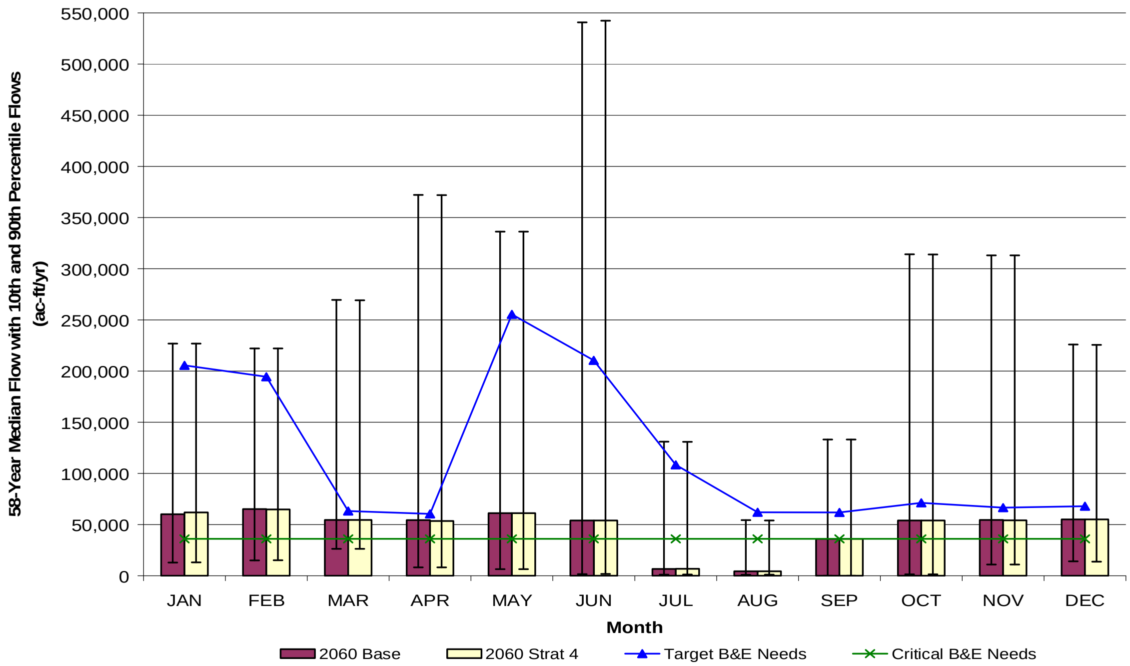


Table 3.3E Strategy 4 (Onion Creek) Frequency of Meeting Target and Critical Needs for 2060

Month	Onion Creek Strategy at CP J10000 (Colorado County)						Onion Creek Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	81.4%	81.4%	0.0%	98.3%	98.3%	0.0%	18.6%	18.6%	0.0%	71.2%	71.2%	0.0%
FEB	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	18.6%	16.9%	-1.7%	76.3%	76.3%	0.0%
MAR	93.2%	88.1%	-5.1%	93.2%	88.1%	-5.1%	42.4%	42.4%	0.0%	76.3%	72.9%	-3.4%
APR	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	45.8%	42.4%	-3.4%	62.7%	59.3%	-3.4%
MAY	89.8%	88.1%	-1.7%	100.0%	100.0%	0.0%	22.0%	22.0%	0.0%	78.0%	72.9%	-5.1%
JUN	96.6%	96.6%	0.0%	100.0%	100.0%	0.0%	30.5%	28.8%	-1.7%	64.4%	61.0%	-3.4%
JUL	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	13.6%	13.6%	0.0%	39.0%	37.3%	-1.7%
AUG	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	8.5%	3.4%	-5.1%	23.7%	23.7%	0.0%
SEP	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	25.4%	23.7%	-1.7%	59.3%	55.9%	-3.4%
OCT	74.6%	74.6%	0.0%	100.0%	100.0%	0.0%	32.2%	28.8%	-3.4%	66.1%	66.1%	0.0%
NOV	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	67.8%	67.8%	0.0%
DEC	84.7%	84.7%	0.0%	98.3%	98.3%	0.0%	45.8%	45.8%	0.0%	72.9%	72.9%	0.0%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	76.3%	76.3%	0.0%

Table 3.3E above shows that the Onion Creek strategy does have an impact on how frequently the target/critical flow levels are met, but that the maximum monthly impact the strategy has is a decrease of

approximately five percent for both the instream flows and freshwater inflows. The strategy does not have an impact at the annual level.

Table 3.3F Strategy 4 (Onion Creek) Flow Duration Below Target and Critical Needs for 2060

Condition	Onion Creek Strategy at CP J10000 (Colorado County)			Onion Creek Strategy at CP M10000 (Matagorda Bay)		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
Number of Times Flow Falls Below **Target** Level	38	41	3	85	86	1
Maximum Duration Below **Target** Level (months)	6	6	0	51	51	0
Total Duration Below **Target** Level (months)	68	72	4	506	516	10
Average Duration Below **Target** Level (months)	2	2	0	6	6	0
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	10,659	9,947	-713	504,744	501,309	-3,435
Number of Times Flow Falls Below **Critical** Level	6	9	3	93	90	-3
Maximum Duration Below **Critical** Level (months)	1	1	0	11	16	5
Total Duration Below **Critical** Level (months)	6	9	3	261	273	12
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	5,068	3,443	-1,625	66,999	70,144	3,145

Table 3.3F above again shows that the Onion Creek strategy does have an impact on whether the instream and freshwater inflows are meeting their respective target/critical levels. This strategy has an increase in the maximum duration below critical level, increases in the number of occurrences and total duration below target/critical level, and an increase in the average volume per event below critical level.

Strategy 5. Construct Goldthwaite channel dam

This strategy consists of the construction of a channel dam that would allow additional storage during periods of high flows, and would allow greater amounts of pumping during these times that would help extend the length of time the City of Goldthwaite could provide service. Because the strategy assumes that the 10^{th} percentile naturalized flows are passed through, the impacts to the 10^{th} percentile instream flows and freshwater inflows should be negligible. For the analysis, the Region K WAM Run 3 Cutoff Model, which inherently contains Strategy 1 (Expand Contract) and Strategy 7 (HB 1437), was used for the base condition.

Impacts are compared at Control Points F10000, I10000, J10000, K20000, K10000, and M10000. *Table 3.4A* shows the comparison at Control Point F10000. *Table 3.4B* shows the comparison at Control Point I10000. *Table 3.4C* shows the comparison at Control Point J10000. *Table 3.4D* shows the comparison at Control Point K20000. *Table 3.4E* shows the comparison at Control Point K10000. *Table 3.4F* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations.

Table 3.4A Strategy 5 (Gold Channel Dam) Comparison of 10th Percentile Flows at CP F10000 (San Saba County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	2,317	5,037	5,037	0.0	5,077	5,077	0.0
FEB	2,317	5,074	5,074	0.0	4,979	4,979	0.0
MAR	2,317	4,028	4,028	0.0	4,286	4,286	0.0
APR	2,317	5,657	5,657	0.0	6,281	6,281	0.0
MAY	2,317	6,077	6,077	0.0	6,384	6,384	0.0
JUN	2,317	9,318	9,318	0.0	9,278	9,278	0.0
JUL	2,317	4,711	4,711	0.0	4,675	4,675	0.0
AUG	2,317	4,043	4,043	0.0	4,490	4,490	0.0
SEP	2,317	3,486	3,486	0.0	3,085	3,085	0.0
OCT	2,317	3,806	3,806	0.0	3,706	3,706	0.0
NOV	2,317	4,046	4,046	0.0	3,990	3,990	0.0
DEC	2,317	4,628	4,628	0.0	4,902	4,902	0.0
Annual	27,804	59,910	59,910	0.0	61,133	61,133	0.0

Table 3.4B Strategy 5 (Gold Channel Dam) Comparison of 10th Percentile Flows at CP I10000 (Austin) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	11,547	10,073	10,073	0.0	8,785	8,835	0.6
FEB	11,547	8,188	8,188	0.0	8,886	8,886	0.0
MAR	11,547	22,124	22,124	0.0	17,696	17,696	0.0
APR	11,547	22,119	22,119	0.0	19,782	19,782	0.0
MAY	11,547	32,388	32,388	0.0	31,805	31,805	0.0
JUN	11,547	36,552	36,552	0.0	26,996	26,996	0.0
JUL	11,547	33,454	33,525	0.2	20,204	20,204	0.0
AUG	11,547	37,812	38,119	0.8	27,245	27,245	0.0
SEP	11,547	18,060	18,060	0.0	17,181	17,181	0.0
OCT	11,547	13,673	13,673	0.0	12,000	12,000	0.0
NOV	11,547	11,197	11,197	0.0	9,409	9,409	0.0
DEC	11,547	10,672	10,672	0.0	10,382	10,382	0.0
Annual	138,564	256,314	256,691	0.1	210,371	210,421	0.0

Table 3.4C Strategy 5 (Gold Channel Dam) Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	18,081	17,518	17,518	0.0	12,916	12,916	0.0
FEB	18,081	14,691	14,691	0.0	12,901	12,901	0.0
MAR	18,081	30,275	30,275	0.0	32,006	32,006	0.0
APR	18,081	31,476	31,476	0.0	30,281	30,281	0.0
MAY	18,081	60,646	60,646	0.0	51,525	51,522	0.0
JUN	18,081	70,621	70,621	0.0	53,258	53,256	0.0
JUL	18,081	52,845	52,845	0.0	36,001	36,000	0.0
AUG	18,081	40,628	40,628	0.0	27,029	27,029	0.0
SEP	18,081	37,639	37,639	0.0	29,694	29,802	0.4
OCT	18,081	22,361	22,361	0.0	16,942	16,942	0.0
NOV	18,081	14,588	14,588	0.0	13,672	13,834	1.2
DEC	18,081	17,822	17,822	0.0	16,264	16,264	0.0
Annual	216,972	411,110	411,110	0.0	332,488	332,753	0.1

Table 3.4D Strategy 5 (Gold Channel Dam) Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	23,613	20,996	20,996	0.0	14,599	14,610	0.1
FEB	23,613	19,465	19,465	0.0	17,368	17,368	0.0
MAR	23,613	30,746	30,746	0.0	33,690	33,691	0.0
APR	23,613	18,450	18,450	0.0	21,167	21,175	0.0
MAY	23,613	30,092	30,092	0.0	27,977	27,976	0.0
JUN	23,613	28,298	28,301	0.0	20,518	20,505	-0.1
JUL	23,613	22,939	22,986	0.2	15,053	15,124	0.5
AUG	23,613	16,170	16,170	0.0	11,617	11,617	0.0
SEP	23,613	13,945	13,945	0.0	11,875	12,046	1.4
OCT	23,613	12,302	12,302	0.0	9,708	9,708	0.0
NOV	23,613	19,736	19,736	0.0	16,617	16,617	0.0
DEC	23,613	20,704	20,704	0.0	17,041	17,041	0.0
Annual	283,356	253,844	253,893	0.0	217,230	217,478	0.1

Table 3.4E Strategy 5 (Gold Channel Dam) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	12,374	20,205	20,205	0.0	15,015	15,186	1.1
FEB	12,374	21,826	21,826	0.0	18,782	18,782	0.0
MAR	12,374	28,665	28,665	0.0	32,712	32,551	-0.5
APR	12,374	9,294	9,294	0.0	12,388	12,407	0.1
MAY	12,374	11,743	11,743	0.0	10,349	10,349	0.0
JUN	12,374	8,204	8,234	0.4	6,701	6,701	0.0
JUL	12,374	6,264	6,341	1.2	4,063	4,058	-0.1
AUG	12,374	4,846	4,978	2.7	4,205	4,205	0.0
SEP	12,374	2,985	2,985	0.0	2,694	2,694	0.0
OCT	12,374	7,867	7,867	0.0	11,468	11,468	0.0
NOV	12,374	19,396	19,396	0.0	16,617	16,617	0.0
DEC	12,374	21,105	21,105	0.0	18,127	18,127	0.0
Annual	148,488	162,401	162,640	0.1	153,121	153,145	0.0

Table 3.4F Strategy 5 (Gold Channel Dam) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2010 and 2060

Month	Target B&E	Critical B&E	2010			2060		
			Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	205,600	36,000	16,939	16,938	0.0	12,939	13,088	1.2
FEB	194,500	36,000	19,941	19,941	0.0	14,988	14,988	0.0
MAR	63,200	36,000	23,842	23,842	0.0	26,337	26,337	0.0
APR	60,400	36,000	6,947	6,947	0.0	8,192	8,196	0.1
MAY	255,400	36,000	10,971	10,971	0.0	6,375	6,375	0.0
JUN	210,500	36,000	6,223	6,223	0.0	1,582	1,581	-0.1
JUL	108,400	36,000	3,476	3,526	1.4	1,122	1,121	-0.1
AUG	62,000	36,000	3,259	3,259	0.0	951	951	0.0
SEP	61,900	36,000	1,048	1,048	0.0	15	15	0.0
OCT	71,300	36,000	2,210	2,210	0.0	1,334	1,334	0.0
NOV	66,500	36,000	17,501	17,501	0.0	11,010	11,136	1.1
DEC	68,000	36,000	18,829	18,829	0.0	14,181	14,181	0.0
Annual	1,427,700	432,000	131,186	131,235	0.0	99,028	99,304	0.3

Overall, the impacts of the Goldthwaite channel dam strategy are negligible, due mainly to the junior priority date combined with the passing of low-flow events. This strategy is not assumed to provide the necessary shortage makeup during periods of drought, but rather to help extend the length of time the City can continue to provide service once flow in the river slows or ceases.

Figure 3.7 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without Strategy 5 at CP M10000 for 2010, along with the target and critical bay and estuary freshwater inflows. *Figure 3.8* shows a similar comparison for 2060.

Figure 3.7 Strategy 5 (Gold Channel Dam) 2010 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

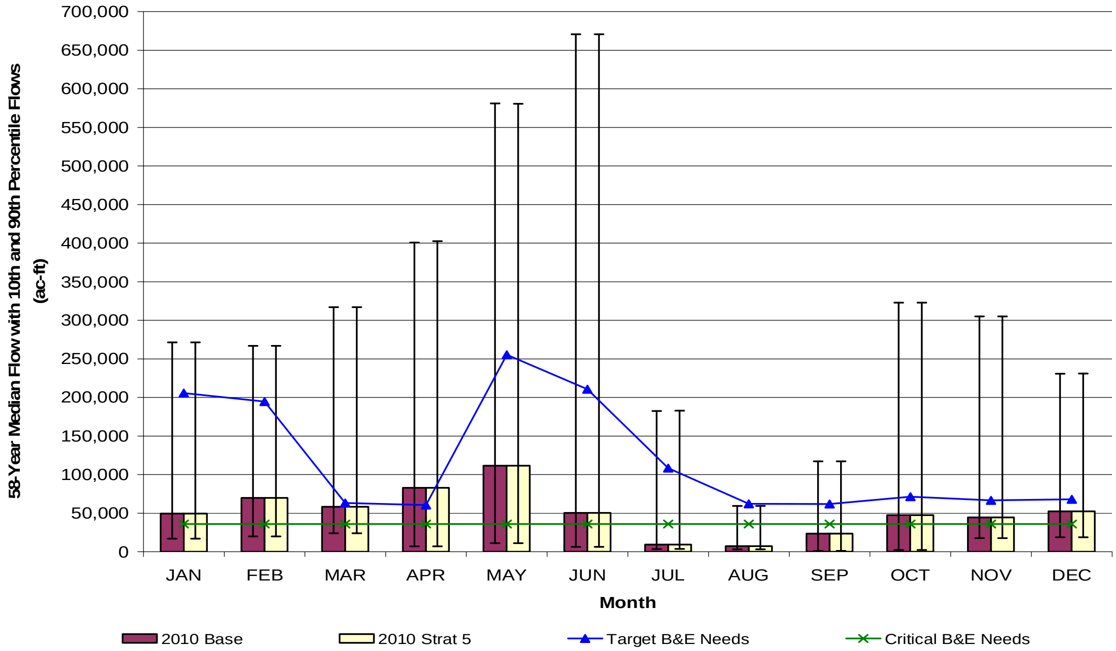


Figure 3.8 Strategy 5 (Gold Channel Dam) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

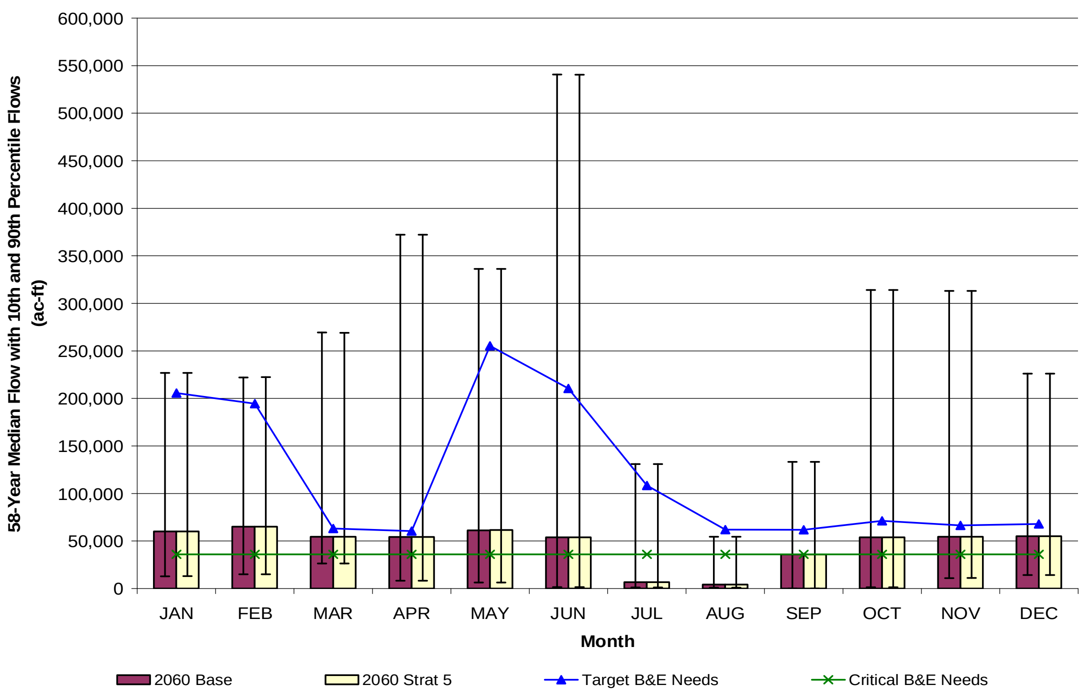


Table 3.4G Strategy 5 (Gold Channel Dam) Frequency of Meeting Target and Critical Needs for 2060

Month	Gold Channel Dam Strategy at CP J10000 (Colorado County)						Gold Channel Dam Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	81.4%	81.4%	0.0%	98.3%	98.3%	0.0%	18.6%	18.6%	0.0%	71.2%	71.2%	0.0%
FEB	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	18.6%	18.6%	0.0%	76.3%	76.3%	0.0%
MAR	93.2%	93.2%	0.0%	93.2%	93.2%	0.0%	42.4%	42.4%	0.0%	76.3%	76.3%	0.0%
APR	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	45.8%	44.1%	-1.7%	62.7%	62.7%	0.0%
MAY	89.8%	89.8%	0.0%	100.0%	100.0%	0.0%	22.0%	22.0%	0.0%	78.0%	78.0%	0.0%
JUN	96.6%	96.6%	0.0%	100.0%	100.0%	0.0%	30.5%	30.5%	0.0%	64.4%	64.4%	0.0%
JUL	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	13.6%	15.3%	1.7%	39.0%	39.0%	0.0%
AUG	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	8.5%	5.1%	-3.4%	23.7%	23.7%	0.0%
SEP	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	25.4%	23.7%	-1.7%	59.3%	59.3%	0.0%
OCT	74.6%	74.6%	0.0%	100.0%	100.0%	0.0%	32.2%	32.2%	0.0%	66.1%	66.1%	0.0%
NOV	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	67.8%	67.8%	0.0%
DEC	84.7%	84.7%	0.0%	98.3%	98.3%	0.0%	45.8%	42.4%	-3.4%	72.9%	72.9%	0.0%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	76.3%	76.3%	0.0%

Table 3.4G above shows that the Goldthwaite Channel Dam Strategy only impacts the frequency that the target needs are met at the Matagorda Bay control point. The critical needs are not impacted by implementation of the strategy. The impacts are less than four percent, although the impacts in the month of August are significant because the frequency of meeting the target needs during that month without the strategy is already so low. The strategy does not have annual impacts, only monthly.

Table 3.4H Strategy 5 (Gold Channel Dam) Flow Duration Below Target and Critical Needs for 2060

Condition	Gold Channel Dam Strategy at CP J10000 (Colorado County)			Gold Channel Dam Strategy at CP M10000 (Matagorda Bay)		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
Number of Times Flow Falls Below **Target** Level	38	38	0	85	85	0
Maximum Duration Below **Target** Level (months)	6	6	0	51	51	0
Total Duration Below **Target** Level (months)	68	68	0	506	511	5
Average Duration Below **Target** Level (months)	2	2	0	6	6	0
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	10,659	10,618	-42	504,744	504,964	220
Number of Times Flow Falls Below **Critical** Level	6	6	0	93	93	0
Maximum Duration Below **Critical** Level (months)	1	1	0	11	11	0
Total Duration Below **Critical** Level (months)	6	6	0	261	261	0
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	5,068	5,068	0	66,999	67,014	15

Table 3.4H above shows small impacts to the total duration below target level for the freshwater inflows, and reasonably negligible impacts to the average volume of flow per event below target/critical levels.

Strategy 6. Construct additional Goldthwaite off-channel reservoir

This strategy involves the construction of a new off-channel reservoir adjacent to the City's existing reservoir on the San Saba Highway. An additional 350 ac-ft/yr of storage could be added at the site to increase the City's total storage capacity, and therefore its ability to survive extended dry periods. The junior priority date should limit the impacts of the strategy on the 10th percentile flows. For the analysis, the Region K WAM Run 3 Cutoff Model, which inherently contains Strategy 1 (Expand Contract) and Strategy 7 (HB 1437), was used for the base condition.

Impacts are compared at Control Points F10000, I10000, J10000, K20000, K10000, and M10000. *Table 3.5A* shows the comparison at Control Point F10000. *Table 3.5B* shows the comparison at Control Point I10000. *Table 3.5C* shows the comparison at Control Point J10000. *Table 3.5D* shows the comparison at Control Point K20000. *Table 3.5E* shows the comparison at Control Point K10000. *Table 3.5F* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations.

Table 3.5A Strategy 6 (Gold Reservoir) Comparison of 10th Percentile Flows at CP F10000 (San Saba County) for 2010 and 2060

Month	7Q2 Flow ac-ft	2010 Base Model ac-ft	2010 Strategy ac-ft	2010 % Change	2060 Base Model ac-ft	2060 Strategy ac-ft	2060 % Change
JAN	2,317	5,037	5,037	0.0	5,077	5,077	0.0
FEB	2,317	5,074	5,074	0.0	4,979	4,979	0.0
MAR	2,317	4,028	4,028	0.0	4,286	4,286	0.0
APR	2,317	5,657	5,657	0.0	6,281	6,281	0.0
MAY	2,317	6,077	6,077	0.0	6,384	6,384	0.0
JUN	2,317	9,318	9,318	0.0	9,278	9,278	0.0
JUL	2,317	4,711	4,711	0.0	4,675	4,675	0.0
AUG	2,317	4,043	4,043	0.0	4,490	4,490	0.0
SEP	2,317	3,486	3,486	0.0	3,085	3,085	0.0
OCT	2,317	3,806	3,806	0.0	3,706	3,706	0.0
NOV	2,317	4,046	4,046	0.0	3,990	3,990	0.0
DEC	2,317	4,628	4,628	0.0	4,902	4,902	0.0
Annual	27,804	59,910	59,910	0.0	61,133	61,133	0.0

Table 3.5B Strategy 6 (Gold Reservoir) Comparison of 10th Percentile Flows at CP I10000 (Austin) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	11,547	10,073	10,073	0.0	8,785	8,785	0.0
FEB	11,547	8,188	8,188	0.0	8,886	8,886	0.0
MAR	11,547	22,124	22,124	0.0	17,696	17,696	0.0
APR	11,547	22,119	22,061	-0.3	19,782	19,782	0.0
MAY	11,547	32,388	32,388	0.0	31,805	31,805	0.0
JUN	11,547	36,552	31,162	-14.7	26,996	26,996	0.0
JUL	11,547	33,454	33,454	0.0	20,204	20,204	0.0
AUG	11,547	37,812	37,812	0.0	27,245	27,245	0.0
SEP	11,547	18,060	18,049	-0.1	17,181	17,181	0.0
OCT	11,547	13,673	13,673	0.0	12,000	12,000	0.0
NOV	11,547	11,197	11,197	0.0	9,409	9,409	0.0
DEC	11,547	10,672	10,672	0.0	10,382	10,382	0.0
Annual	138,564	256,314	250,854	-2.1	210,371	210,371	0.0

Table 3.5C Strategy 6 (Gold Reservoir) Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	18,081	17,518	17,551	0.2	12,916	12,920	0.0
FEB	18,081	14,691	14,703	0.1	12,901	12,913	0.1
MAR	18,081	30,275	30,275	0.0	32,006	32,067	0.2
APR	18,081	31,476	31,536	0.2	30,281	30,335	0.2
MAY	18,081	60,646	60,707	0.1	51,525	51,582	0.1
JUN	18,081	70,621	67,509	-4.4	53,258	53,259	0.0
JUL	18,081	52,845	52,905	0.1	36,001	35,996	0.0
AUG	18,081	40,628	40,742	0.3	27,029	27,090	0.2
SEP	18,081	37,639	37,628	0.0	29,694	29,712	0.1
OCT	18,081	22,361	22,421	0.3	16,942	16,995	0.3
NOV	18,081	14,588	14,598	0.1	13,672	13,804	1.0
DEC	18,081	17,822	17,870	0.3	16,264	16,246	-0.1
Annual	216,972	411,110	408,444	-0.6	332,488	332,919	0.1

Table 3.5D Strategy 6 (Gold Reservoir) Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	23,613	20,996	21,004	0.0	14,599	14,651	0.4
FEB	23,613	19,465	19,525	0.3	17,368	17,428	0.3
MAR	23,613	30,746	30,748	0.0	33,690	33,751	0.2
APR	23,613	18,450	18,503	0.3	21,167	21,235	0.3
MAY	23,613	30,092	30,155	0.2	27,977	28,029	0.2
JUN	23,613	28,298	28,190	-0.4	20,518	20,566	0.2
JUL	23,613	22,939	22,992	0.2	15,053	15,096	0.3
AUG	23,613	16,170	16,223	0.3	11,617	11,677	0.5
SEP	23,613	13,945	14,005	0.4	11,875	11,958	0.7
OCT	23,613	12,302	12,348	0.4	9,708	9,768	0.6
NOV	23,613	19,736	19,759	0.1	16,617	16,677	0.4
DEC	23,613	20,704	20,721	0.1	17,041	17,024	-0.1
Annual	283,356	253,844	254,173	0.1	217,230	217,860	0.3

Table 3.5E Strategy 6 (Gold Reservoir) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	12,374	20,205	20,401	1.0	15,015	15,032	0.1
FEB	12,374	21,826	21,839	0.1	18,782	18,842	0.3
MAR	12,374	28,665	28,677	0.0	32,712	32,611	-0.3
APR	12,374	9,294	9,354	0.6	12,388	12,468	0.6
MAY	12,374	11,743	11,797	0.5	10,349	10,401	0.5
JUN	12,374	8,204	7,874	-4.0	6,701	6,702	0.0
JUL	12,374	6,264	6,285	0.3	4,063	4,126	1.5
AUG	12,374	4,846	4,906	1.3	4,205	4,217	0.3
SEP	12,374	2,985	3,049	2.1	2,694	2,729	1.3
OCT	12,374	7,867	7,919	0.7	11,468	11,509	0.4
NOV	12,374	19,396	19,419	0.1	16,617	16,677	0.4
DEC	12,374	21,105	21,136	0.1	18,127	18,145	0.1
Annual	148,488	162,401	162,657	0.2	153,121	153,458	0.2

Table 3.5F Strategy 6 (Gold Reservoir) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2010 and 2060

Month	Target B&E	Critical B&E	2010			2060		
			Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	205,600	36,000	16,939	17,870	5.5	12,939	12,938	0.0
FEB	194,500	36,000	19,941	20,001	0.3	14,988	15,038	0.3
MAR	63,200	36,000	23,842	23,842	0.0	26,337	26,398	0.2
APR	60,400	36,000	6,947	7,007	0.9	8,192	8,256	0.8
MAY	255,400	36,000	10,971	11,023	0.5	6,375	6,422	0.7
JUN	210,500	36,000	6,223	5,656	-9.1	1,582	1,593	0.7
JUL	108,400	36,000	3,476	3,526	1.4	1,122	1,135	1.1
AUG	62,000	36,000	3,259	3,316	1.7	951	1,011	6.3
SEP	61,900	36,000	1,048	1,116	6.5	15	60	300.0
OCT	71,300	36,000	2,210	2,259	2.2	1,334	1,391	4.3
NOV	66,500	36,000	17,501	17,524	0.1	11,010	11,126	1.1
DEC	68,000	36,000	18,829	18,860	0.2	14,181	14,185	0.0
Annual	1,427,700	432,000	131,186	132,000	0.6	99,028	99,554	0.5

Overall, the impacts to the instream flows and freshwater inflows are negligible. The 2010 model shows a fairly significant negative impact to the 10th percentile flows during the month of June at several control points downstream from the strategy location. This negative impact does not occur at the control point immediately downstream of the strategy, nor does it occur in the 2060 model, so the strategy may be having a slight impact on LCRA's operational system involving the release of water downstream in the 2010 model.

Figure 3.9 Strategy 6 (Gold Reservoir) 2010 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

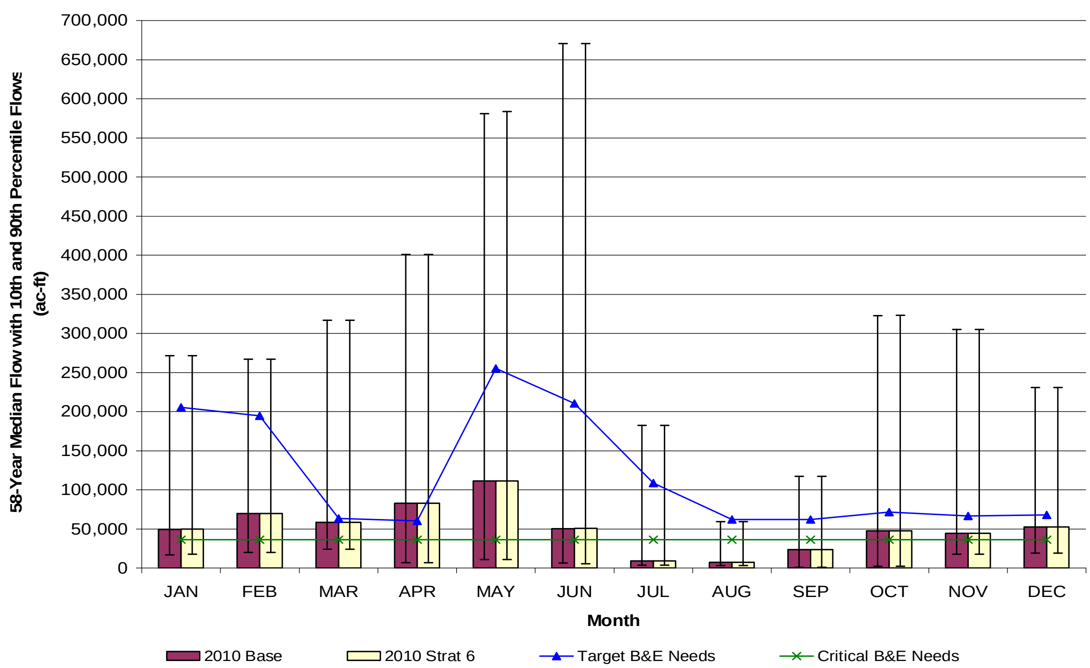


Figure 3.9 above shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without Strategy 6 at CP M10000 for 2010, along with the target and critical bay and estuary freshwater inflows. *Figure 3.10* below shows a similar comparison for 2060.

Figure 3.10 Strategy 6 (Gold Reservoir) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

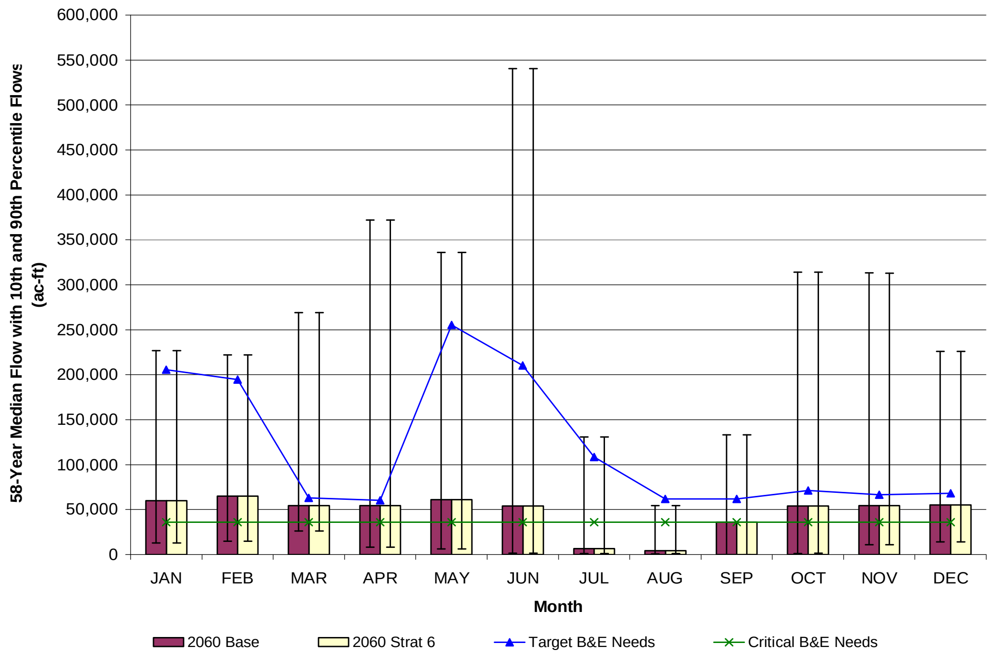


Table 3.5G Strategy 6 (Gold Reservoir) Frequency of Meeting Target and Critical Needs for 2060

Month	Gold Reservoir Strategy at CP J10000 (Colorado County)						Gold Reservoir Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	81.4%	81.4%	0.0%	98.3%	98.3%	0.0%	18.6%	18.6%	0.0%	71.2%	71.2%	0.0%
FEB	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	18.6%	18.6%	0.0%	76.3%	76.3%	0.0%
MAR	93.2%	93.2%	0.0%	93.2%	93.2%	0.0%	42.4%	42.4%	0.0%	76.3%	76.3%	0.0%
APR	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	45.8%	45.8%	0.0%	62.7%	62.7%	0.0%
MAY	89.8%	89.8%	0.0%	100.0%	100.0%	0.0%	22.0%	22.0%	0.0%	78.0%	78.0%	0.0%
JUN	96.6%	96.6%	0.0%	100.0%	100.0%	0.0%	30.5%	30.5%	0.0%	64.4%	64.4%	0.0%
JUL	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	13.6%	15.3%	1.7%	39.0%	39.0%	0.0%
AUG	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	8.5%	8.5%	0.0%	23.7%	23.7%	0.0%
SEP	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	25.4%	25.4%	0.0%	59.3%	59.3%	0.0%
OCT	74.6%	74.6%	0.0%	100.0%	100.0%	0.0%	32.2%	32.2%	0.0%	66.1%	66.1%	0.0%
NOV	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	67.8%	67.8%	0.0%
DEC	84.7%	84.7%	0.0%	98.3%	98.3%	0.0%	45.8%	45.8%	0.0%	72.9%	72.9%	0.0%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	76.3%	76.3%	0.0%

Table 3.5G above shows that the Goldthwaite reservoir strategy has no negative impact on the frequency that the instream flows and freshwater inflows meet their target and critical levels.

Table 3.5H Strategy 6 (Gold Reservoir) Flow Duration Below Target and Critical Needs for 2060

Condition	Gold Reservoir Strategy at CP J10000 (Colorado County)			Gold Reservoir Strategy at CP M10000 (Matagorda Bay)		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
Number of Times Flow Falls Below **Target** Level	38	38	0	85	85	0
Maximum Duration Below **Target** Level (months)	6	6	0	51	51	0
Total Duration Below **Target** Level (months)	68	68	0	506	505	-1
Average Duration Below **Target** Level (months)	2	2	0	6	6	0
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	10,659	10,573	-87	504,744	504,711	-33
Number of Times Flow Falls Below **Critical** Level	6	6	0	93	93	0
Maximum Duration Below **Critical** Level (months)	1	1	0	11	11	0
Total Duration Below **Critical** Level (months)	6	6	0	261	261	0
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	5,068	5,024	-44	66,999	66,937	-62

Table 3.5H above shows that the Goldthwaite reservoir strategy does not negatively impact the number of events, duration of events, and average volume of events of instream flow and freshwater inflow below the target and critical levels. For this table, a negative value in the Difference column means that the strategy causes shorter occurrences or smaller volumes below the target/critical level than without the strategy.

Strategy 7. HB 1437

The HB 1437 strategy is a Region G strategy that provides a transfer of up to an additional 25,000 ac-ft/yr from the Colorado River Basin to new customers within the Brazos River Basin in Williamson County. The strategy is a conservation strategy in which improvements are made in farms and in the irrigation districts that reduce agricultural use of the surface water. As a result, no impacts to the instream flows and freshwater inflows are expected from this strategy. The base model (Region K WAM Run 3) inherently contains both Strategy 1 (Expand Contract) and Strategy 7 (HB 1437), so for this analysis, Strategy 7 had to be removed from the base model in order to show the "without strategy" condition. See page 2-6 for more explanation.

Impacts are compared at Control Points I10000, J10000, K20000, K10000, and M10000. *Table 3.6A* shows the comparison at Control Point I10000. *Table 3.6B* shows the comparison at Control Point J10000. *Table 3.6C* shows the comparison at Control Point K20000. *Table 3.6D* shows the comparison at Control Point K10000. *Table 3.6E* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations.

Table 3.6A Strategy 7 (HB 1437) Comparison of 10th Percentile Flows at CP I10000 (Austin) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	11,547	10,073	10,073	0.0	8,785	8,785	0.0
FEB	11,547	8,188	8,188	0.0	8,886	8,886	0.0
MAR	11,547	22,124	22,124	0.0	17,696	17,696	0.0
APR	11,547	22,119	22,119	0.0	19,782	19,782	0.0
MAY	11,547	32,388	32,388	0.0	31,805	31,805	0.0
JUN	11,547	36,552	36,552	0.0	26,996	26,996	0.0
JUL	11,547	33,454	33,454	0.0	20,204	20,204	0.0
AUG	11,547	37,812	37,812	0.0	27,245	27,245	0.0
SEP	11,547	18,060	18,060	0.0	17,181	17,181	0.0
OCT	11,547	13,673	13,673	0.0	12,000	12,000	0.0
NOV	11,547	11,197	11,197	0.0	9,409	9,409	0.0
DEC	11,547	10,672	10,672	0.0	10,382	10,382	0.0
Annual	138,564	256,314	256,314	0.0	210,371	210,371	0.0

Table 3.6B Strategy 7 (HB 1437) Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	18,081	17,518	17,518	0.0	12,916	12,916	0.0
FEB	18,081	14,691	14,691	0.0	12,901	12,901	0.0
MAR	18,081	30,275	30,275	0.0	32,006	32,006	0.0
APR	18,081	31,476	31,476	0.0	30,281	30,281	0.0
MAY	18,081	60,646	60,646	0.0	51,522	51,525	0.0
JUN	18,081	70,621	70,621	0.0	53,256	53,258	0.0
JUL	18,081	52,989	52,845	-0.3	36,000	36,001	0.0
AUG	18,081	40,767	40,628	-0.3	27,029	27,029	0.0
SEP	18,081	37,639	37,639	0.0	29,694	29,694	0.0
OCT	18,081	22,361	22,361	0.0	16,942	16,942	0.0
NOV	18,081	14,588	14,588	0.0	13,783	13,672	-0.8
DEC	18,081	17,822	17,822	0.0	16,264	16,264	0.0
Annual	216,972	411,394	411,110	-0.1	332,594	332,488	0.0

Table 3.6C Strategy 7 (HB 1437) Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	23,613	20,996	20,996	0.0	14,599	14,599	0.0
FEB	23,613	19,465	19,465	0.0	17,368	17,368	0.0
MAR	23,613	30,746	30,746	0.0	33,691	33,690	0.0
APR	23,613	18,450	18,450	0.0	21,179	21,167	-0.1
MAY	23,613	30,092	30,092	0.0	27,976	27,977	0.0
JUN	23,613	28,298	28,298	0.0	20,505	20,518	0.1
JUL	23,613	22,939	22,939	0.0	15,053	15,053	0.0
AUG	23,613	16,170	16,170	0.0	11,617	11,617	0.0
SEP	23,613	13,945	13,945	0.0	11,938	11,875	-0.5
OCT	23,613	12,302	12,302	0.0	9,708	9,708	0.0
NOV	23,613	19,736	19,736	0.0	16,617	16,617	0.0
DEC	23,613	20,704	20,704	0.0	17,041	17,041	0.0
Annual	283,356	253,844	253,844	0.0	217,292	217,230	0.0

Table 3.6D Strategy 7 (HB 1437) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	12,374	20,205	20,205	0.0	15,015	15,015	0.0
FEB	12,374	21,826	21,826	0.0	18,782	18,782	0.0
MAR	12,374	28,665	28,665	0.0	32,551	32,712	0.5
APR	12,374	9,294	9,294	0.0	12,407	12,388	-0.1
MAY	12,374	11,743	11,743	0.0	10,349	10,349	0.0
JUN	12,374	8,204	8,204	0.0	6,701	6,701	0.0
JUL	12,374	6,264	6,264	0.0	4,058	4,063	0.1
AUG	12,374	4,846	4,846	0.0	4,205	4,205	0.0
SEP	12,374	2,985	2,985	0.0	2,694	2,694	0.0
OCT	12,374	7,867	7,867	0.0	11,468	11,468	0.0
NOV	12,374	19,396	19,396	0.0	16,617	16,617	0.0
DEC	12,374	21,105	21,105	0.0	18,127	18,127	0.0
Annual	148,488	162,401	162,401	0.0	152,973	153,121	0.1

Table 3.6E Strategy 7 (HB 1437) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2010 and 2060

Month	Target B&E ac-ft	Critical B&E ac-ft	2010 Base Model ac-ft	2010 Strategy ac-ft	2010 % Change	2060 Base Model ac-ft	2060 Strategy ac-ft	2060 % Change
JAN	205,600	36,000	16,939	16,939	0.0	12,939	12,939	0.0
FEB	194,500	36,000	19,941	19,941	0.0	14,988	14,988	0.0
MAR	63,200	36,000	23,842	23,842	0.0	26,337	26,337	0.0
APR	60,400	36,000	6,947	6,947	0.0	8,196	8,192	-0.1
MAY	255,400	36,000	10,971	10,971	0.0	6,375	6,375	0.0
JUN	210,500	36,000	6,223	6,223	0.0	1,581	1,582	0.1
JUL	108,400	36,000	3,482	3,476	-0.2	1,121	1,122	0.1
AUG	62,000	36,000	3,259	3,259	0.0	951	951	0.0
SEP	61,900	36,000	1,048	1,048	0.0	15	15	0.0
OCT	71,300	36,000	2,210	2,210	0.0	1,334	1,334	0.0
NOV	66,500	36,000	17,501	17,501	0.0	11,085	11,010	-0.7
DEC	68,000	36,000	18,829	18,829	0.0	14,181	14,181	0.0
Annual	1,427,700	432,000	131,192	131,186	0.0	99,105	99,028	-0.1

As expected, the impacts to the 10th percentile instream flows and freshwater inflows at the various control points can be considered negligible.

Figure 3.11 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without Strategy 7 at CP M10000 for 2010, along with the target and critical bay and estuary freshwater inflows. *Figure 3.12* below shows a similar comparison for 2060.

Figure 3.11 Strategy 7 (HB 1437) 2010 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

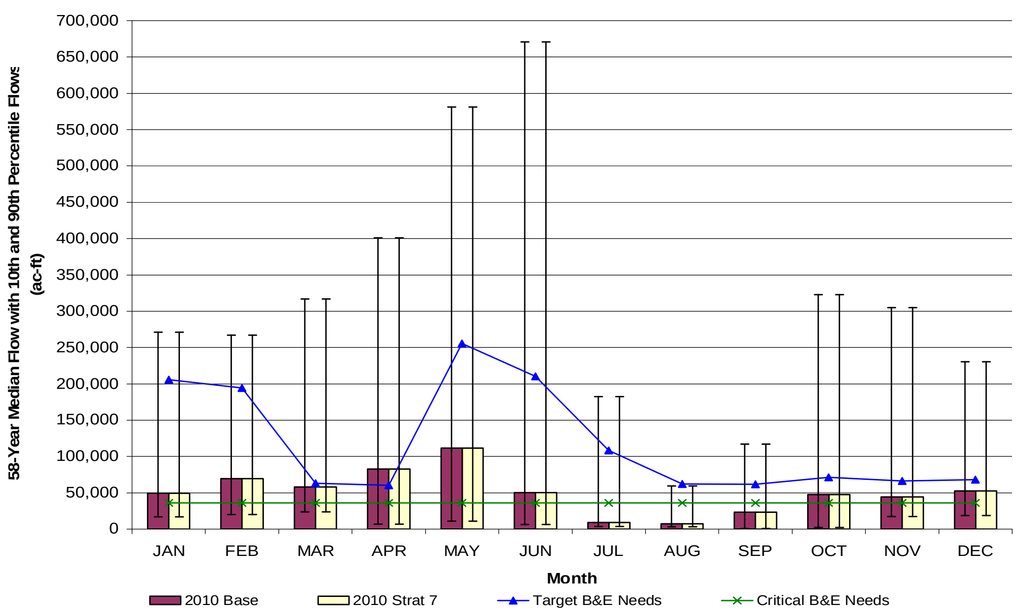


Figure 3.12 Strategy 7 (HB 1437) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

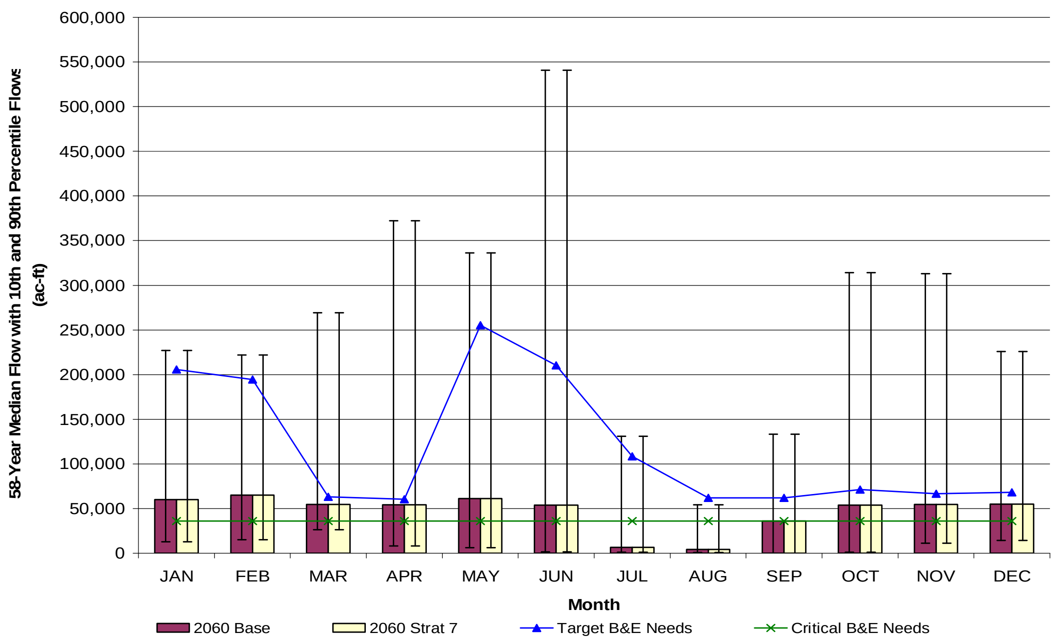


Table 3.6F Strategy 7 (HB 1437) Frequency of Meeting Target and Critical Needs for 2060

	HB 1437 Strategy at CP J10000 (Colorado County)						HB 1437 Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
Month	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	81.4%	81.4%	0.0%	98.3%	98.3%	0.0%	18.6%	18.6%	0.0%	71.2%	71.2%	0.0%
FEB	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	18.6%	18.6%	0.0%	76.3%	76.3%	0.0%
MAR	93.2%	93.2%	0.0%	93.2%	93.2%	0.0%	42.4%	42.4%	0.0%	76.3%	76.3%	0.0%
APR	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	45.8%	45.8%	0.0%	62.7%	62.7%	0.0%
MAY	89.8%	89.8%	0.0%	100.0%	100.0%	0.0%	22.0%	22.0%	0.0%	78.0%	78.0%	0.0%
JUN	96.6%	96.6%	0.0%	100.0%	100.0%	0.0%	30.5%	30.5%	0.0%	64.4%	64.4%	0.0%
JUL	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	13.6%	13.6%	0.0%	39.0%	39.0%	0.0%
AUG	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	8.5%	8.5%	0.0%	23.7%	23.7%	0.0%
SEP	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	25.4%	25.4%	0.0%	59.3%	59.3%	0.0%
OCT	74.6%	74.6%	0.0%	100.0%	100.0%	0.0%	32.2%	32.2%	0.0%	66.1%	66.1%	0.0%
NOV	84.7%	84.7%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	67.8%	67.8%	0.0%
DEC	84.7%	84.7%	0.0%	98.3%	98.3%	0.0%	45.8%	45.8%	0.0%	72.9%	72.9%	0.0%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	76.3%	76.3%	0.0%

Table 3.6F demonstrates that the HB 1437 strategy has no impact on the frequency of the instream flows and freshwater inflows meeting their target and critical levels.

Table 3.6G Strategy 7 (HB 1437) Flow Duration Below Target and Critical Needs for 2060

Condition	HB 1437 Strategy at CP J10000 (Colorado County)			HB 1437 Strategy at CP M10000 (Matagorda Bay)		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
Number of Times Flow Falls Below **Target** Level	38	38	0	85	85	0
Maximum Duration Below **Target** Level (months)	6	6	0	51	51	0
Total Duration Below **Target** Level (months)	68	68	0	506	506	0
Average Duration Below **Target** Level (months)	2	2	0	6	6	0
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	10,634	10,659	25	504,828	504,744	-84
Number of Times Flow Falls Below **Critical** Level	6	6	0	93	93	0
Maximum Duration Below **Critical** Level (months)	1	1	0	11	11	0
Total Duration Below **Critical** Level (months)	6	6	0	261	261	0
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	5,068	5,068	0	67,034	66,999	-35

Table 3.6G shows that the HB 1437 strategy has a minimal impact on the average volume below the target and critical levels.

Strategy 8. Desalination of seawater or brackish groundwater

Impacts from this strategy on the instream flows and freshwater inflows would likely be negligible, depending on where the desalination brine is discharged. It is assumed the brine would either be discharged offshore or by deep well injection into the ground. This would limit the impact of the total dissolved solids (TDS) on the environment as well.

Strategy 9. LCRA-SAWS Water Sharing Project (LSWP)

This strategy incorporates the transfer of water from Region K to Region L. The funds collected from the water transfer will be used to develop conservation improvements for rice irrigation, which will in turn, reduce the amount of water needed and allow some of that water to remain in the river as environmental flows. Components of the strategy that include on-farm conservation, irrigation district conveyance improvements, conjunctive use of groundwater, and development of new rice varieties, will all reduce the amount of water needed by rice irrigation farmers. The funds provided by the LSWP will allow farmers to make these improvements that they might not otherwise be able to afford on their own. For the analysis, the Region K WAM Run 3 Cutoff Model, which inherently contains Strategy 1 (Expand Contract) and Strategy 7 (HB 1437), was used for the base condition. The LSWP Model was used for the strategy condition, and contains Strategies 1, 7, 12 (Irrigation Amendment), and 13 (Excess Flows), as well as the 2007 Settlement Agreement between the City of Austin and the LCRA. Please see page 2-8 for more explanation.

Impacts are compared for 2060 at Control Points I10000, J10000, K20000, K10000, and M10000. *Table 3.7A* shows the comparison at Control Point I10000. *Table 3.7B* shows the comparison at Control Point J10000. *Table 3.7C* shows the comparison at Control Point K20000. *Table 3.7D* shows the comparison at Control Point K10000. *Table 3.7E* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations.

Table 3.7A Strategy 9 (LSWP) Comparison of 10th Percentile Flows at CP I10000 (Austin) for 2060

Month	7Q2 Flow	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft	
JAN	11,547	8,785	8,125	-7.5
FEB	11,547	8,886	8,775	-1.2
MAR	11,547	17,696	13,851	-21.7
APR	11,547	19,782	13,643	-31.0
MAY	11,547	31,805	32,530	2.3
JUN	11,547	26,996	28,167	4.3
JUL	11,547	20,204	17,021	-15.8
AUG	11,547	27,245	20,718	-24.0
SEP	11,547	17,181	10,784	-37.2
OCT	11,547	12,000	13,011	8.4
NOV	11,547	9,409	10,654	13.2
DEC	11,547	10,382	10,889	4.9
Annual	138,564	210,371	188,168	-10.6

The instream flow impacts at CP I10000 are negative during many months as well as overall annually. The annual 10th percentile flows are still significantly greater than the 7Q2 flows at CP I10000, but the strategy during the month of September causes the instream flows to fall below the 7Q2 flow level. This negative impact is occurring because this control point is upstream of where the rice irrigation conservation improvements would take place.

Table 3.7B Strategy 9 (LSWP) Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2060

Month	7Q2 Flow	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft	
JAN	18,081	12,916	28,709	122.3
FEB	18,081	12,901	30,066	133.1
MAR	18,081	32,006	32,281	0.9
APR	18,081	30,281	29,877	-1.3
MAY	18,081	51,525	54,629	6.0
JUN	18,081	53,258	51,941	-2.5
JUL	18,081	36,001	30,096	-16.4
AUG	18,081	27,029	23,426	-13.3
SEP	18,081	29,694	25,611	-13.7
OCT	18,081	16,942	25,609	51.2
NOV	18,081	13,672	26,943	97.1
DEC	18,081	16,264	30,612	88.2
Annual	216,972	332,488	389,801	17.2

As the water moves downstream, the impacts of the LSWP strategy begin to become more positive. At CP J10000, there are still some negative impacts during the summer months, but during the winter months, the 10th percentile instream flows significantly increase.

Table 3.7C Strategy 9 (LSWP) Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	23,613	14,599	30,284	107.4
FEB	23,613	17,368	35,830	106.3
MAR	23,613	33,690	32,939	-2.2
APR	23,613	21,167	23,996	13.4
MAY	23,613	27,977	29,923	7.0
JUN	23,613	20,518	22,638	10.3
JUL	23,613	15,053	20,034	33.1
AUG	23,613	11,617	17,197	48.0
SEP	23,613	11,875	23,120	94.7
OCT	23,613	9,708	25,723	165.0
NOV	23,613	16,617	29,798	79.3
DEC	23,613	17,041	29,129	70.9
Annual	283,356	217,230	320,612	47.6

As the water moves further downstream, the 10th percentile flows at CP K20000 are impacted slightly negatively during just one month. The annual 10th percentile flow impact is positive, and for many of the months, the LSWP strategy increases the 10th percentile instream flows from below the 7Q2 level to above it.

Table 3.7D Strategy 9 (LSWP) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	12,374	15,015	30,299	101.8
FEB	12,374	18,782	35,112	86.9
MAR	12,374	32,712	30,107	-8.0
APR	12,374	12,388	19,234	55.3
MAY	12,374	10,349	24,785	139.5
JUN	12,374	6,701	17,113	155.4
JUL	12,374	4,063	12,830	215.8
AUG	12,374	4,205	10,962	160.7
SEP	12,374	2,694	27,015	902.9
OCT	12,374	11,468	25,898	125.8
NOV	12,374	16,617	29,067	74.9
DEC	12,374	18,127	30,078	65.9
Annual	148,488	153,121	292,500	91.0

At CP K10000, the 10th percentile instream flow impacts are positive. The annual 10th percentile flows nearly double, and again, for many of the months, the LSWP strategy increases the instream flows from below the 7Q2 level to above it.

Table 3.7E Strategy 9 (LSWP) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2060

Month	Target B&E ac-ft	Critical B&E ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	205,600	36,000	12,939	22,948	77.4
FEB	194,500	36,000	14,988	29,513	96.9
MAR	63,200	36,000	26,337	27,947	6.1
APR	60,400	36,000	8,192	15,787	92.7
MAY	255,400	36,000	6,375	17,361	172.3
JUN	210,500	36,000	1,582	12,986	720.6
JUL	108,400	36,000	1,122	8,869	690.2
AUG	62,000	36,000	951	7,906	731.0
SEP	61,900	36,000	15	23,421	156,038.7
OCT	71,300	36,000	1,334	20,151	1,410.3
NOV	66,500	36,000	11,010	23,120	110.0
DEC	68,000	36,000	14,181	25,774	81.8
Annual	1,427,700	432,000	99,028	235,783	138.1

The impacts to the 10th percentile freshwater inflows to Matagorda Bay at CP M10000 are positive. Although the 10th percentile flows are still well below the critical bay and estuary inflows, the annual 10th percentile inflows more than doubled as compared to the base model.

Figure 3.13 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without the LSWP strategy at CP M10000 for 2060, along with the target and critical bay and estuary freshwater inflows.

Figure 3.13 Strategy 9 (LSWP) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

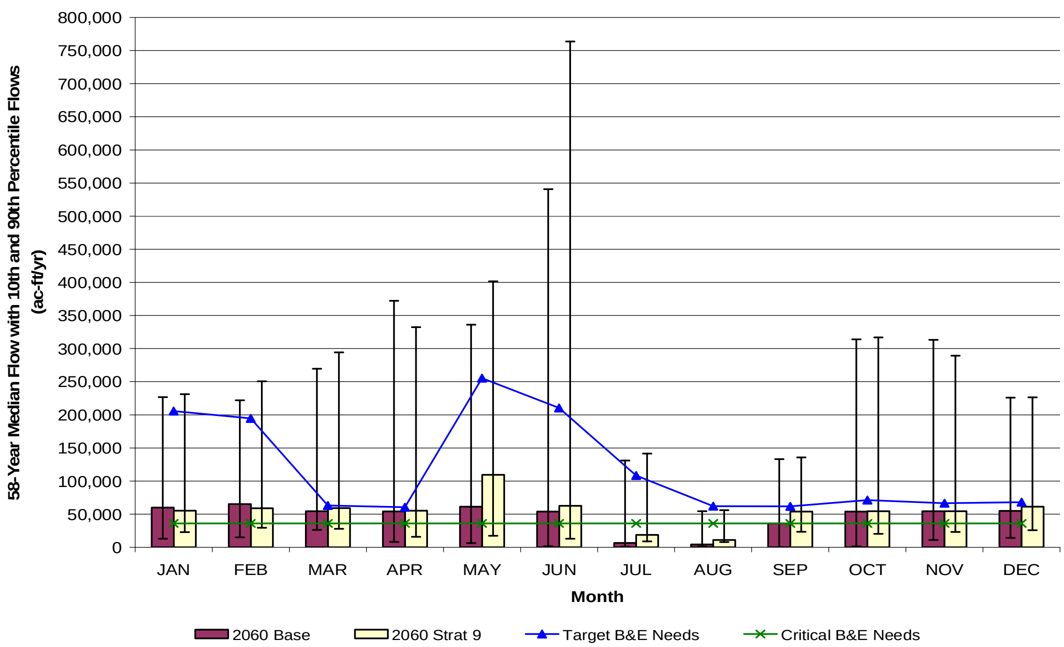


Table 3.7F Strategy 9 (LSWP) Frequency of Meeting Target and Critical Needs for 2060

	LSWP Strategy at CP J10000 (Colorado County)						LSWP Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
Month	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	81.4%	100.0%	18.6%	98.3%	100.0%	1.7%	18.6%	23.7%	5.1%	71.2%	78.0%	6.8%
FEB	84.7%	100.0%	15.3%	100.0%	100.0%	0.0%	18.6%	22.0%	3.4%	76.3%	86.4%	10.2%
MAR	93.2%	100.0%	6.8%	93.2%	100.0%	6.8%	42.4%	45.8%	3.4%	76.3%	74.6%	-1.7%
APR	100.0%	89.8%	-10.2%	100.0%	89.8%	-10.2%	45.8%	49.2%	3.4%	62.7%	67.8%	5.1%
MAY	89.8%	96.6%	6.8%	100.0%	98.3%	-1.7%	22.0%	27.1%	5.1%	78.0%	83.1%	5.1%
JUN	96.6%	98.3%	1.7%	100.0%	100.0%	0.0%	30.5%	32.2%	1.7%	64.4%	71.2%	6.8%
JUL	98.3%	100.0%	1.7%	100.0%	100.0%	0.0%	13.6%	18.6%	5.1%	39.0%	37.3%	-1.7%
AUG	98.3%	100.0%	1.7%	100.0%	100.0%	0.0%	8.5%	10.2%	1.7%	23.7%	23.7%	0.0%
SEP	98.3%	96.6%	-1.7%	100.0%	100.0%	0.0%	25.4%	32.2%	6.8%	59.3%	76.3%	16.9%
OCT	74.6%	91.5%	16.9%	100.0%	100.0%	0.0%	32.2%	39.0%	6.8%	66.1%	74.6%	8.5%
NOV	84.7%	100.0%	15.3%	100.0%	100.0%	0.0%	39.0%	33.9%	-5.1%	67.8%	78.0%	10.2%
DEC	84.7%	100.0%	15.3%	98.3%	100.0%	1.7%	45.8%	45.8%	0.0%	72.9%	81.4%	8.5%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	39.0%	40.7%	1.7%	76.3%	83.1%	6.8%

Table 3.7F above demonstrates that the LSWP strategy has some negative impacts on the frequency that the instream flows and freshwater inflows meet their target and critical levels. The maximum impact occurs during April at CP J10000 (Colorado County), where the frequency of meeting both the target and critical levels decreases by approximately 10 percent, due to the implementation of the strategy. The strategy does not impact the flows negatively on an annual basis, only monthly.

Table 3.7G Strategy 9 (LSWP) Flow Duration Below Target and Critical Needs for 2060

	LSWP Strategy at CP J10000 (Colorado County)			LSWP Strategy at CP M10000 (Matagorda Bay)		
Condition	**Without Strategy**	**With Strategy**	**Difference**	**Without Strategy**	**With Strategy**	**Difference**
Number of Times Flow Falls Below **Target** Level	38	14	-24	85	90	5
Maximum Duration Below **Target** Level (months)	6	2	-4	51	83	32
Total Duration Below **Target** Level (months)	68	16	-52	506	484	-22
Average Duration Below **Target** Level (months)	2	1	-1	6	5	-1
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	10,659	5,119	-5,540	504,744	425,660	-79,084
Number of Times Flow Falls Below **Critical** Level	6	7	1	93	82	-11
Maximum Duration Below **Critical** Level (months)	1	1	0	11	11	0
Total Duration Below **Critical** Level (months)	6	7	1	261	217	-44
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	5,068	3,955	-1,113	66,999	45,390	-21,609

Table 3.7G demonstrates the various impacts that the LSWP strategy has on the number of occurrences of the flow falling below target/critical levels, and duration and volume of those occurrences, as compared to not implementing the strategy. Negative impacts occur at the Matagorda Bay control point for the number of times the flow falls below the target level (increased from 85 to 90), and the maximum duration below the target level (increased from 51 months to 83 months). The other negative impacts occur at the Colorado County control point for the number of times the flow falls below the critical level and the total duration below the critical level (both increased from 6 to 7).

As was mentioned in Section 2.0 Methodology, the model used for the LSWP strategy also contained other strategies within it that could not be removed. It is likely that having the incorporation of the 2007 Settlement Agreement between City of Austin and the LCRA in the LSWP model created impact results that were more positive than if it was not included, as it is not for other strategy comparisons. The results are not as accurate as they could be if a more separate and detailed analysis were done, and these strategies and analyses should be updated in the future to provide a better idea of the true impact of the LSWP strategy.

Strategy 10. City of Austin return flows for downstream needs

The City of Austin currently returns approximately 60 percent of its water demand to the Colorado River as wastewater discharges. By 2090, the City of Austin may achieve full utilization (zero return flow). In the interim, return flows from the City of Austin wastewater treatment plants are to be reused as a temporary water management strategy to meet project water supply shortages within Region K. For the analysis, the Region K WAM Run 3 Cutoff Model, which inherently contains Strategy 1 (Expand Contract) and Strategy 7 (HB 1437), was used for the base condition.

Return flows are expected to increase the instream flows and freshwater inflows. Impacts are compared at Control Points J10000, K20000, K10000, and M10000. *Table 3.8A* shows the comparison at Control Point J10000. *Table 3.8B* shows the comparison at Control Point K20000. *Table 3.8C* shows the comparison at Control Point K10000. *Table 3.8D* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations. Please see Appendix C (pages C-80 through C-92) for impact analysis results of control points not discussed in this section.

Table 3.8A Strategy 10 (COA Return Flow) Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	18,081	17,518	22,501	28.4	12,916	28,432	120.1
FEB	18,081	14,691	22,459	52.9	12,901	28,869	123.8
MAR	18,081	30,275	30,275	0.0	32,006	32,554	1.7
APR	18,081	31,476	34,962	11.1	30,281	33,269	9.9
MAY	18,081	60,646	70,354	16.0	51,525	53,021	2.9
JUN	18,081	70,621	75,969	7.6	53,258	57,235	7.5
JUL	18,081	52,845	55,512	5.0	36,001	40,141	11.5
AUG	18,081	40,628	42,948	5.7	27,029	35,985	33.1
SEP	18,081	37,639	40,001	6.3	29,694	34,686	16.8
OCT	18,081	22,361	27,269	21.9	16,942	28,561	68.6
NOV	18,081	14,588	21,994	50.8	13,672	27,909	104.1
DEC	18,081	17,822	24,190	35.7	16,264	29,343	80.4
Annual	216,972	411,110	468,433	13.9	332,488	430,005	29.3

As expected, the City of Austin return flow strategy increases the instream flows downstream of the City of Austin. Because of the increase in projected demands from 2010 to 2060, the strategy has an even greater impact in 2060.

Table 3.8B Strategy 10 (COA Return Flow) Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	23,613	20,996	24,511	16.7	14,599	31,625	116.6
FEB	23,613	19,465	25,394	30.5	17,368	33,317	91.8
MAR	23,613	30,746	31,312	1.8	33,690	34,438	2.2
APR	23,613	18,450	20,533	11.3	21,167	25,451	20.2
MAY	23,613	30,092	37,227	23.7	27,977	28,128	0.5
JUN	23,613	28,298	30,760	8.7	20,518	21,172	3.2
JUL	23,613	22,939	24,532	6.9	15,053	18,681	24.1
AUG	23,613	16,170	17,696	9.4	11,617	15,180	30.7
SEP	23,613	13,945	18,066	29.6	11,875	14,957	26.0
OCT	23,613	12,302	16,544	34.5	9,708	21,263	119.0
NOV	23,613	19,736	24,410	23.7	16,617	31,080	87.0
DEC	23,613	20,704	24,190	16.8	17,041	31,047	82.2
Annual	283,356	253,844	295,176	16.3	217,230	306,338	41.0

Table 3.8C Strategy 10 (COA Return Flow) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	12,374	20,205	23,664	17.1	15,015	32,898	119.1
FEB	12,374	21,826	26,785	22.7	18,782	35,045	86.6
MAR	12,374	28,665	28,305	-1.3	32,712	33,414	2.1
APR	12,374	9,294	11,376	22.4	12,388	20,644	66.6
MAY	12,374	11,743	21,126	79.9	10,349	11,614	12.2
JUN	12,374	8,204	6,905	-15.8	6,701	7,395	10.3
JUL	12,374	6,264	5,398	-13.8	4,063	4,217	3.8
AUG	12,374	4,846	4,147	-14.4	4,205	4,493	6.9
SEP	12,374	2,985	3,003	0.6	2,694	4,300	59.6
OCT	12,374	7,867	12,999	65.2	11,468	22,223	93.8
NOV	12,374	19,396	23,461	21.0	16,617	31,636	90.4
DEC	12,374	21,105	23,646	12.0	18,127	32,816	81.0
Annual	148,488	162,401	190,815	17.5	153,121	240,694	57.2

Table 3.8D Strategy 10 (COA Return Flow) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2010 and 2060

Month	Target B&E	Critical B&E	2010			2060		
			Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	205,600	36,000	16,939	21,388	26.3	12,939	27,830	115.1
FEB	194,500	36,000	19,941	22,030	10.5	14,988	30,903	106.2
MAR	63,200	36,000	23,842	23,976	0.6	26,337	28,148	6.9
APR	60,400	36,000	6,947	9,810	41.2	8,192	14,721	79.7
MAY	255,400	36,000	10,971	18,976	73.0	6,375	7,196	12.9
JUN	210,500	36,000	6,223	5,018	-19.4	1,582	3,078	94.5
JUL	108,400	36,000	3,476	2,851	-18.0	1,122	479	-57.4
AUG	62,000	36,000	3,259	2,358	-27.6	951	714	-24.9
SEP	61,900	36,000	1,048	1,331	27.0	15	881	5776.0
OCT	71,300	36,000	2,210	10,737	385.8	1,334	13,466	909.3
NOV	66,500	36,000	17,501	21,388	22.2	11,010	25,648	132.9
DEC	68,000	36,000	18,829	21,524	14.3	14,181	27,824	96.2
Annual	1,427,700	432,000	131,186	161,388	23.0	99,028	180,887	82.7

The impacts of the City of Austin return flow strategy on the freshwater inflows overall is positive. During the summer months, the 10th percentile inflows decrease, possibly due to irrigation, but as is shown below in *Figures 3.14* and *3.15*, the median and 90th percentile inflows for those months still increase as a result of the strategy.

Figure 3.14 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without Strategy 10 at CP M10000 for 2010, along with the target and critical bay and estuary freshwater inflows. *Figure 3.15* shows a similar comparison for 2060. The impacts of the strategy are positive.

Figure 3.14 Strategy 10 (COA Return Flow) 2010 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

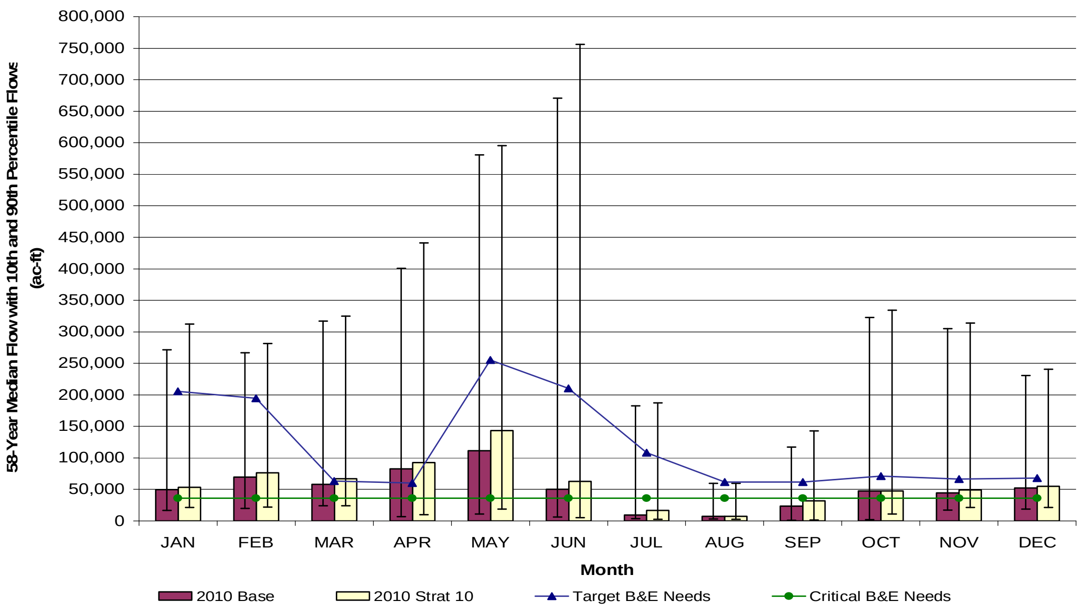


Figure 3.15 Strategy 10 (COA Return Flow) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

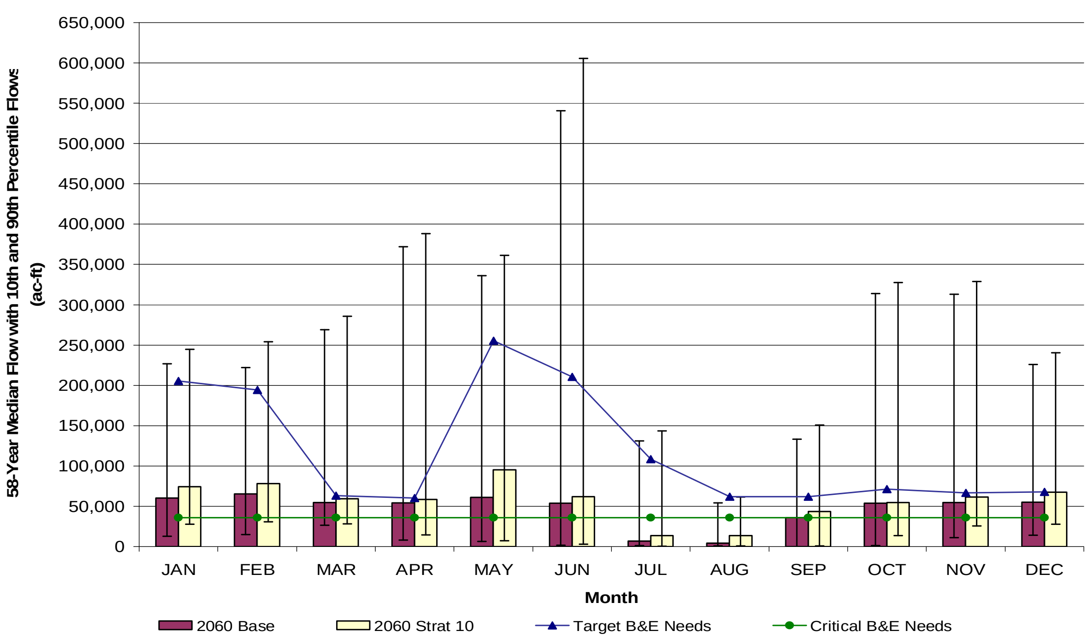


Table 3.8E Strategy 10 (COA Return Flow) Frequency of Meeting Target and Critical Needs for 2060

Month	COA Return Flow Strategy at CP J10000 (Colorado County)						COA Return Flow Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	81.4%	98.3%	16.9%	98.3%	100.0%	1.7%	18.6%	20.3%	1.7%	71.2%	81.4%	10.2%
FEB	84.7%	100.0%	15.3%	100.0%	100.0%	0.0%	18.6%	23.7%	5.1%	76.3%	84.7%	8.5%
MAR	93.2%	94.9%	1.7%	93.2%	94.9%	1.7%	42.4%	49.2%	6.8%	76.3%	79.7%	3.4%
APR	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	45.8%	49.2%	3.4%	62.7%	69.5%	6.8%
MAY	89.8%	93.2%	3.4%	100.0%	100.0%	0.0%	22.0%	23.7%	1.7%	78.0%	79.7%	1.7%
JUN	96.6%	98.3%	1.7%	100.0%	100.0%	0.0%	30.5%	30.5%	0.0%	64.4%	69.5%	5.1%
JUL	98.3%	100.0%	1.7%	100.0%	100.0%	0.0%	13.6%	18.6%	5.1%	39.0%	40.7%	1.7%
AUG	98.3%	100.0%	1.7%	100.0%	100.0%	0.0%	8.5%	10.2%	1.7%	23.7%	37.3%	13.6%
SEP	98.3%	100.0%	1.7%	100.0%	100.0%	0.0%	25.4%	32.2%	6.8%	59.3%	59.3%	0.0%
OCT	74.6%	93.2%	18.6%	100.0%	100.0%	0.0%	32.2%	39.0%	6.8%	66.1%	72.9%	6.8%
NOV	84.7%	100.0%	15.3%	100.0%	100.0%	0.0%	39.0%	47.5%	8.5%	67.8%	81.4%	13.6%
DEC	84.7%	98.3%	13.6%	98.3%	100.0%	1.7%	45.8%	49.2%	3.4%	72.9%	83.1%	10.2%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	39.0%	44.1%	5.1%	76.3%	79.7%	3.4%

Table 3.8E demonstrates that the City of Austin Return Flow strategy does not have any negative impacts on the frequency that the instream flows and freshwater inflows meet their respective target and critical flow levels.

Table 3.8F Strategy 10 (COA Return Flow) Flow Duration Below Target and Critical Needs for 2060

Condition	COA Return Flow Strategy at CP J10000 (Colorado County)			COA Return Flow Strategy at CP M10000 (Matagorda Bay)		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
Number of Times Flow Falls Below **Target** Level	38	14	-24	85	94	9
Maximum Duration Below **Target** Level (months)	6	1	-5	51	39	-12
Total Duration Below **Target** Level (months)	68	14	-54	506	476	-30
Average Duration Below **Target** Level (months)	2	1	-1	6	5	-1
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	10,659	4,402	-6,258	504,744	407,864	-96,880
Number of Times Flow Falls Below **Critical** Level	6	3	-3	93	72	-21
Maximum Duration Below **Critical** Level (months)	1	1	0	11	11	0
Total Duration Below **Critical** Level (months)	6	3	-3	261	213	-48
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	5,068	469	-4,599	66,999	64,654	-2,345

Table 3.8F above shows that although the City of Austin Return Flow strategy increases the number of times that the freshwater inflows fall below the target level (85 times to 94 times), the maximum and total

duration values both decrease. There are no other negative impacts regarding occurrences, duration, or volume of flow for the instream flows and freshwater inflows.

Strategy 11. City of Austin reuse

By 2090, the City of Austin may achieve full utilization (zero return flow). This strategy consists of the City of Austin reusing wastewater effluent, either by direct reuse or indirect reuse, for municipal, manufacturing, and steam electric needs. The amount of reuse is subtracted from what would be full return flows, and the remaining water is returned to the river to travel downstream, satisfying other water rights. The Region K WAM Run 3 Model (inherently containing Strategy 1 (Expand Contract) and Strategy 7 (HB 1437)) was used for the base condition with full return flows turned on. This allowed for an analysis of the impact of just the reuse.

Impacts are compared at Control Points J10000, K20000, K10000, and M10000. *Table 3.8A* shows the comparison at Control Point J10000. *Table 3.8B* shows the comparison at Control Point K20000. *Table 3.8C* shows the comparison at Control Point K10000. *Table 3.8D* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations. Please see Appendix C (pages C-93 through C-105) for impact analysis results of control points not discussed in this section.

Table 3.9A Strategy 11 (COA Reuse) Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	18,081	22,501	22,207	-1.3	28,432	26,531	-6.7
FEB	18,081	22,459	22,379	-0.4	28,869	27,424	-5.0
MAR	18,081	30,275	30,275	0.0	32,554	31,374	-3.6
APR	18,081	34,962	34,318	-1.8	33,269	30,570	-8.1
MAY	18,081	70,354	69,131	-1.7	53,021	50,670	-4.4
JUN	18,081	75,969	75,612	-0.5	57,235	54,093	-5.5
JUL	18,081	55,512	54,427	-2.0	40,141	39,942	-0.5
AUG	18,081	42,948	43,479	1.2	35,985	29,885	-17.0
SEP	18,081	40,001	38,187	-4.5	34,686	33,754	-2.7
OCT	18,081	27,269	26,854	-1.5	28,561	24,076	-15.7
NOV	18,081	21,994	21,820	-0.8	27,909	25,975	-6.9
DEC	18,081	24,190	24,091	-0.4	29,343	28,201	-3.9
Annual	216,972	468,433	462,781	-1.2	430,005	402,495	-6.4

The base model used for comparison in this strategy is the full return flow model, so the impacts can be determined for the reuse strategy specifically. As is shown in *Tables 3.9A* through *3.9C*, the reuse strategy reduces instream flow volumes downstream of the reuse diversion points, and has a greater impact in 2060 than in 2010, due to increased water demand. The return flows are reduced by the amount of water that is reused, thus creating a decrease in the instream flows below the diversion point, but potentially allowing for an increase in storage above the diversion.

Table 3.9B Strategy 11 (COA Reuse) Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	23,613	24,511	23,418	-4.5	31,625	29,708	-6.1
FEB	23,613	25,394	25,297	-0.4	33,317	31,812	-4.5
MAR	23,613	31,312	30,383	-3.0	34,438	33,008	-4.2
APR	23,613	20,533	19,889	-3.1	25,451	22,840	-10.3
MAY	23,613	37,227	33,397	-10.3	28,128	26,498	-5.8
JUN	23,613	30,760	30,572	-0.6	21,172	19,876	-6.1
JUL	23,613	24,532	25,386	3.5	18,681	17,292	-7.4
AUG	23,613	17,696	17,002	-3.9	15,180	13,411	-11.6
SEP	23,613	18,066	17,857	-1.2	14,957	13,981	-6.5
OCT	23,613	16,544	15,809	-4.4	21,263	19,212	-9.6
NOV	23,613	24,410	23,968	-1.8	31,080	30,140	-3.0
DEC	23,613	24,190	24,091	-0.4	31,047	29,922	-3.6
Annual	283,356	295,176	287,069	-2.7	306,338	287,703	-6.1

Table 3.9C Strategy 11 (COA Reuse) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2010 and 2060

Month	7Q2 Flow	2010			2060		
		Base Model	Strategy	% Change	Base Model	Strategy	% Change
	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	
JAN	12,374	23,664	21,146	-10.6	32,898	30,530	-7.2
FEB	12,374	26,785	26,417	-1.4	35,045	33,423	-4.6
MAR	12,374	28,305	28,194	-0.4	33,414	32,530	-2.6
APR	12,374	11,376	11,940	5.0	20,644	17,547	-15.0
MAY	12,374	21,126	15,914	-24.7	11,614	10,909	-6.1
JUN	12,374	6,905	7,188	4.1	7,395	6,261	-15.3
JUL	12,374	5,398	5,902	9.3	4,217	5,092	20.8
AUG	12,374	4,147	4,508	8.7	4,493	4,219	-6.1
SEP	12,374	3,003	3,087	2.8	4,300	3,990	-7.2
OCT	12,374	12,999	12,263	-5.7	22,223	18,215	-18.0
NOV	12,374	23,461	23,391	-0.3	31,636	30,743	-2.8
DEC	12,374	23,646	23,605	-0.2	32,816	31,591	-3.7
Annual	148,488	190,815	183,556	-3.8	240,694	225,050	-6.5

Table 3.9D Strategy 11 (COA Reuse) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2010 and 2060

Month	Target B&E	Critical B&E	2010			2060		
	ac-ft	ac-ft	Base Model ac-ft	Strategy ac-ft	% Change	Base Model ac-ft	Strategy ac-ft	% Change
JAN	205,600	36,000	21,388	21,388	0.0	27,830	25,894	-7.0
FEB	194,500	36,000	22,030	21,388	-2.9	30,903	29,575	-4.3
MAR	63,200	36,000	23,976	23,956	-0.1	28,148	27,013	-4.0
APR	60,400	36,000	9,810	9,167	-6.6	14,721	12,782	-13.2
MAY	255,400	36,000	18,976	13,652	-28.1	7,196	8,660	20.3
JUN	210,500	36,000	5,018	5,301	5.6	3,078	1,284	-58.3
JUL	108,400	36,000	2,851	3,284	15.2	479	1,447	202.3
AUG	62,000	36,000	2,358	2,772	17.5	714	1,465	105.1
SEP	61,900	36,000	1,331	1,392	4.6	881	668	-24.2
OCT	71,300	36,000	10,737	10,002	-6.8	13,466	9,092	-32.5
NOV	66,500	36,000	21,388	21,350	-0.2	25,648	24,184	-5.7
DEC	68,000	36,000	21,524	21,524	0.0	27,824	26,697	-4.1
Annual	1,427,700	432,000	161,388	155,175	-3.8	180,887	168,760	-6.7

The City of Austin reuse strategy appears to reduce the freshwater flows slightly as well. During the summer months, the 10th percentile inflows increase somewhat, perhaps due to irrigation-related activities, or as a result of an increase in the storage level of Lakes Travis and Buchanan, which may result in an increase in the frequency of engaging the system in Target environmental flow mode. Further analyses may be warranted in the 2011 Plan to determine the full balance of effects associated with reuse in lieu of stored water consumption.

Figure 3.16 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without Strategy 11 at CP M10000 for 2010, along with the target and critical bay and estuary freshwater inflows. *Figure 3.17* shows a similar comparison for 2060. The impacts of the strategy are slightly negative.

Figure 3.16 Strategy 11 (COA Reuse) 2010 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

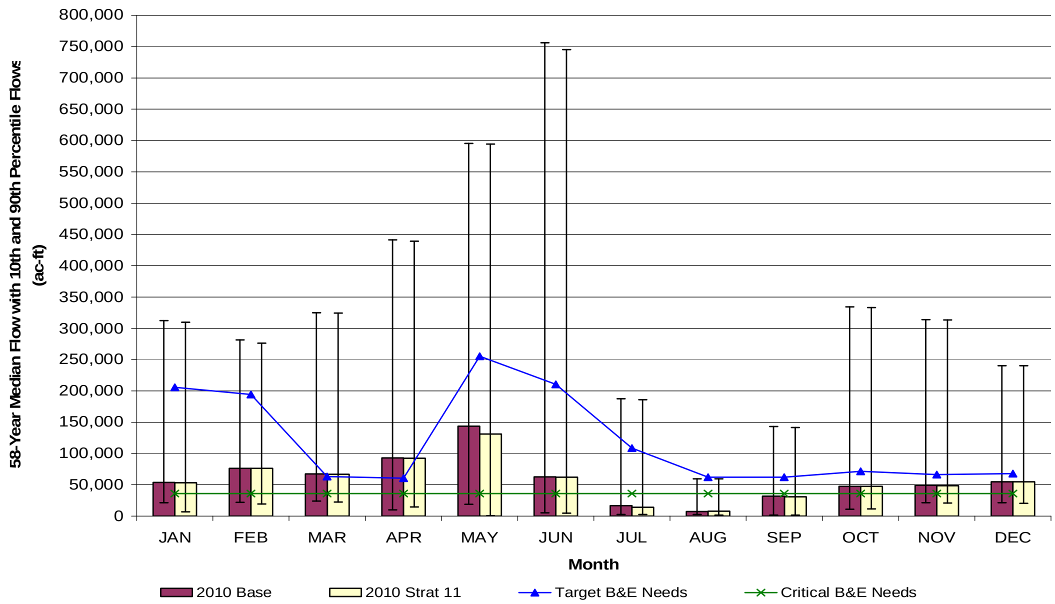


Figure 3.17 Strategy 11 (COA Reuse) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

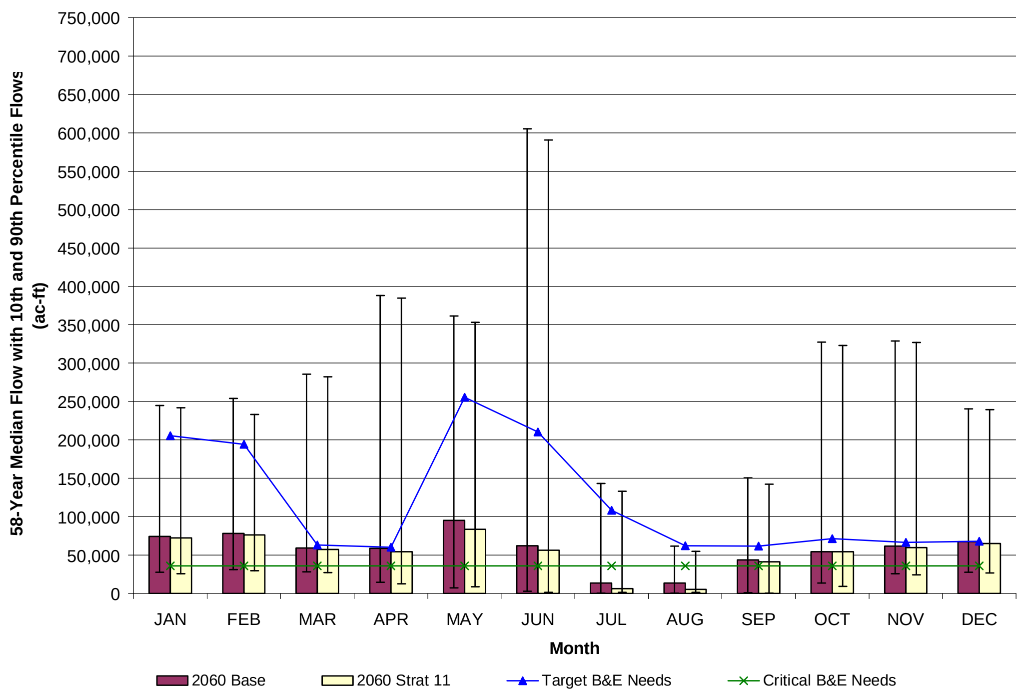


Table 3.9E Strategy 11 (COA Reuse) Frequency of Meeting Target and Critical Needs for 2060

Month	COA Reuse Strategy at CP J10000 (Colorado County)						COA Reuse Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	20.3%	20.3%	0.0%	81.4%	79.7%	-1.7%
FEB	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	23.7%	23.7%	0.0%	84.7%	84.7%	0.0%
MAR	94.9%	91.5%	-3.4%	94.9%	91.5%	-3.4%	49.2%	47.5%	-1.7%	79.7%	79.7%	0.0%
APR	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	49.2%	47.5%	-1.7%	69.5%	66.1%	-3.4%
MAY	93.2%	89.8%	-3.4%	100.0%	98.3%	-1.7%	23.7%	23.7%	0.0%	79.7%	79.7%	0.0%
JUN	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	30.5%	30.5%	0.0%	69.5%	67.8%	-1.7%
JUL	100.0%	98.3%	-1.7%	100.0%	100.0%	0.0%	18.6%	16.9%	-1.7%	40.7%	39.0%	-1.7%
AUG	100.0%	98.3%	-1.7%	100.0%	100.0%	0.0%	10.2%	8.5%	-1.7%	37.3%	27.1%	-10.2%
SEP	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	32.2%	28.8%	-3.4%	59.3%	59.3%	0.0%
OCT	93.2%	89.8%	-3.4%	100.0%	100.0%	0.0%	39.0%	35.6%	-3.4%	72.9%	69.5%	-3.4%
NOV	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	47.5%	45.8%	-1.7%	81.4%	81.4%	0.0%
DEC	98.3%	98.3%	0.0%	100.0%	100.0%	0.0%	49.2%	47.5%	-1.7%	83.1%	83.1%	0.0%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	44.1%	40.7%	-3.4%	79.7%	79.7%	0.0%

Table 3.9E above demonstrates the impacts the City of Austin Reuse strategy has on the frequency of meeting target and critical instream flows and freshwater inflows. The table does not show the frequency of years in which Lakes Travis and Buchanan are engaged in Critical or Target environmental flow mode in accordance with LCRA's Water Management Plan. The reuse strategy is compared to the full return flow strategy. The impacts are generally less than four percent, although the largest impact occurs at the Matagorda Bay control point where the frequency of meeting the critical freshwater inflows decreases by 10 percent.

Table 3.9F Strategy 11 (COA Reuse) Flow Duration Below Target and Critical Needs for 2060

Condition	COA Reuse Strategy at CP J10000 (Colorado County)			COA Reuse Strategy at CP M10000 (Matagorda Bay)		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
Number of Times Flow Falls Below **Target** Level	14	20	6	94	92	-2
Maximum Duration Below **Target** Level (months)	1	3	2	39	39	0
Total Duration Below **Target** Level (months)	14	22	8	476	486	10
Average Duration Below **Target** Level (months)	1	1	0	5	5	0
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	4,402	5,024	623	407,864	432,524	24,660
Number of Times Flow Falls Below **Critical** Level	3	6	3	72	77	5
Maximum Duration Below **Critical** Level (months)	1	1	0	11	11	0
Total Duration Below **Critical** Level (months)	3	6	3	213	226	13
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	469	3,117	2,648	64,654	66,304	1,650

Table 3.9F above shows the impact the reuse strategy has on the number of times the instream flows and freshwater inflows fall below target/critical levels, and the duration and volume of those occurrences. The reuse strategy increases the number of times the instream flows fall below target and critical levels, the number of times freshwater inflows fall below critical levels, the maximum duration below the target level for the instream flows, the total duration below the target and critical levels for the instream flows and freshwater inflows, and the average volume of flow per occurrence for the instream flows and freshwater inflows. The reuse strategy is compared to the full return flow strategy (Strategy 10), at control points below the reuse diversion point. Effects of retaining stored water upstream in lieu of a release to meet downstream demands are not explored here.

Strategy 12. Amendment of LCRA irrigation water rights

This strategy is a necessary component of the LSWP strategy, and thus was not modeled separately from the LSWP strategy. Please see Strategy 9 (LSWP) for results.

Strategy 13. LCRA excess flows permit and off-channel storage

This strategy uses two off-channel reservoirs, one in Matagorda County, and one in Colorado County, to collect excess flows during periods of high flow. The target bay and estuary inflows from the 2006 Matagorda Bay Freshwater Inflow Needs Study (FINS) and the target instream flows identified in the LCRA 2003 Water Management Plan were used as the bay and estuary and instream flow requirements that needed to be met before any excess flow could be diverted to either of the reservoirs. This strategy is only needed in 2060, and therefore, was only modeled for 2060. Because of the stringent environmental flow requirements, little impact to the 10^{th} percentile flows is expected. For the analysis, the Region K WAM Run 3 Cutoff Model, which inherently contains Strategy 1 (Expand Contract) and Strategy 7 (HB 1437), was used for the base condition.

Impacts are compared for 2060 at Control Points K20000, K10000, and M10000. *Table 3.10A* shows the comparison at Control Point K20000. *Table 3.10B* shows the comparison at Control Point K10000. *Table 3.10C* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations. Please see Appendix C (pages C-106 through C-112) for impact analysis results of control points not discussed in this section.

Table 3.10A Strategy 13 (Excess Flows) Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	23,613	14,599	14,599	0.0
FEB	23,613	17,368	17,368	0.0
MAR	23,613	33,690	33,691	0.0
APR	23,613	21,167	21,175	0.0
MAY	23,613	27,977	27,976	0.0
JUN	23,613	20,518	20,505	-0.1
JUL	23,613	15,053	15,053	0.0
AUG	23,613	11,617	11,617	0.0
SEP	23,613	11,875	11,937	0.5
OCT	23,613	9,708	9,708	0.0
NOV	23,613	16,617	16,617	0.0
DEC	23,613	17,041	17,041	0.0
Annual	283,356	217,230	217,288	0.0

Table 3.10B Strategy 13 (Excess Flows) Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	12,374	15,015	15,015	0.0
FEB	12,374	18,782	18,782	0.0
MAR	12,374	32,712	32,551	-0.5
APR	12,374	12,388	12,407	0.1
MAY	12,374	10,349	10,349	0.0
JUN	12,374	6,701	6,701	0.0
JUL	12,374	4,063	4,058	-0.1
AUG	12,374	4,205	4,205	0.0
SEP	12,374	2,694	2,694	0.0
OCT	12,374	11,468	11,468	0.0
NOV	12,374	16,617	16,617	0.0
DEC	12,374	18,127	18,127	0.0
Annual	148,488	153,121	152,973	-0.1

As is shown in *Tables 3.10A* and *3.10B* above, the 10th percentile instream flow impacts at CP K20000 and CP K10000 are very minor, and can be considered negligible. This was expected, considering the stringent environmental requirements placed on the strategy. The graphic results in Appendix C (C-107 through C-112) display the 90th percentile flow impacts at each control point, and show decreases in flow volume of as much as 10 percent for the months of January through May.

Table 3.10C Strategy 13 (Excess Flows) Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2060

Month	Target B&E ac-ft	Critical B&E ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	205,600	36,000	12,939	12,939	0.0
FEB	194,500	36,000	14,988	14,988	0.0
MAR	63,200	36,000	26,337	26,337	0.0
APR	60,400	36,000	8,192	8,196	0.1
MAY	255,400	36,000	6,375	6,375	0.0
JUN	210,500	36,000	1,582	1,581	-0.1
JUL	108,400	36,000	1,122	1,121	-0.1
AUG	62,000	36,000	951	951	0.0
SEP	61,900	36,000	15	15	0.0
OCT	71,300	36,000	1,334	1,334	0.0
NOV	66,500	36,000	11,010	11,136	1.1
DEC	68,000	36,000	14,181	14,181	0.0
Annual	1,427,700	432,000	99,028	99,156	0.1

For Strategy 13, like the impacts to the 10th percentile instream flows, the impacts to the 10th percentile freshwater inflows at CP M10000 are very small, as is shown in *Table 3.10C*, and can be considered negligible.

Figure 3.18 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without Strategy 13 at CP M10000 for 2060, along with the target and critical bay and estuary freshwater inflows. An impact from the strategy that that can be seen clearly is a decrease in the 90th percentile inflows during January through April. This would seem appropriate given that the strategy diverts water during periods of high flow.

Figure 3.18 Strategy 13 (Excess Flows) 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

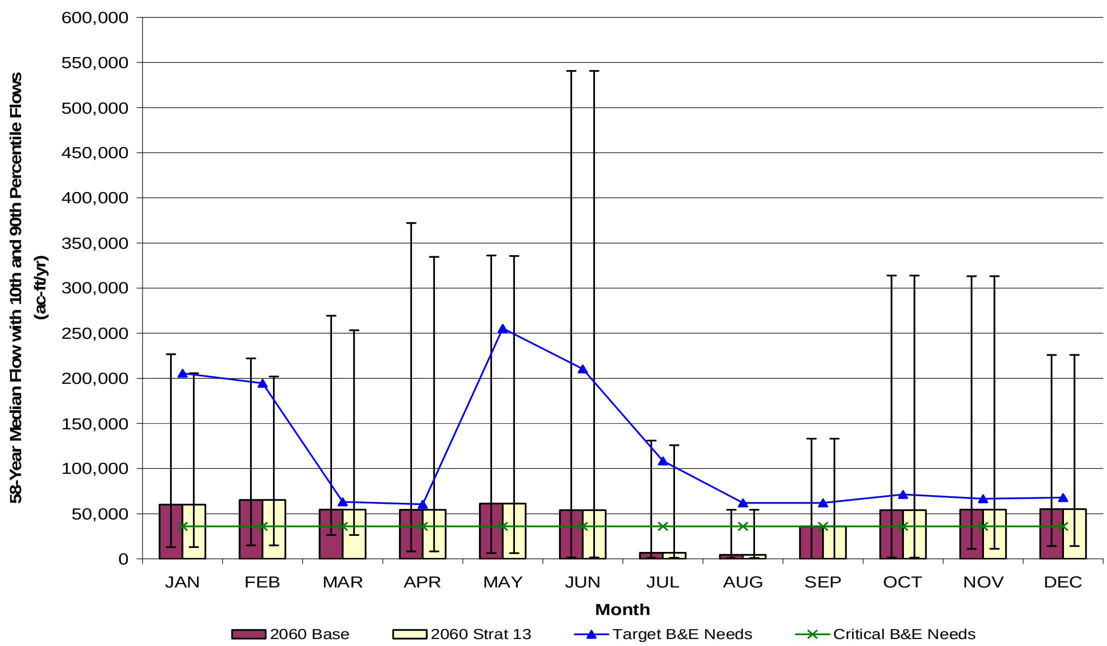


Table 3.10D Strategy 13 (Excess Flows) Frequency of Meeting Target and Critical Needs for 2060

Month	Excess Flows Strategy at CP K20000 (Wharton County)						Excess Flows Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	89.8%	89.8%	0.0%	98.3%	98.3%	0.0%	18.6%	18.6%	0.0%	71.2%	71.2%	0.0%
FEB	91.5%	91.5%	0.0%	100.0%	100.0%	0.0%	18.6%	18.6%	0.0%	76.3%	76.3%	0.0%
MAR	98.3%	98.3%	0.0%	93.2%	93.2%	0.0%	42.4%	42.4%	0.0%	76.3%	76.3%	0.0%
APR	84.7%	84.7%	0.0%	74.6%	74.6%	0.0%	45.8%	45.8%	0.0%	62.7%	62.7%	0.0%
MAY	78.0%	78.0%	0.0%	84.7%	84.7%	0.0%	22.0%	22.0%	0.0%	78.0%	78.0%	0.0%
JUN	76.3%	76.3%	0.0%	98.3%	98.3%	0.0%	30.5%	30.5%	0.0%	64.4%	64.4%	0.0%
JUL	89.8%	89.8%	0.0%	98.3%	98.3%	0.0%	13.6%	13.6%	0.0%	39.0%	39.0%	0.0%
AUG	94.9%	94.9%	0.0%	96.6%	96.6%	0.0%	8.5%	8.5%	0.0%	23.7%	23.7%	0.0%
SEP	76.3%	76.3%	0.0%	98.3%	98.3%	0.0%	25.4%	25.4%	0.0%	59.3%	59.3%	0.0%
OCT	78.0%	78.0%	0.0%	93.2%	93.2%	0.0%	32.2%	32.2%	0.0%	66.1%	66.1%	0.0%
NOV	89.8%	89.8%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	67.8%	67.8%	0.0%
DEC	94.9%	94.9%	0.0%	100.0%	100.0%	0.0%	45.8%	45.8%	0.0%	72.9%	72.9%	0.0%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	39.0%	39.0%	0.0%	76.3%	71.2%	-5.1%

Table 3.10D above shows that although the Excess Flows strategy has no monthly impacts to the frequency of the target and critical flow levels being met, it does have a negative impact of approximately five percent

on the frequency of meeting the Matagorda Bay critical freshwater inflow level on an annual basis. The instream flows were analyzed at the Wharton County control point (CP K20000) for this strategy because the strategy occurs downstream of the J10000 control point the rest of the strategies were analyzed at. Target instream flow levels were available at this control point from the LCRA Water Management Plan, but there are no stated critical flow levels at this point. As such, the listed critical levels for the J10000 control point were used for comparison purposes only.

Table 3.10E Strategy 13 (Excess Flows) Flow Duration Below Target and Critical Needs for 2060

Condition	Excess Flows Strategy at CP K20000 (Wharton County)			Excess Flows Strategy at CP M10000 (Matagorda Bay)		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
Number of Times Flow Falls Below **Target** Level	62	62	0	85	85	0
Maximum Duration Below **Target** Level (months)	5	5	0	51	51	0
Total Duration Below **Target** Level (months)	93	93	0	506	506	0
Average Duration Below **Target** Level (months)	2	2	0	6	6	0
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	10,977	10,979	2	503,853	504,827	974
Number of Times Flow Falls Below **Critical** Level	30	30	0	92	93	1
Maximum Duration Below **Critical** Level (months)	2	2	0	11	11	0
Total Duration Below **Critical** Level (months)	38	38	0	263	261	-2
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	8,177	8,224	47	67,895	67,032	-863

Table 3.10E shows that the Excess Flows strategy does have a small impact on the number, duration, and volume of occurrences below the target/critical flow levels. The negative impacts are small increases in the average volume of flow below the target/critical flow levels, and an increase in the number of times the freshwater inflow fell below the target level (92 to 93).

Strategy 14. Comprehensive Model containing all of the Strategies

This strategy cumulates all of the individual strategies into one model to demonstrate the overall impact on the environmental flows. For the analysis, the Region K WAM Run 3 Model had its inherent Strategy 1 (Expand Contract) and Strategy 7 (HB 1437) removed from the model for use as the base condition. The strategy model began with the LSWP model and added Strategies 3 (GBRA Pipeline), 4 (Onion Creek), 5 (Gold Channel Dam) , and 6 (Gold Reservoir). Please see page 2-9 for more explanation. Impacts are compared for 2060 at Control Points I10000, J10000, K20000, K10000, and M10000. *Table 3.11A* shows the comparison at Control Point I10000. *Table 3.11B* shows the comparison at Control Point J10000. *Table 3.11C* shows the comparison at Control Point K20000. *Table 3.11D* shows the comparison at Control Point K10000. *Table 3.11E* shows the comparison at Control Point M10000. See *Figure 3.1* for control point locations.

Table 3.11A Comprehensive Model Comparison of 10th Percentile Flows at CP I10000 (Austin) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	11,547	8,923	8,081	-9.4
FEB	11,547	8,886	8,739	-1.7
MAR	11,547	17,696	13,767	-22.2
APR	11,547	19,782	13,643	-31.0
MAY	11,547	31,803	32,482	2.1
JUN	11,547	30,600	28,080	-8.2
JUL	11,547	20,204	17,021	-15.8
AUG	11,547	27,245	20,680	-24.1
SEP	11,547	17,181	10,723	-37.6
OCT	11,547	11,711	12,997	11.0
NOV	11,547	9,377	10,023	6.9
DEC	11,547	10,196	10,893	6.8
Annual	138,564	213,603	187,129	-12.4

Because the LSWP model (used in the LSWP strategy analysis - Strategy 9) contains several strategies that have large impacts, the results for the comprehensive strategy model are very similar to the results shown for the LSWP strategy, in this report. The impacts at CP I10000 are mainly negative impacts, although only during September do the strategies cause the instream flows to go below the 7Q2 flow levels.

Table 3.11B Comprehensive Model Comparison of 10th Percentile Flows at CP J10000 (Colorado County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	18,081	13,467	28,785	113.7
FEB	18,081	12,901	30,179	133.9
MAR	18,081	31,475	32,281	2.6
APR	18,081	30,338	29,950	-1.3
MAY	18,081	51,567	54,505	5.7
JUN	18,081	54,177	51,941	-4.1
JUL	18,081	37,175	30,187	-18.8
AUG	18,081	28,807	23,814	-17.3
SEP	18,081	30,163	25,620	-15.1
OCT	18,081	15,923	25,695	61.4
NOV	18,081	13,672	26,997	97.5
DEC	18,081	14,991	30,865	105.9
Annual	216,972	334,657	390,819	16.8

Again, similar to the LSWP strategy results, the overall impacts to the instream flows at CP J10000 are positive, with some negative impacts occurring during the summer months. The impacts of the strategies cause the 10th percentile instream flows to increase above the 7Q2 flow levels during several of the winter months.

Table 3.11C Comprehensive Model Comparison of 10th Percentile Flows at CP K20000 (Wharton County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	23,613	16,140	30,337	88.0
FEB	23,613	17,188	35,866	108.7
MAR	23,613	33,101	32,939	-0.5
APR	23,613	20,782	24,129	16.1
MAY	23,613	27,546	29,816	8.2
JUN	23,613	20,624	22,637	9.8
JUL	23,613	15,157	20,648	36.2
AUG	23,613	11,617	17,285	48.8
SEP	23,613	11,702	23,193	98.2
OCT	23,613	8,952	25,737	187.5
NOV	23,613	15,596	29,852	91.4
DEC	23,613	16,400	29,183	77.9
Annual	283,356	214,806	321,624	49.7

Table 3.11D Comprehensive Model Comparison of 10th Percentile Flows at CP K10000 (Matagorda County) for 2060

Month	7Q2 Flow ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	12,374	18,402	30,417	65.3
FEB	12,374	17,507	35,148	100.8
MAR	12,374	32,540	30,107	-7.5
APR	12,374	12,140	19,295	58.9
MAY	12,374	10,349	24,840	140.0
JUN	12,374	5,886	17,113	190.7
JUL	12,374	4,340	12,900	197.2
AUG	12,374	4,205	11,094	163.9
SEP	12,374	2,607	27,083	939.0
OCT	12,374	10,105	25,898	156.3
NOV	12,374	16,199	29,121	79.8
DEC	12,374	17,747	30,150	69.9
Annual	148,488	152,027	293,168	92.8

The impacts on instream flows at CP K20000 and K10000 are also very similar to the LSWP strategy impacts. Nearly all of the impacts are positive, with large increases in flow.

Table 3.11E Comprehensive Model Comparison of 10th Percentile Flows at CP M10000 (Entrance to Matagorda Bay) for 2060

Month	Target B&E ac-ft	Critical B&E ac-ft	Base Model ac-ft	Strategy ac-ft	% Change
JAN	205,600	36,000	12,939	23,091	78.5
FEB	194,500	36,000	14,988	29,513	96.9
MAR	63,200	36,000	26,324	27,947	6.2
APR	60,400	36,000	8,131	15,892	95.5
MAY	255,400	36,000	6,375	17,352	172.2
JUN	210,500	36,000	1,595	12,986	714.3
JUL	108,400	36,000	1,292	9,025	598.3
AUG	62,000	36,000	1,154	7,899	584.3
SEP	61,900	36,000	15	23,490	156,498.7
OCT	71,300	36,000	1,334	20,220	1,415.3
NOV	66,500	36,000	11,010	23,173	110.5
DEC	68,000	36,000	13,749	25,903	88.4
Annual	1,427,700	432,000	98,908	236,490	139.1

The impacts to the freshwater inflows at CP M10000 are also similar to the LSWP strategy impacts. The annual 10th percentile flows more than double, although they are still much less than the critical bay and estuary inflows.

Figure 3.19 below shows a bar graph of the median flows, as well as lines showing the range of 10th percentile to 90th percentile flows both with and without all of the strategies at CP M10000 for 2060, along with the target and critical bay and estuary freshwater inflows.

Figure 3.19 Comprehensive Model 2060 Comparison of Freshwater Inflow Results at CP M10000 (Entrance to Matagorda Bay)

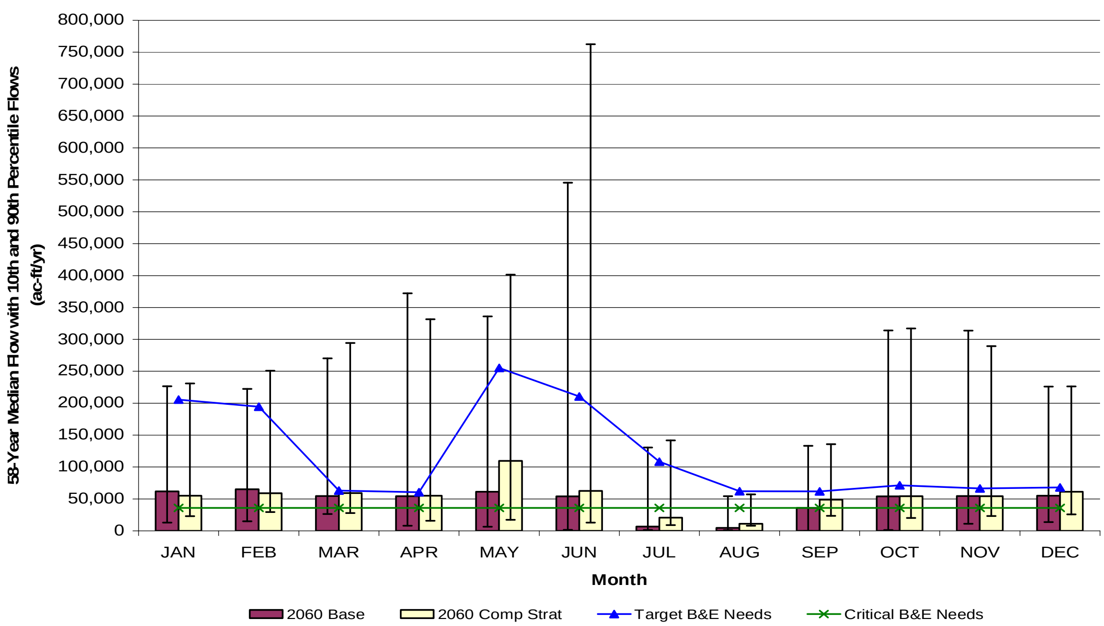


Table 3.11F Comprehensive Model Frequency of Meeting Target and Critical Needs for 2060

	Comprehensive Strategy at CP J10000 (Colorado County)						Comprehensive Strategy at CP M10000 (Matagorda Bay)					
	% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**			% of Time Flow Meets or Exceeds **Target Needs**			% of Time Flow Meets or Exceeds **Critical Needs**		
Month	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
JAN	81.4%	100.0%	18.6%	100.0%	100.0%	0.0%	18.6%	23.7%	5.1%	71.2%	78.0%	6.8%
FEB	84.7%	100.0%	15.3%	100.0%	100.0%	0.0%	18.6%	22.0%	3.4%	76.3%	86.4%	10.2%
MAR	91.5%	100.0%	8.5%	91.5%	100.0%	8.5%	42.4%	44.1%	1.7%	74.6%	71.2%	-3.4%
APR	100.0%	89.8%	-10.2%	100.0%	89.8%	-10.2%	45.8%	49.2%	3.4%	62.7%	67.8%	5.1%
MAY	89.8%	96.6%	6.8%	98.3%	98.3%	0.0%	22.0%	28.8%	6.8%	78.0%	79.7%	1.7%
JUN	94.9%	98.3%	3.4%	100.0%	100.0%	0.0%	30.5%	30.5%	0.0%	64.4%	67.8%	3.4%
JUL	98.3%	100.0%	1.7%	100.0%	100.0%	0.0%	13.6%	18.6%	5.1%	37.3%	37.3%	0.0%
AUG	98.3%	100.0%	1.7%	100.0%	100.0%	0.0%	8.5%	10.2%	1.7%	23.7%	23.7%	0.0%
SEP	98.3%	96.6%	-1.7%	100.0%	100.0%	0.0%	25.4%	28.8%	3.4%	59.3%	72.9%	13.6%
OCT	74.6%	91.5%	16.9%	100.0%	100.0%	0.0%	32.2%	39.0%	6.8%	66.1%	72.9%	6.8%
NOV	83.1%	100.0%	16.9%	100.0%	100.0%	0.0%	39.0%	32.2%	-6.8%	67.8%	78.0%	10.2%
DEC	84.7%	100.0%	15.3%	98.3%	100.0%	1.7%	45.8%	45.8%	0.0%	72.9%	81.4%	8.5%
Annual	100.0%	100.0%	0.0%	100.0%	100.0%	0.0%	39.0%	40.7%	1.7%	76.3%	83.1%	6.8%

Table 3.11F demonstrates that all of the strategies together have some negative impacts on the frequency that the instream flows and freshwater inflows meet their target and critical levels. The maximum negative impact occurs during April at CP J10000 (Colorado County), where the frequency of meeting both the target and critical levels decreases by approximately 10 percent, due to the implementation of all of the strategies. Another significant negative impact occurs during November at CP M10000 (Matagorda Bay), where the frequency of meeting the target freshwater inflows decreases by approximately seven percent. The strategies do not impact the flows negatively on an annual basis, only monthly.

Table 3.11G Comprehensive Model Flow Duration Below Target and Critical Needs for 2060

Condition	Comprehensive Strategy at CP J10000 (Colorado County)			Comprehensive Strategy at CP M10000 (Matagorda Bay)		
	Without Strategy	With Strategy	Difference	Without Strategy	With Strategy	Difference
Number of Times Flow Falls Below **Target** Level	39	14	-25	85	90	5
Maximum Duration Below **Target** Level (months)	6	2	-4	51	83	32
Total Duration Below **Target** Level (months)	71	16	-55	506	488	-18
Average Duration Below **Target** Level (months)	2	1	-1	6	5	-1
Average Volume of Flow Per Event Below **Target** Level (Ac-Ft)	10,700	5,036	-5,664	503,853	426,967	-76,886
Number of Times Flow Falls Below **Critical** Level	7	7	0	92	80	-12
Maximum Duration Below **Critical** Level (months)	1	1	0	11	21	10
Total Duration Below **Critical** Level (months)	7	7	0	263	226	-37
Average Duration Below **Critical** Level (months)	1	1	0	3	3	0
Average Volume of Flow Per Event Below **Critical** Level (Ac-Ft)	3,823	3,880	58	67,895	46,704	-21,191

Table 3.11G demonstrates the various impacts that the Comprehensive group of strategies has on the number of occurrences of the flow falling below target/critical levels, and the duration and volume of those occurrences, as compared to not implementing the strategies. Negative impacts occur at the Matagorda Bay control point for the number of times the flow falls below the target level (increased from 85 to 90), and the maximum duration below the target level (increased from 51 months to 83 months) and the critical level (increased from 11 months to 21 months).

4.0 CONCLUSIONS

A major goal of the regional water planning process is planning for future water supplies while protecting the State's environmental, agricultural, and natural resources. This goal has been considered throughout the planning process by the LCRWPG when selecting strategies to meet water needs for the future. One of the specific objectives of this study was to determine if the impacts of the water management strategies are reasonable, consistent with protection of environmental flows, and consistent with long-term protection of the state's water resources, natural resources, and agricultural resources. Comparisons of the predicted environmental instream flows and bay and estuary flows for basin conditions both with and without water management strategies are but one tool used by the Lower Colorado RWPG to accomplish these goals. However, these comparisons also provide additional insight into the impacts of these strategies and allow additional future consideration of operational and design modifications for those strategies which might better mitigate any identified undesirable consequences. Each of the strategies is addressed further below.

- Contract expansions, such as those with LCRA, increase the availability of water used for municipal and manufacturing purposes, and decrease the amount of interruptible water that is available for downstream needs such as irrigation. These strategies also have negative impacts on the instream flows in the lower portion of the basin, although the impacts are very small and can be considered reasonable, especially when considering the lack of any feasible alternatives.

- The strategy of purchasing treated water from the Canyon Lake Water Supply Corporation does not appear to have any significant environmental flow impacts on the Colorado River Basin. Since the Goforth Water Supply Corporation, which would make the treated water purchase, does not have any wastewater treatment plants, there will not be a subsequent discharge of any treated wastewater return flows into the Colorado River. The strategy would, however, remove 863 ac-ft/yr in 2060 from the Guadalupe River Basin, none of which would be returned to the Guadalupe River. That small negative impact must be appropriately addressed within the Guadalupe Basin analysis. The overall impact of this strategy to the Colorado River Basin is small and can be considered reasonable.

- The GBRA Hays County pipeline strategy, which provides a small amount of additional water to the City of Buda, also has a fairly negligible effect on the instream flows in Onion Creek and the Colorado River. The additional return flows from water outside of the basin should have some limited positive impacts on the instream flows in the Colorado Basin although this strategy will have an off-setting negative impact on the Guadalupe Basin. Because of the extremely small nature of the changes, this strategy can be considered consistent with the long-term protection of the state's water resources.

- The Onion Creek recharge structure strategy is shown under this analysis to have fairly negligible impacts on downstream environmental flows; however, it has been previously questioned regarding its validity as a strategy, both in the sense that it may not be able to supply the amount of water needed and because it has the potential to cause water quality issues during periods of high flow. The LCRWPG should continue to evaluate this strategy and potential alternatives during the next phase of planning.

- The two strategies recommended for the City of Goldthwaite involve the construction of impounding structures. New impoundments at the sites will slightly reduce instream flows by capturing interruptible flows during high-flow conditions. The junior priority dates combined with the passage of inflows during low-flow conditions create negligible, and sometimes even positive, impacts during periods of low-flow or drought.

- The HB 1437 strategy, as part of its requirements, should have “no net loss” to the Colorado River Basin. While conservation measures reduce the amount of water needed in the lower portion of the basin, the strategy does permanently remove water from the region and therefore reduces the amount of water available for downstream uses, including environmental flows. There is potential for future agreements to be executed which would convey the return flows from the transferred water back to the Colorado Basin.

- Desalination of seawater or brackish groundwater is currently considered as a “last-option” strategy due to its large expense. No freshwater inflows would be removed from the basin as a result of this strategy. Additionally, the waste brine created from the desalination process has significantly high levels of total dissolved solids (TDS) and it would likely be desirable to discharge the brine at an offshore discharge point versus in the tidally influenced segment of the Colorado River. Because of the likely location of this discharge, the quantity of instream flows and freshwater inflows is not likely to be impacted in any way as a result of this strategy..

- The LCRA-SAWS Water Project (LSWP) is subject to a number of special legislative environmental conditions as well as statutory requirements. A part of the project includes the conservation of irrigation water (through on-farm water conservation measures, irrigation district conveyance improvements, and new high yielding/water efficient rice varieties), pumping limited amounts of groundwater during drought conditions, and primarily capturing the remaining permitted portion of Colorado River flows. This study is not able to show the impact of only the LSWP strategy, as the LSWP model used contains other strategies, as well as the 2007 Settlement Agreement between the City of Austin and the LCRA. The effect of these additions is that the results shown are likely more positive than they would be if only the LSWP strategy was included. A future update of the analysis is recommended to provide more definitive results. The strategy does have some negative impacts on the frequency that target and critical instream flows and freshwater inflows are met, specifically in the months of April and November. Conservation measures are an important part of maintaining agricultural resources in the basin. This strategy will allow farmers to implement these conservation measures when otherwise they might not be able to afford to.

- The City of Austin strategies work together to provide water in different ways. The return flows provide additional interim instream flows for needed diversions downstream, as well as increased freshwater inflows to Matagorda Bay. The reuse strategy extends current supplies and helps to meet future growth and water supply shortages by reusing a portion of the City’s wastewater effluent. Over time, reuse is expected to increase, but municipal return flows are also expected to increase due to growth. Even so, by reusing wastewater effluent instead of discharging it downstream, instream flows would correspondingly decrease if all other factors remained unchanged. Other future operational measures may be considered to further impact this strategy.

- The LCRA excess flows permit and off-channel storage strategy shows a decrease in instream flows and freshwater inflows only during periods of high flow. Low-flow conditions show negligible impact.

Overall, based upon the modeling assumptions developed as a part of this study, the individual water management strategies evaluated appear reasonable and consistent with the long-term protection of the state's water resources, natural resources, and agricultural resources. Likewise, the cumulative impacts of all of these strategies are generally within expected ranges and are similar to the results generated by the LSWP model, which contains the LSWP strategy along with other strategies, which have larger positive impacts on the basin than the rest of the strategies. The LCRWPG will continue to consider all of these strategies in further detail during future regional water planning updates, as well as examine potential alternative strategies for selected areas and for changed conditions.

The results of this study have also created concern among planning group members that freshwater inflows to Matagorda Bay are meeting the Critical amounts detailed in the 2006 Matagorda Bay Freshwater Inflow Needs Study only 76 percent of the time, even prior to the implementation of any strategy. This is an area that the planning group may want to evaluate in future studies to determine whether the frequency of the freshwater inflows meeting the Critical level can be increased towards 100 percent.

APPENDIX A

DESCRIPTION OF REGION K WAM RUN 3 CUTOFF MODEL

MATRIX OF COMPONENTS OF SUPPLY MODEL VERSUS STRATEGY MODEL

DESCRIPTION OF REGION K WAM RUN 3 CUTOFF MODEL

The TCEQ's Colorado WAM Run 3 (circa September 17, 2007) was used as the base model for constructing the current version of what is referred to as the Region K WAM Run 3 Cutoff Model. This model is believed to be exactly the same as the TCEQ's current Run 3 version of the Colorado Basin WAM, except that it has been modified to reflect historical and existing operations of water rights with respect to reservoirs in the upper basin above Ivie and Brownwood Dams and to be generally consistent with procedures for determining the firm yield of the Highland Lakes as incorporated in the currently effective LCRA 1999 Water Management Plan (WMP). Specifically, the following modifications have been made to the TCEQ model for purposes of Region K planning:

1) The Colorado River Basin has been divided into two subbasins; one above Ivie and Brownwood Dams and one below these dams, with all water rights in the upper basin made senior in priority to all water rights in the lower subbasin while still maintaining priority order among the water rights in each subbasin.
2) The interruptible supply of water from the Highland Lakes that is authorized under the LCRA 1999 WMP for supplementing the water supply of downstream run-of-the-river water rights has been eliminated to reflect future firm yield operation of the Highland Lakes in accordance with policies incorporated in the WMP.
3) In accordance with provisions of the 2006 Settlement Agreement between the LCRA and the South Texas Project (STP), the available supply of run-of-river water for STP under Certificate of Adjudication No. 14-5437 is authorized at 102,000 ac-ft/yr (excluding Highland Lakes backup water), and the available supply of backup water for STP from the Highland Lakes is limited to 20,000 ac-ft/yr (as a 5-year rolling average) with two generating units in operation (as will be the case through the year 2015 according to STP) and to 40,000 ac-ft/yr (as a 5-year rolling average) with any additional generating units in operation (beginning in the year 2016 according to STP). In the WAM, water requirements for STP in excess of these limits are assumed to be obtained from external sources other than the Colorado River.
4) While the combined effects of these modifications to the model have resulted in changes in the overall available supply of water for various users in the basin, the authorized diversion amount (demand) for the LCRA "uncommitted card" (WAM Water Right ID No. 61405482001C) is still set at 132,000 ac-ft/yr in order to maintain the Highland Lakes system in a firm yield condition in accordance with WMP procedures.

Following is a summary of specific features and information regarding the Region K WAM Run 3 Cutoff Model as it currently exists:

1) All water rights in the entire Colorado River Basin and the Colorado-Brazos Coastal Basin (San Bernard River) are individually represented and simulated in accordance with their full authorized diversion and reservoir storage amounts.

2) All streamflow restrictions and environmental flow requirements stipulated in individual water rights, including the LCRA 1999 WMP, that limit diversions and/or reservoir storage are accounted for in the model.

3) Simulations with the WAM are made using a monthly time step over the entire period from 1940 through 1998.

4) Monthly naturalized streamflows are input to the model at primary control points (gaging stations) for the entire 1940-1998 simulation period and used to describe the available naturalized flows at all water right locations based on drainage area ratios.

5) The original naturalized flows for September 1952 for all primary control points on the mainstem of the Colorado River from Mansfield Dam to the Gulf of Mexico have been reduced by 300,000 acre-feet to reflect an adjustment in the original procedures used to estimate inflows to Lake Travis from its upstream ungaged watershed.

6) The area-capacity relationships for all reservoirs represented in the model correspond to authorized conservation storage quantities stipulated in existing water rights; however, for purposes of evaluating future water supply strategies, these area-capacity relationships will be adjusted to reflect future sedimentation conditions in the reservoirs corresponding to the future demand (decade) conditions being analyzed.

7) Bay and estuary (B&E) freshwater inflow requirements for Critical and Target conditions as stipulated in the LCRA 1999 WMP are fully engaged in the model based on the 1997 FINS criteria, including the Buchanan-Travis combined storage triggers for determining when Highland Lakes water is made available for satisfying the various B&E inflow needs. For purposes of evaluating future water supply strategies, alternative B&E inflow requirements may be used such as the 2006 FINS criteria or the LCRA/SAWS Water Project bay health criteria.

8) Instream environmental flow requirements at various locations along the Lower Colorado River are represented in the model in accordance with the LCRA 1999 WMP, including the Buchanan-Travis combined storage triggers for determining when Highland Lakes water is made available for satisfying the various instream environmental flow needs.

9) Annual and multi-year environmental flow caps from the LCRA 1999 WMP are included in the model for limiting the use of Highland Lakes water for satisfying instream and B&E environmental flow requirements. For purposes of evaluating future water supply strategies, it is anticipated that these caps will be eliminated from the model because the need for environmental flows will change as other demands for water from the Highland Lakes change in the future.

10) In accordance with the restructuring of the model for Region K planning, no interruptible water from the Highland Lakes is provided for supplying the demands of any water rights in the lower basin. For purposes of evaluating future water supply strategies, it is anticipated that interruptible water from the Highland Lakes will be provided for supplying demands in the lower basin in order to be more consistent with actual system operations and that appropriate irrigation demand curtailment procedures will be used in accordance with current WMP practices.

11) Water demands for LCRA's four lower basin irrigation operations are set at the annual diversion amounts authorized in the existing water rights for these operations, which totals

636,750 ac-ft/yr; however, for purposes of evaluating future water supply strategies, these irrigation water demands will be reduced to levels consistent with anticipated future usage and may be varied annually and monthly as a function of weather conditions.

12) Unless specified otherwise in a particular water right, no Municipal or Industrial return flows, including those from the City of Austin, are accounted for in the model. Municipal or Industrial return flows may be addressed as part of future water supply strategies.

13) No Irrigation return flows are discharged into the Colorado River or any of its tributaries in the model. Irrigation return flows may be addressed as part of future water supply strategies.

14) In accordance with provisions in water rights owned by Austin and LCRA, Austin's most senior water authorizing the diversion of 250,000 ac-ft/yr from the Colorado River is designated as being senior in priority to all of LCRA's water rights, with the exception of the Garwood right, even though some of LCRA's water rights have priority dates older than the Austin senior water right.

15) The provisions of the recent Settlement Agreement between the LCRA and the City of Austin are not represented in the model, but may be incorporated as part of the evaluation of future water supply strategies.

16) The provisions of the recent Settlement Agreement between LCRA and the South Texas Project are represented in the model.

17) Operating rules for Lakes Buchanan and Travis maintain consistent levels of drawdown in each of the reservoirs under specified demands, with Lake Buchanan serving as the last source of water for meeting demands during extreme drought conditions. Reservoir operating rules may change as part of the evaluation of future water supply strategies.

18) No existing term permits for water rights are included in the model.

SUMMARY OF REGION K WAM MODELING ASSUMPTIONS REGARDING SUPPLY AND STRATEGY ANALYSES

NO.	ASSUMPTION	INCLUDE FOR SUPPLY ANALYSIS	INCLUDE FOR STRATEGY ANALYSIS
1	Use of Natural Priority for All Upstream Water Rights	No	No
2	Use of 1999 Water Management Plan Environmental Flow Caps	Yes	No
3	Use of Pending 2003 Water Management Plan Environmental Flow Caps	No	No
4	Use of Reservoir Area-Capacity Relationships Reflecting Future Sedimentation Conditions by Decade	Yes	Yes
5	Use of 1997 FINS Criteria for B&E Inflow Requirements	Yes	No
6	Use of 2006 FINS Criteria for B&E Inflow Requirements	No	Yes [1]
7	Use of 1999 Water Management Plan Instream Flow Criteria	Yes	Yes
8	Simulate Interruptible Water from the Highland Lakes	No	Yes
9	Include Curtailment of Total Demand of LCRA Interruptible Water Users as Necessary to Satisfy LCRA Municipal/Industrial Demands	No	Yes
10	Set Irrigation Demands Associated with LCRA Lower-Basin Run-of-River Rights Equal to Full Authorized Diversion Amounts	Yes	No
11	Set Irrigation Demands Associated with LCRA Lower-Basin Run-of-River Rights Equal to Projected Future Demands	No	Yes
12	Apply Weather-Variable Irrigation Demands for LCRA Lower-Basin Run-of-River Rights	No	Yes
13	Include LCRA Irrigation Return Flows to the Colorado River	No	Yes
14	Include Reuse Provisions of LCRA-Austin 2007 Settlement Agreement, Including Environmental Flow Mitigation	No	No [2]
15	Include Return Flows from Municipal/Industrial Wastewater Treatment Plants	No	No [2]
16	Include Provisions of LCRA-STP 2006 Settlement Agreement	Yes	Yes
17	Include Operating Rules for Lakes Buchanan and Travis to Maintain Consistent Levels of Drawdown in the Lakes	Yes	Yes
18	Assist in Meeting Junction and Brady Future Water Demands in Region F	No	As a Strategy [3]
19	Include Term Permits as Water Demands	No	No

[1] The 2006 Freshwater Inflow Needs Study criteria have been approved by the State agencies, but have not been included in any permit or Water Management Plan. They will be applied to the Highland Lakes for the Strategy Analysis, but they will be considered on a case-by-case basis for their application to individual strategies.

[2] Only as part of the LSWP Model

[3] Only at the request of the Region F Water Planning Group.

APPENDIX B

DEFINITIONS

LOCATION OF ALL CONTROL POINTS ANALYZED FOR ENVIRONMENTAL IMPACTS

DEFINITIONS

CP F10000: Control point in San Saba County

CP I10000: Control point near Austin in Travis County

CP J10000: Control point in Colorado County

CP K20000: Control point in Wharton County

CP K10000: Control point in Matagorda County

CP M10000: Control point at entrance to Matagorda Bay

Strategy Abbreviations

Strategy 1: Expand Contract

Strategy 2: Canyon Lake

Strategy 3: GBRA Pipeline

Strategy 4: Onion Creek

Strategy 5: Gold Channel Dam

Strategy 6: Gold Reservoir

Strategy 7: HB 1437

Strategy 8: Desalination

Strategy 9: LSWP

Strategy 10: COA Return Flow

Strategy 11: COA Reuse

Strategy 12: Amend Irrigation

Strategy 13: Excess Flows

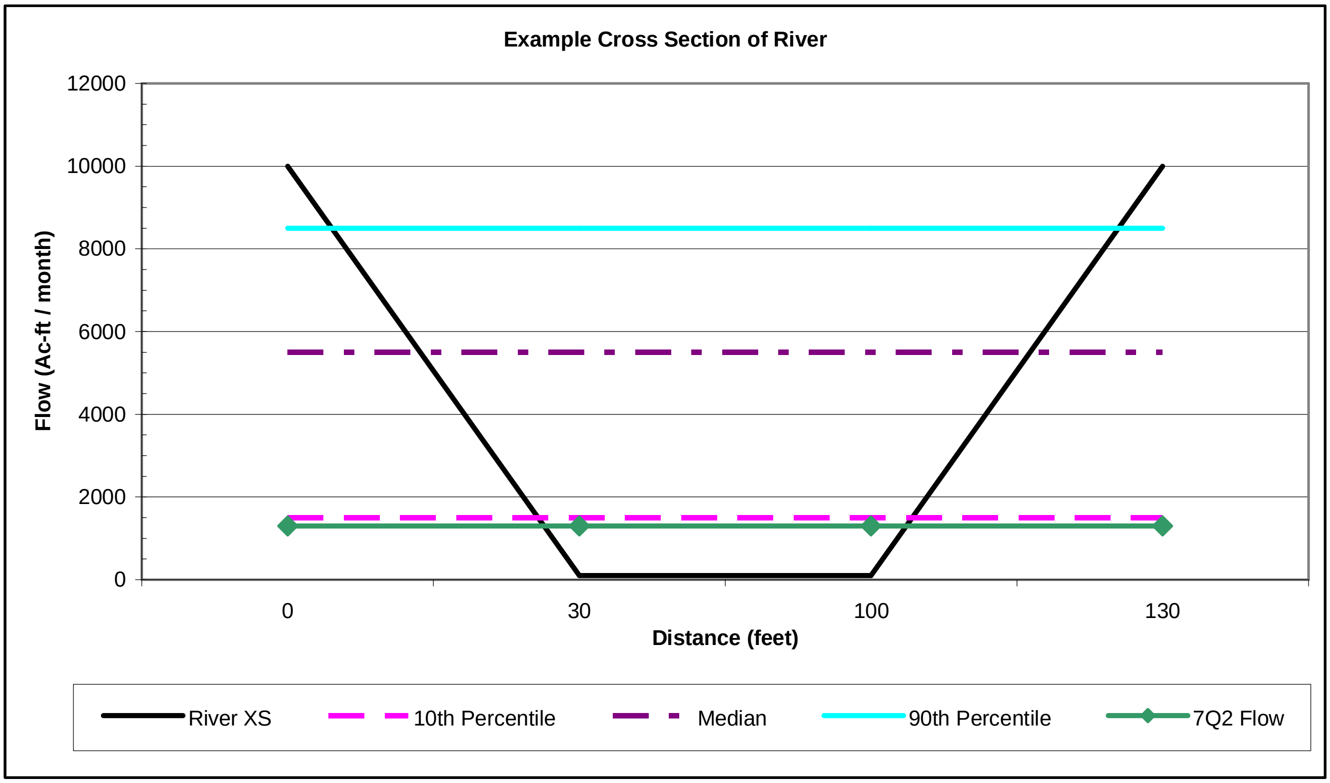
Strategy 14: Comprehensive

10th Percentile: The 10th percentile value for a set of values states that at least ten percent (10%) of the values in the set are less than or equal to this value.

90th Percentile: The 90th percentile value for a set of values states that at least ninety percent (90%) of the values in the set are less than or equal to this value.

Median: The middle value in a set of statistical values that are arranged in ascending or descending order. Equal to the 50th percentile.

7Q2 Flow: The lowest average discharge over a period of one week (7 days) with a recurrence interval of 2 years, based on historical data.



Bay and Estuary Target and Critical Inflow Needs

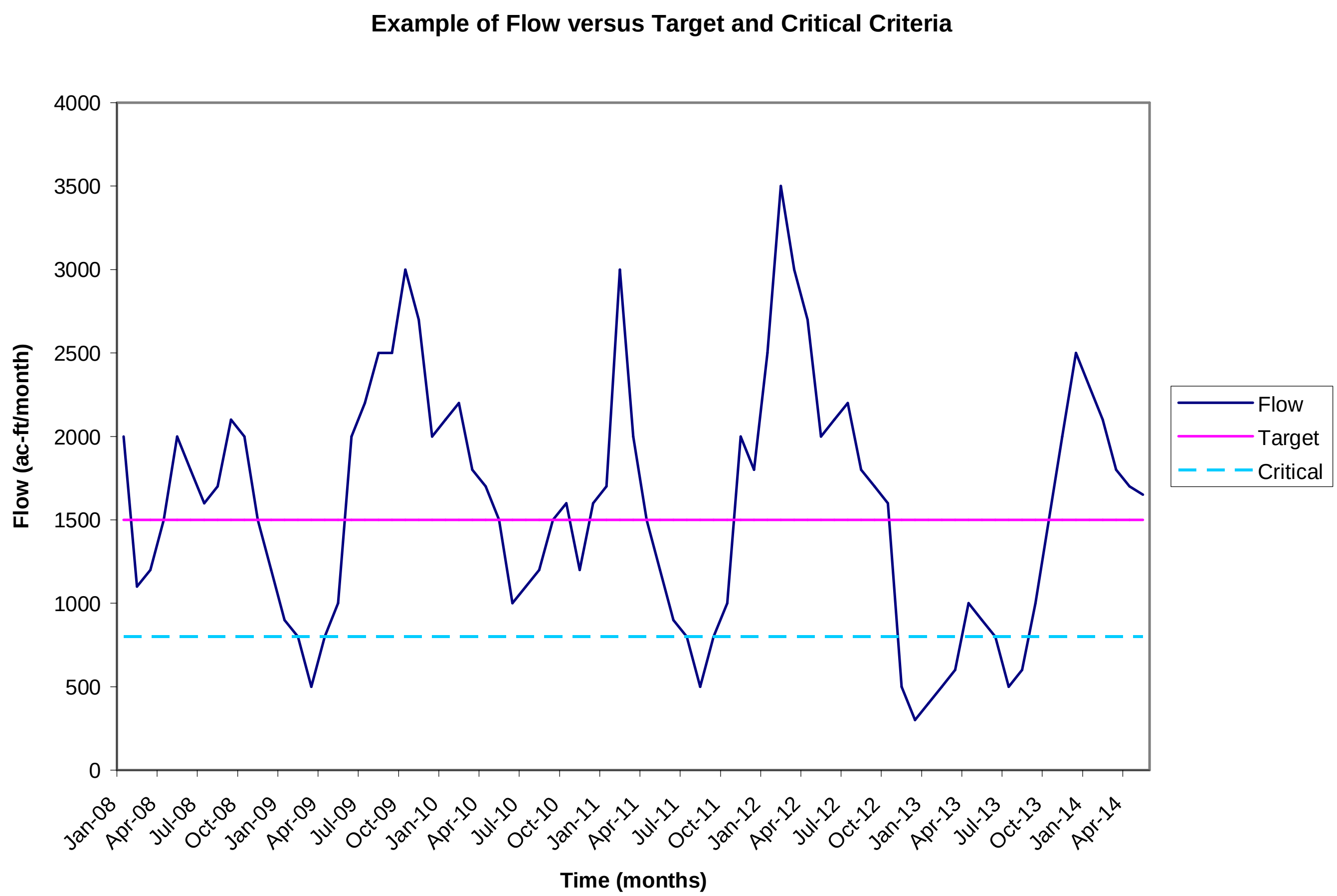
	Bay and Estuary Flow Targets (ac-ft) from 2006 FINS											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Target	205,600	194,500	63,200	60,400	255,400	210,500	108,400	62,000	61,900	71,300	66,500	68,000
Critical	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000

CP J10000 (Colorado County) Instream Flow Target and Critical Needs from LCRA WMP

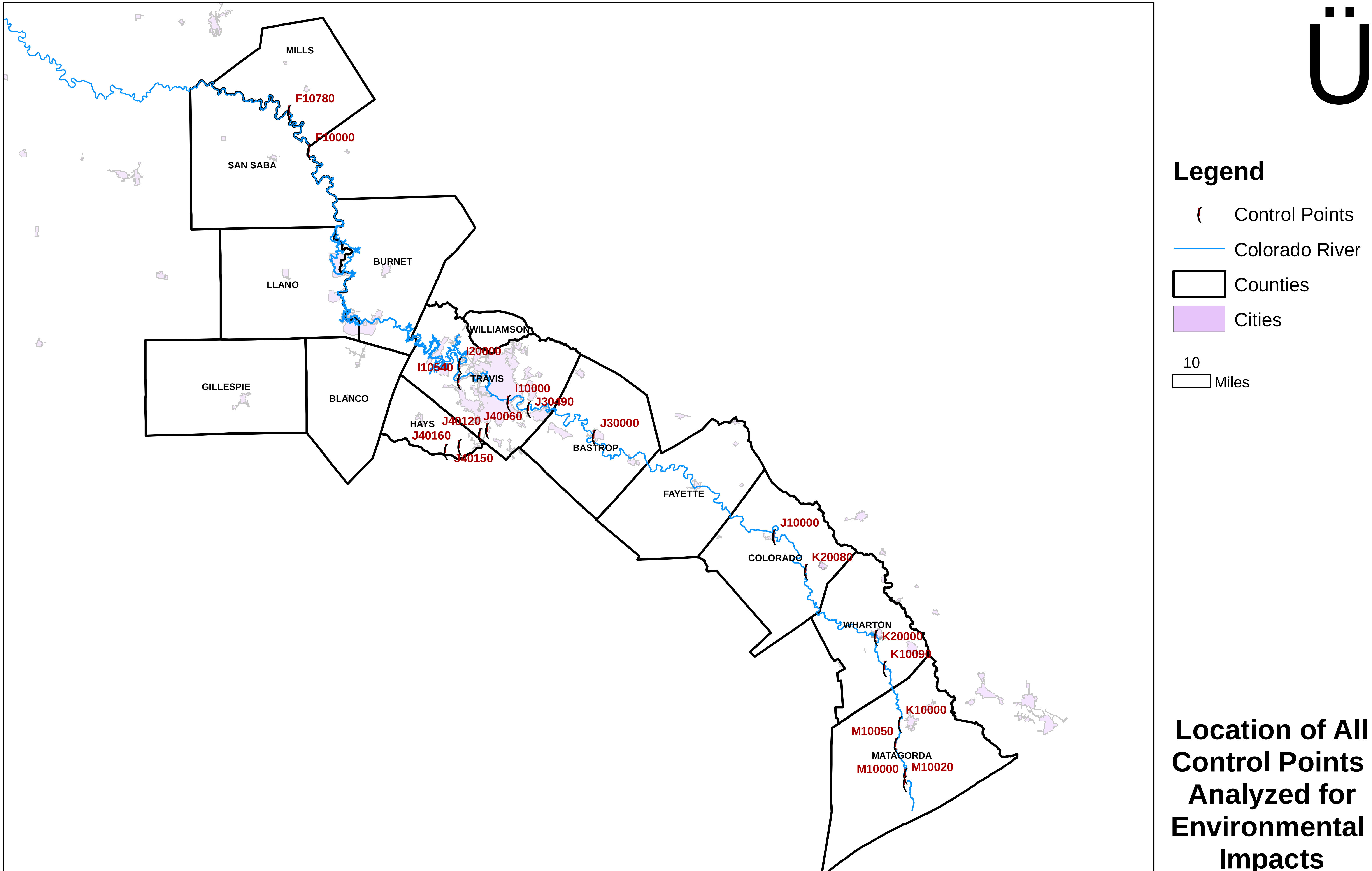
	CP J10000 Instream Flow Targets (ac-ft) from LCRA WMP											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Target	18,446	18,883	30,744	29,752	50,420	39,273	18,446	12,298	19,041	23,365	17,256	16,602
Critical	7,379	6,664	30,744	29,752	30,744	7,140	7,379	7,379	7,140	7,379	7,140	7,379

CP K20000 (Wharton County) Instream Flow Target Needs from LCRA WMP

	CP K20000 Instream Flow Targets (ac-ft) from LCRA WMP											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Target	14,757	15,550	22,136	23,207	41,197	32,132	14,757	9,838	15,471	19,061	14,281	13,527



Number of times flow falls below Target line: 6
Number of times flow falls below Critical line: 4
Duration equals the number of months the flow graph stays below the target or critical line.
Volume equals the flow per month multiplied by the number of months below the target or critical line.

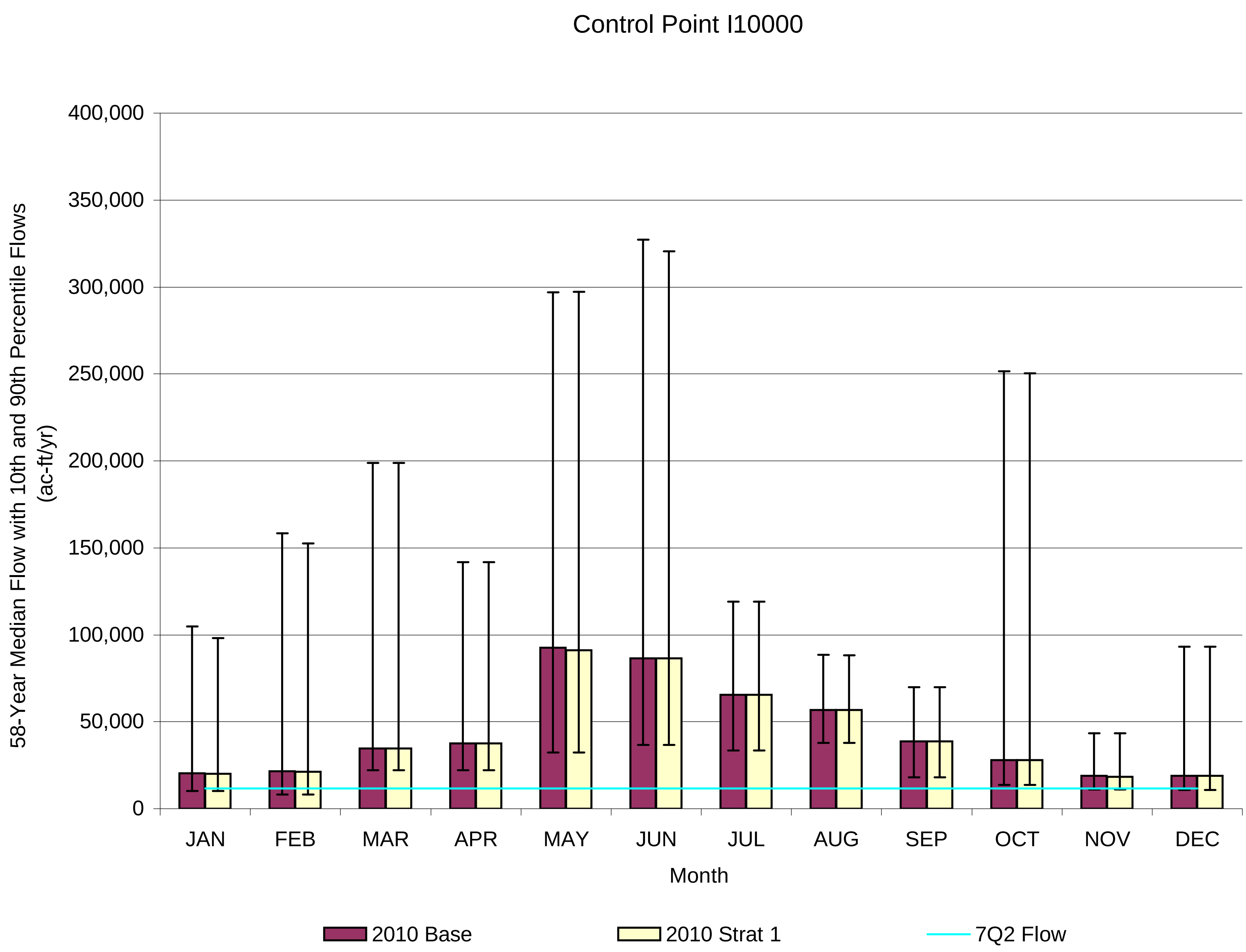


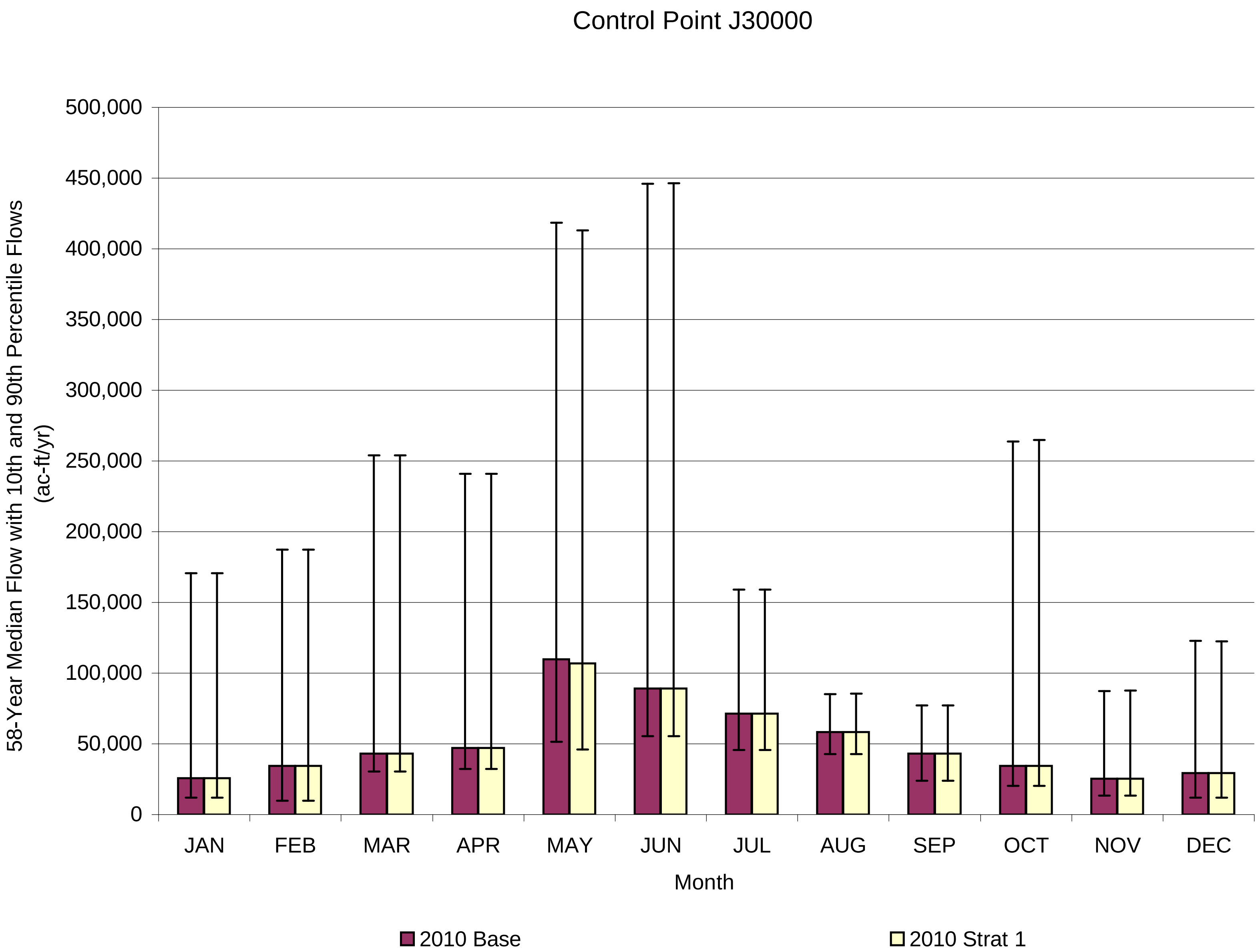
Location of All Control Points Analyzed for Environmental Impacts

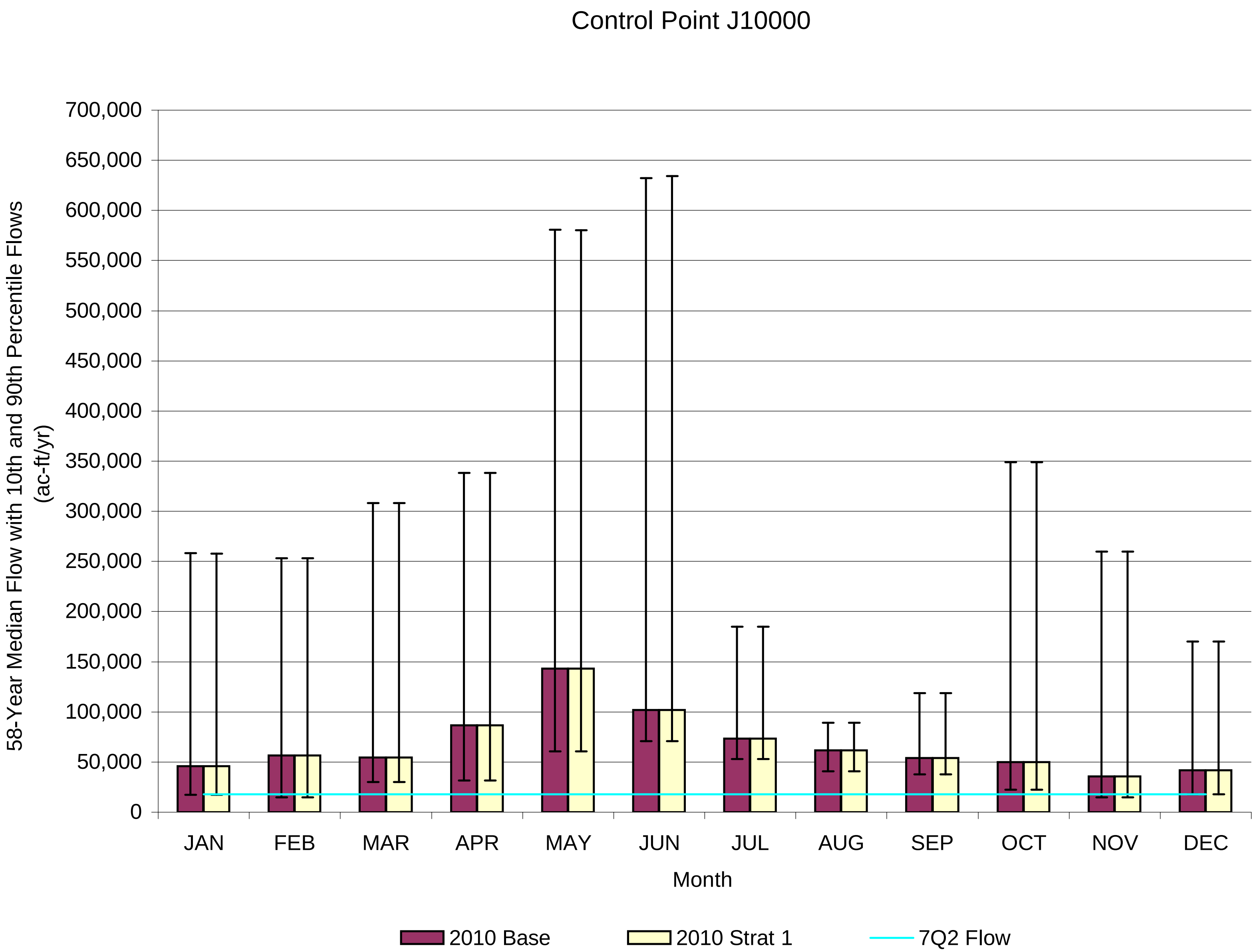
APPENDIX C

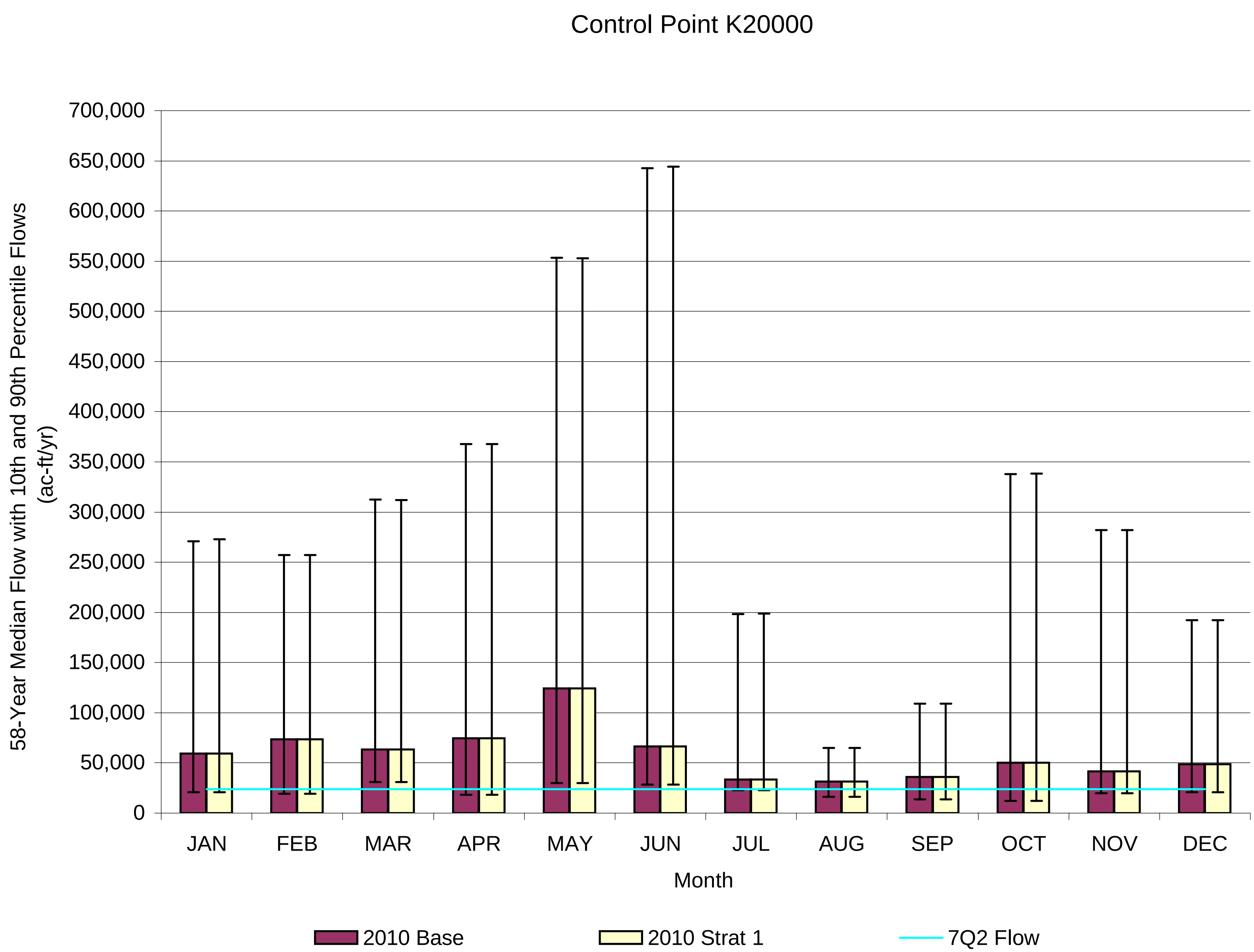
IMPACT COMPARISON GRAPHS AT VARIOUS CONTROL POINTS FOR EACH STRATEGY

STRATEGY 1
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2010 AND 2060


Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 1
7Q2 Flow


Control Point J30000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 1


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 1
7Q2 Flow


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows
(ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
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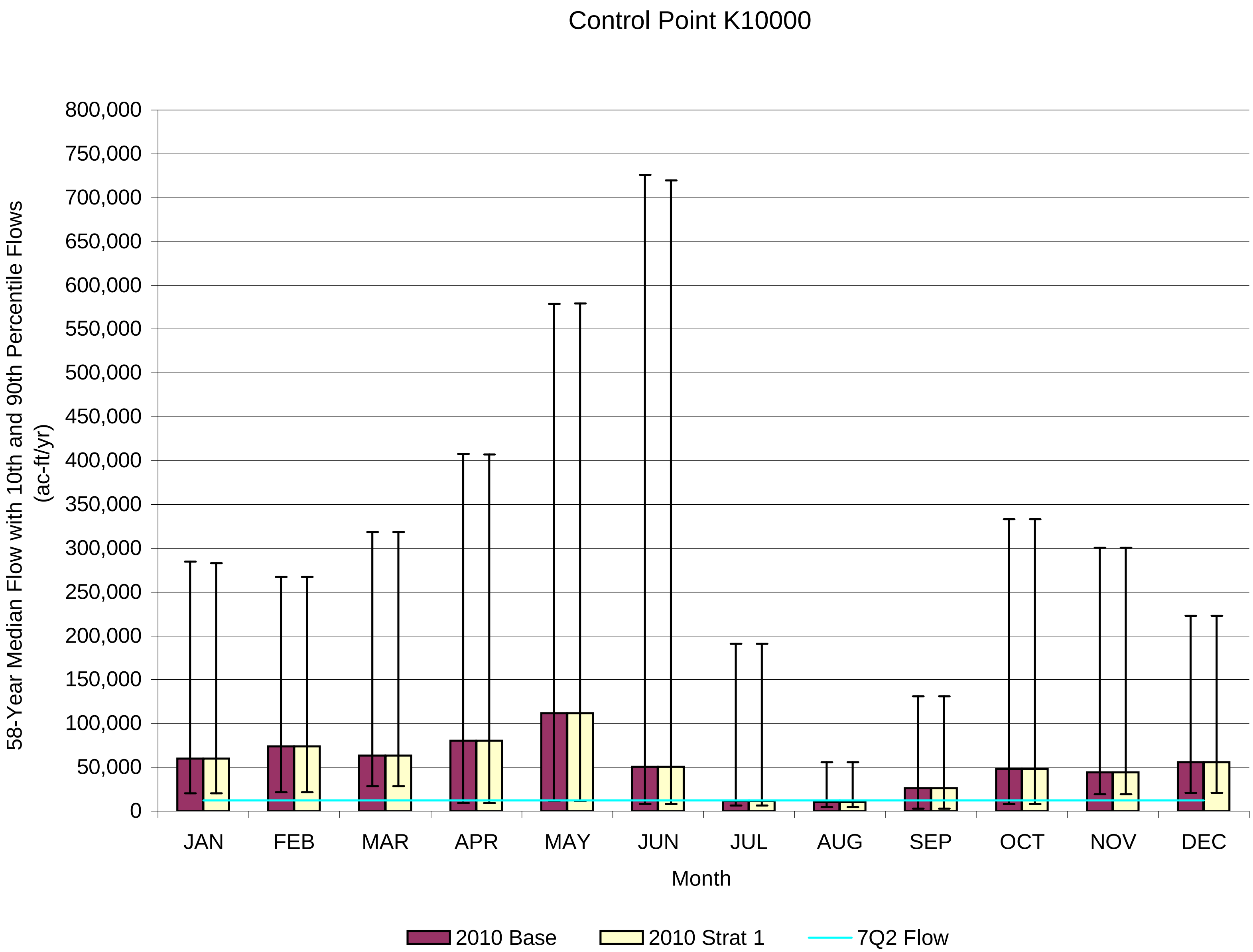
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 1
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
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JUN
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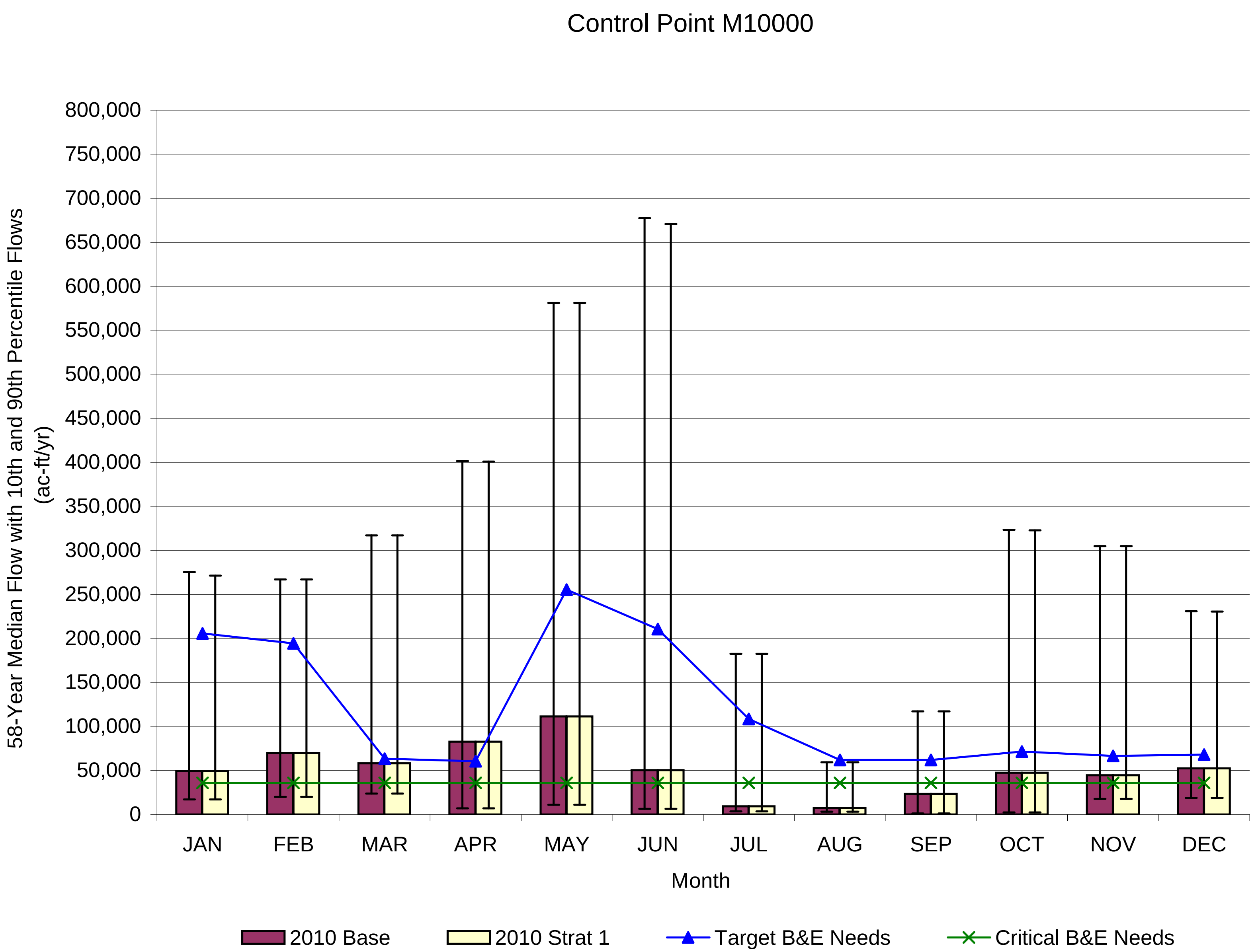
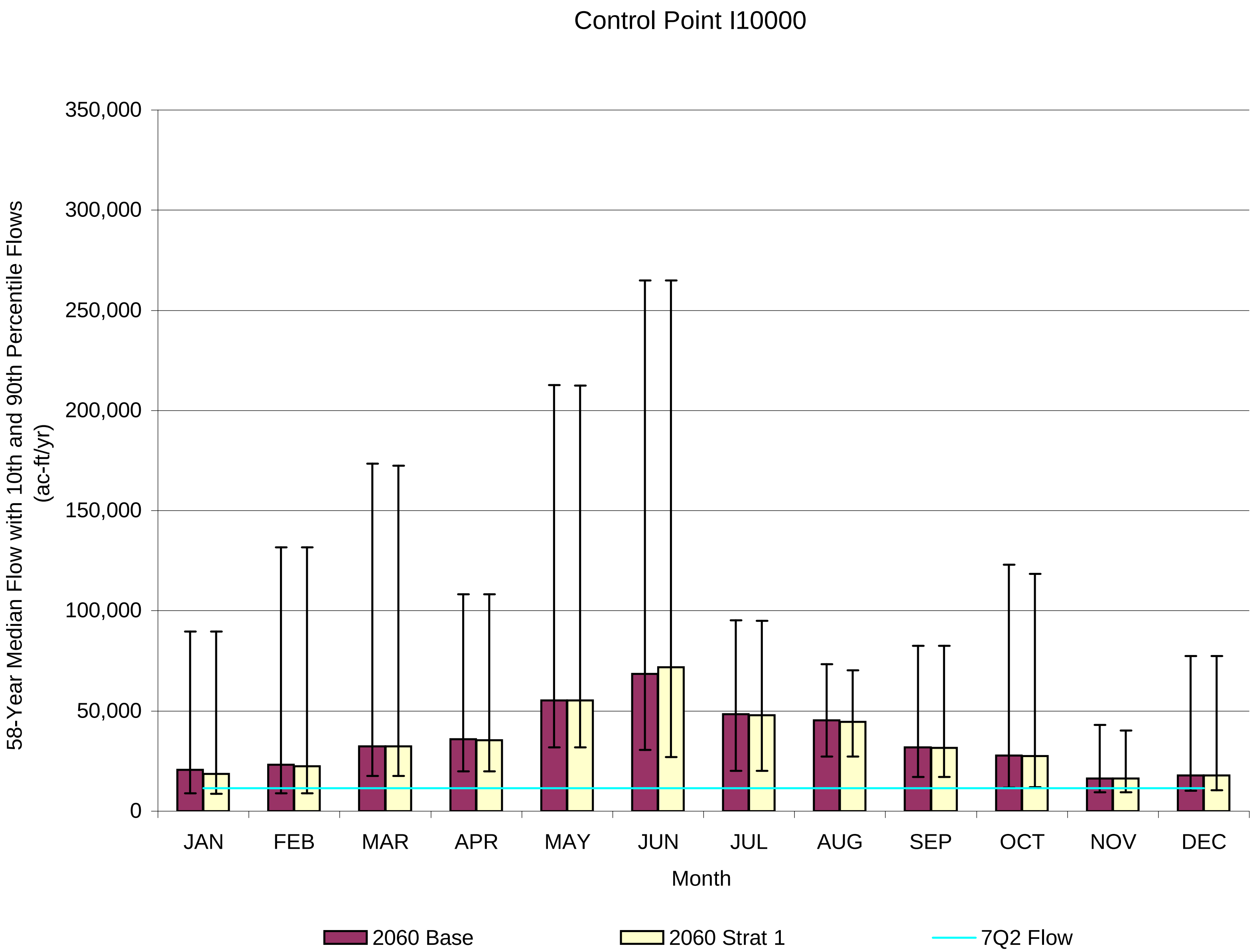
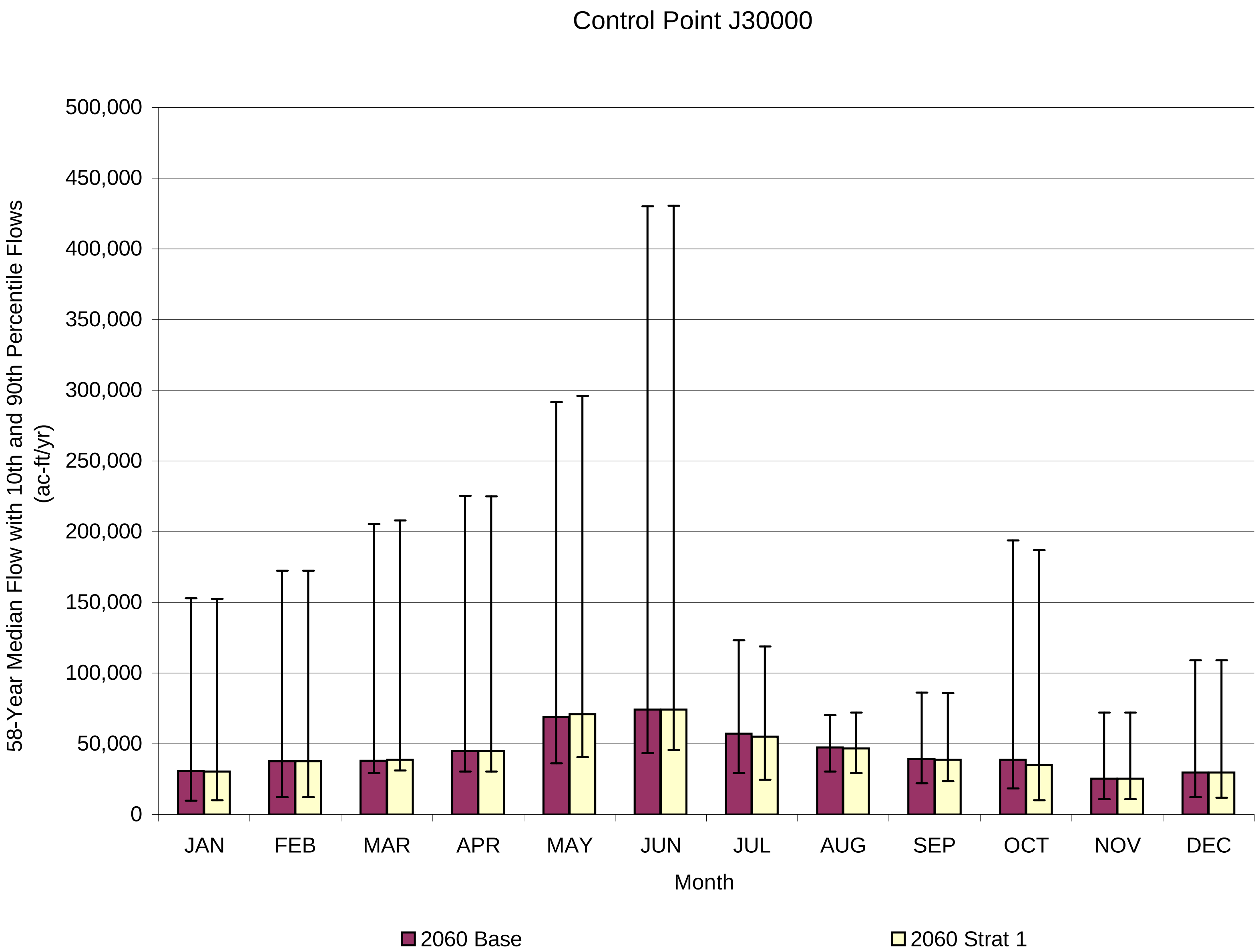
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 1
7Q2 Flow


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 1
Target B&E Needs
Critical B&E Needs


Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 1
7Q2 Flow


Control Point J30000
58-Year Median Flow with 10th and 90th Percentile Flows
(ac-ft/yr)
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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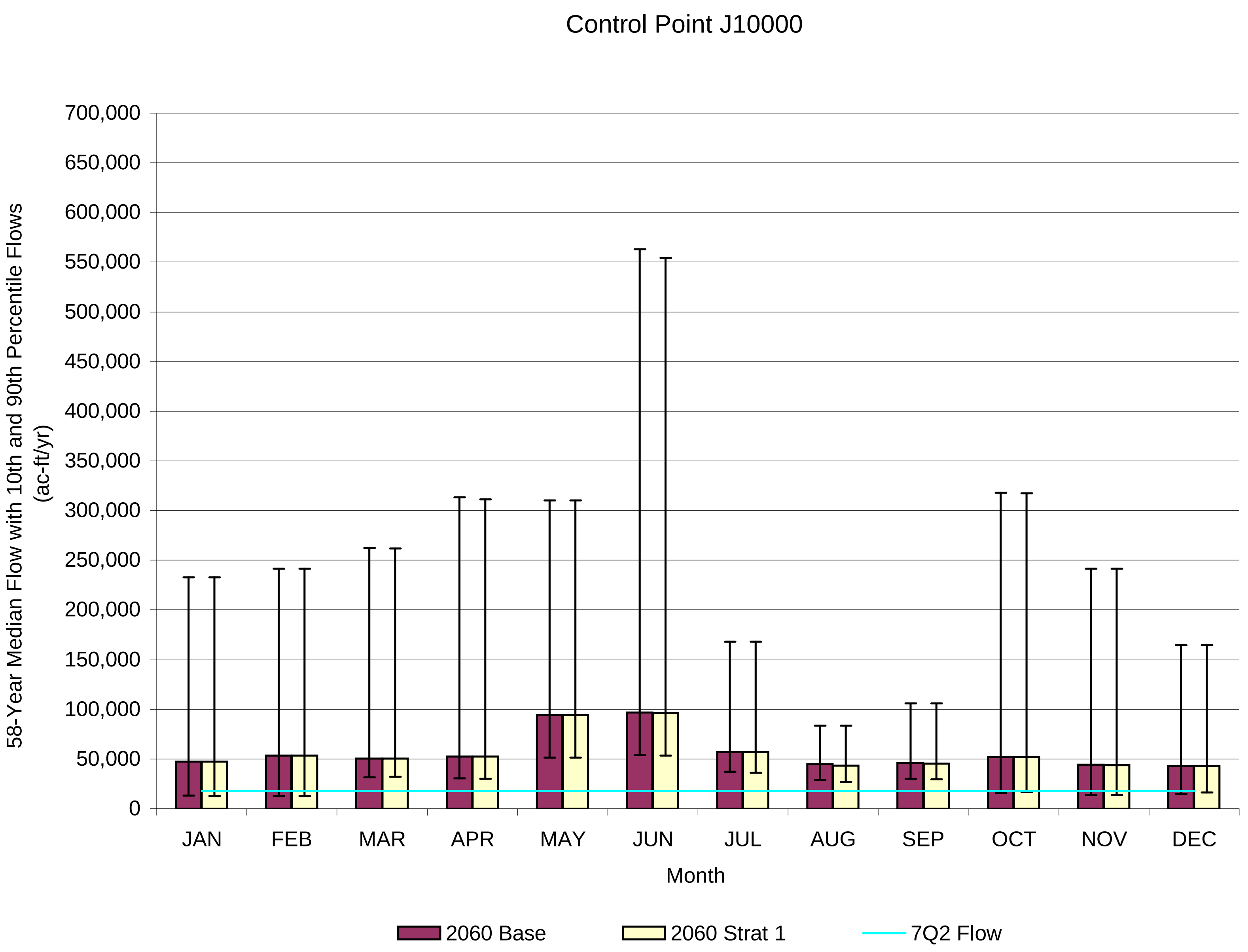
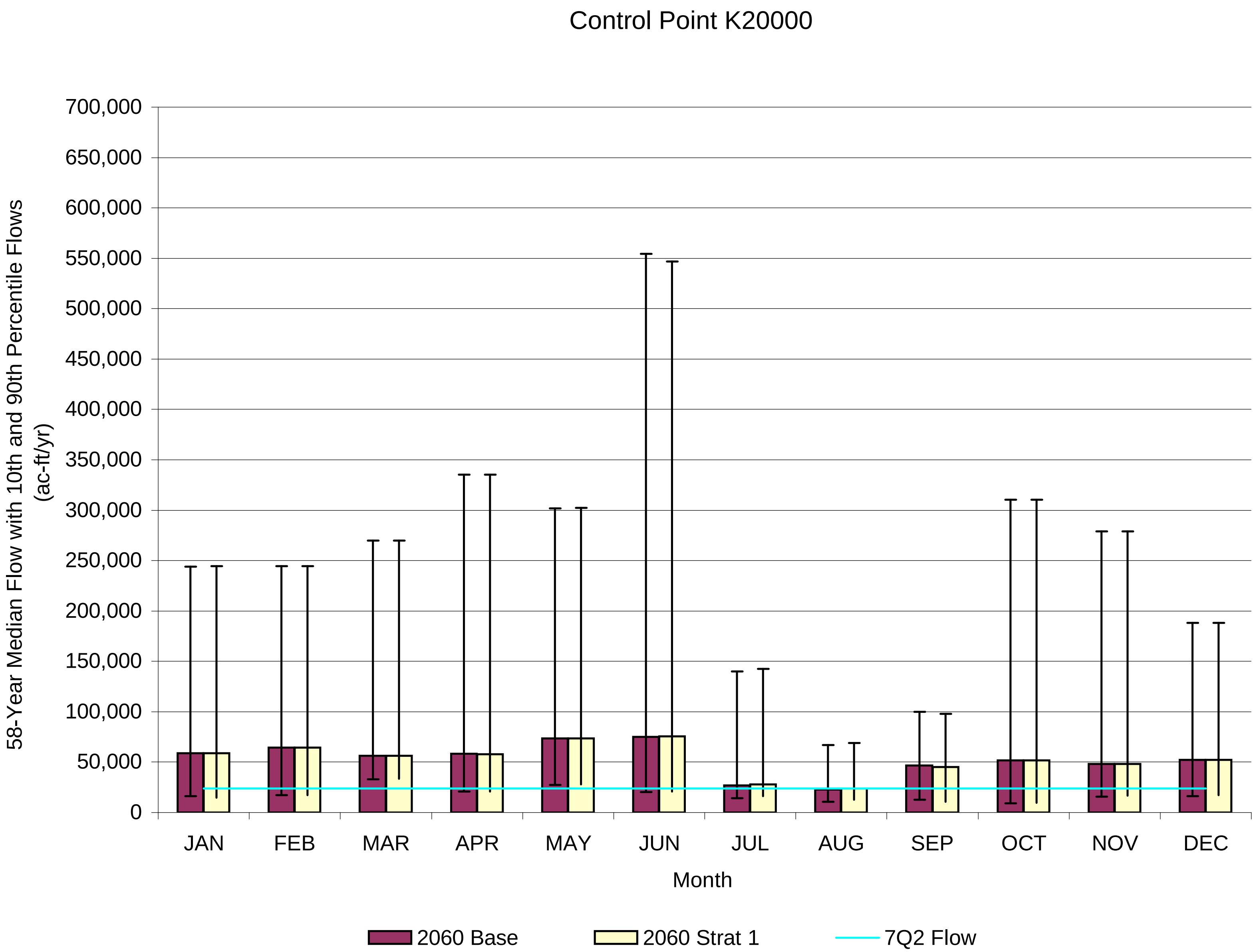
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 1


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 1
7Q2 Flow


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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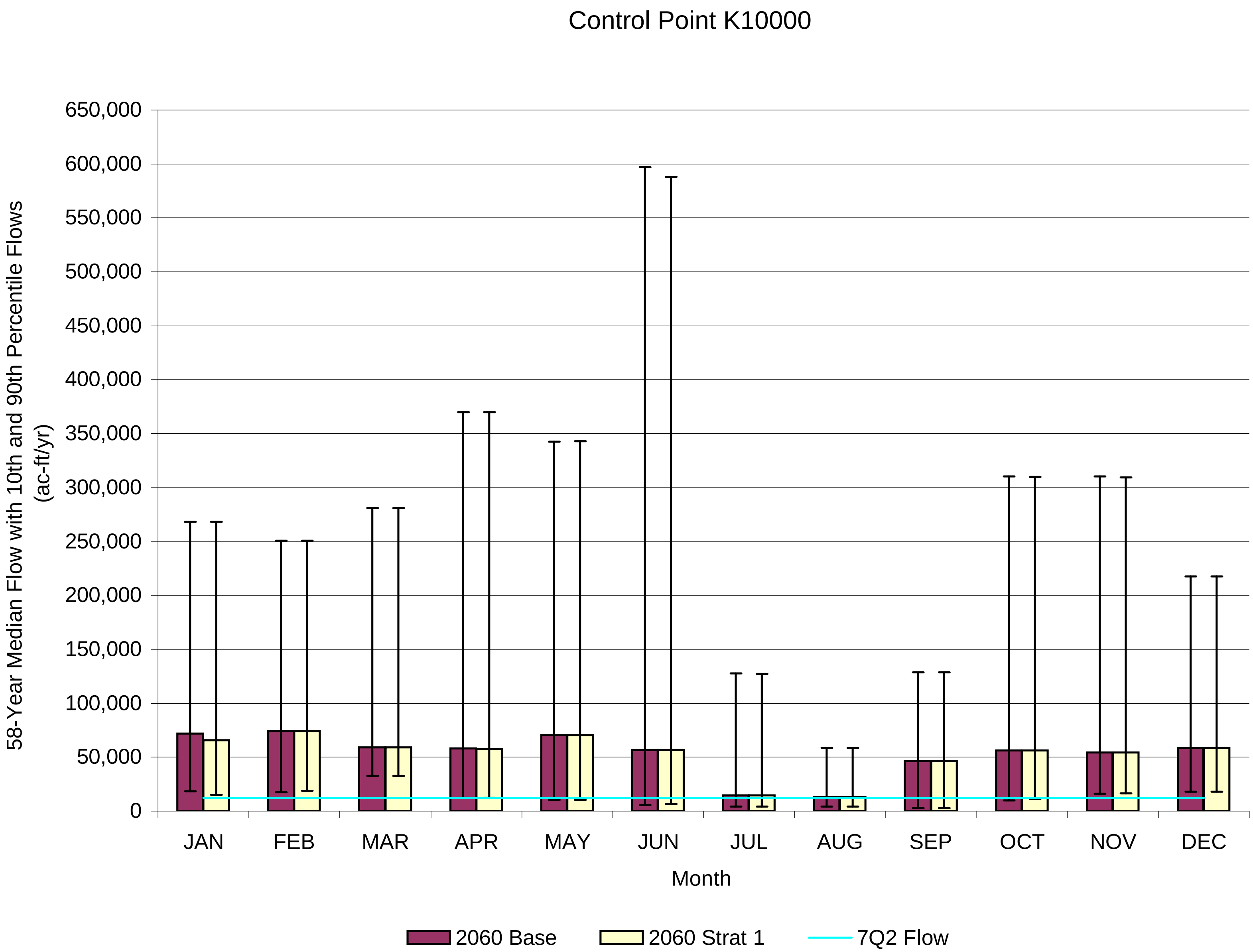
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 1
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
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APR
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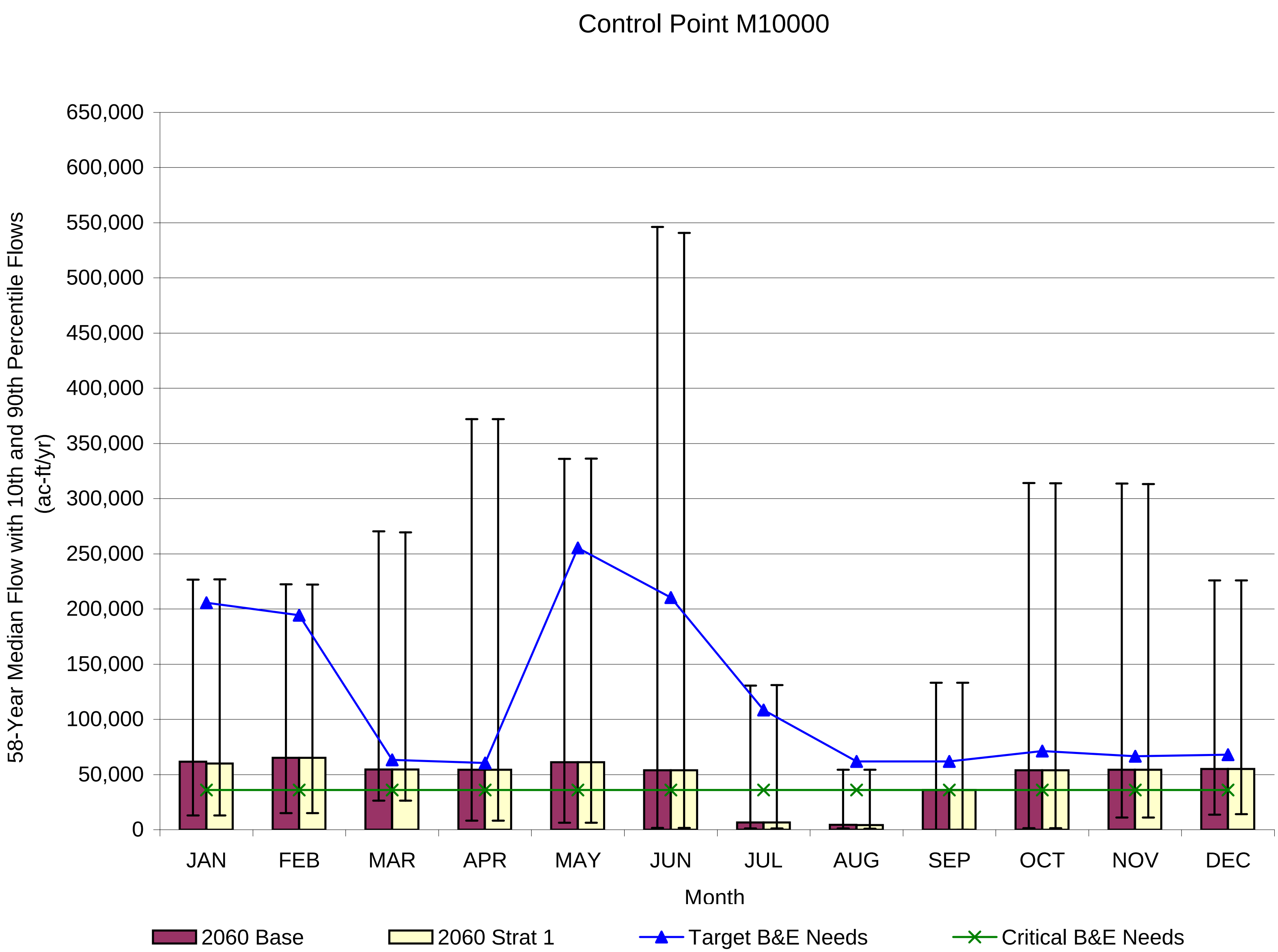
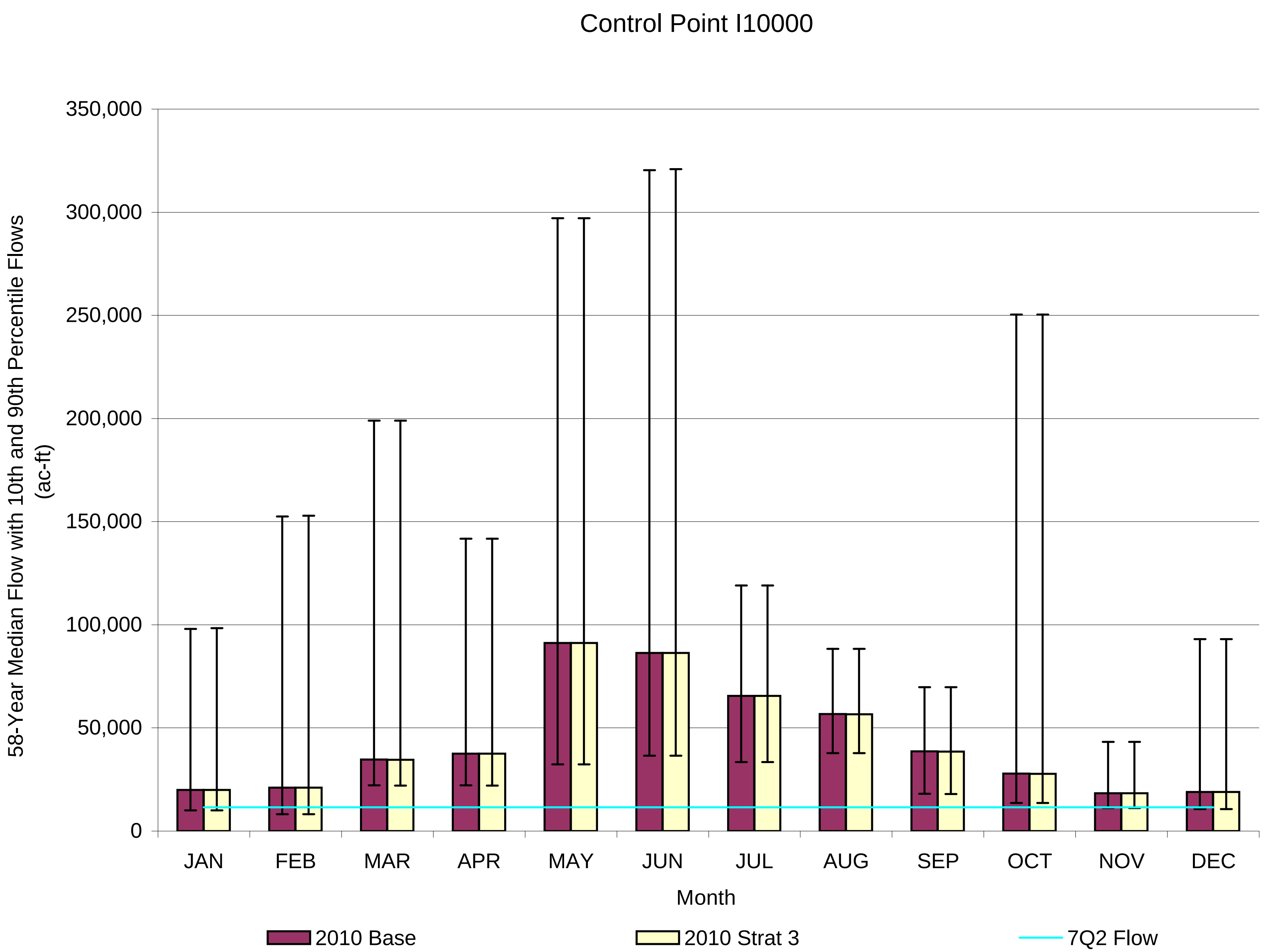
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 1
7Q2 Flow


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 1
Target B&E Needs
Critical B&E Needs

STRATEGY 3
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2010 AND 2060


Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
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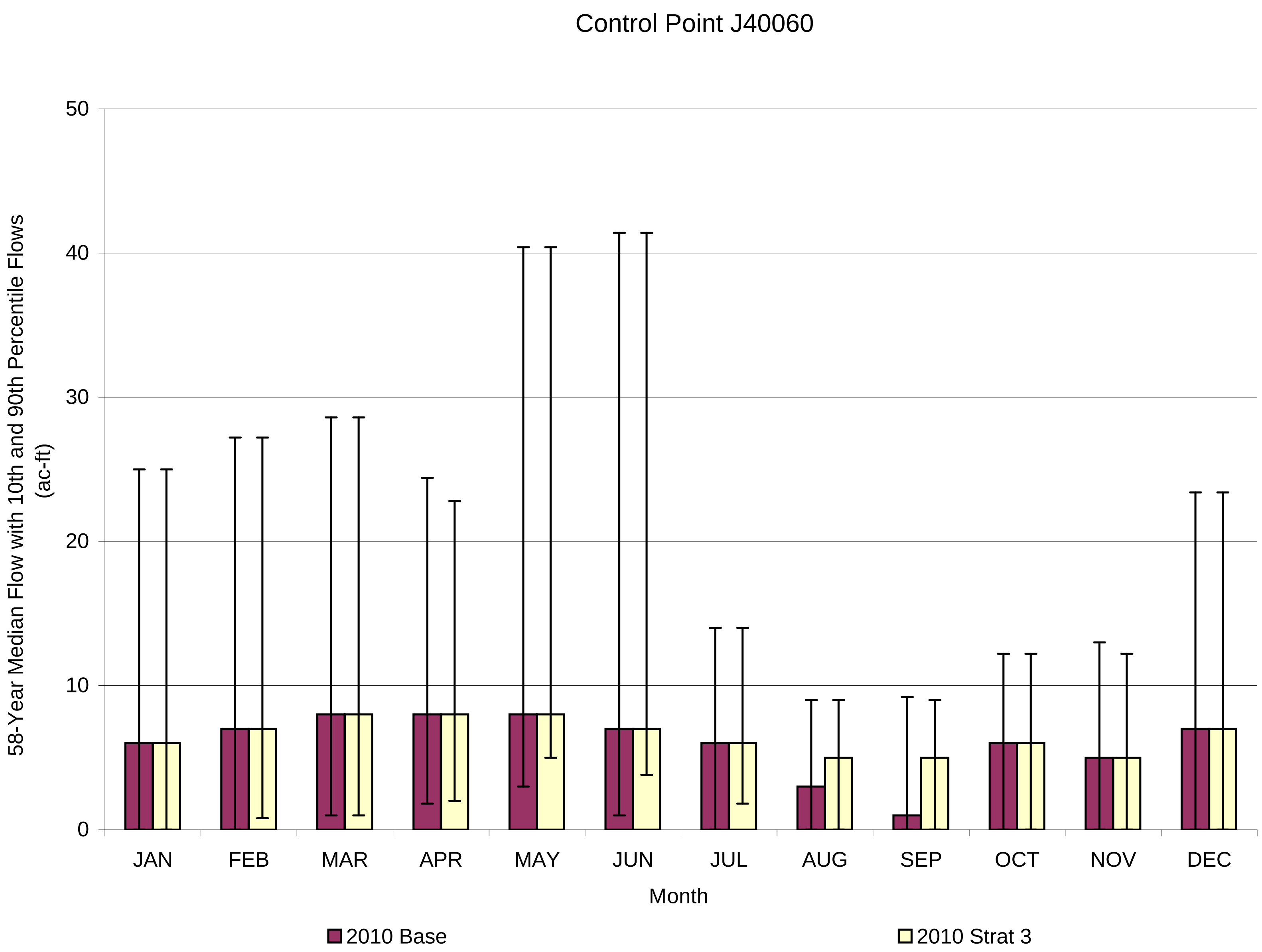
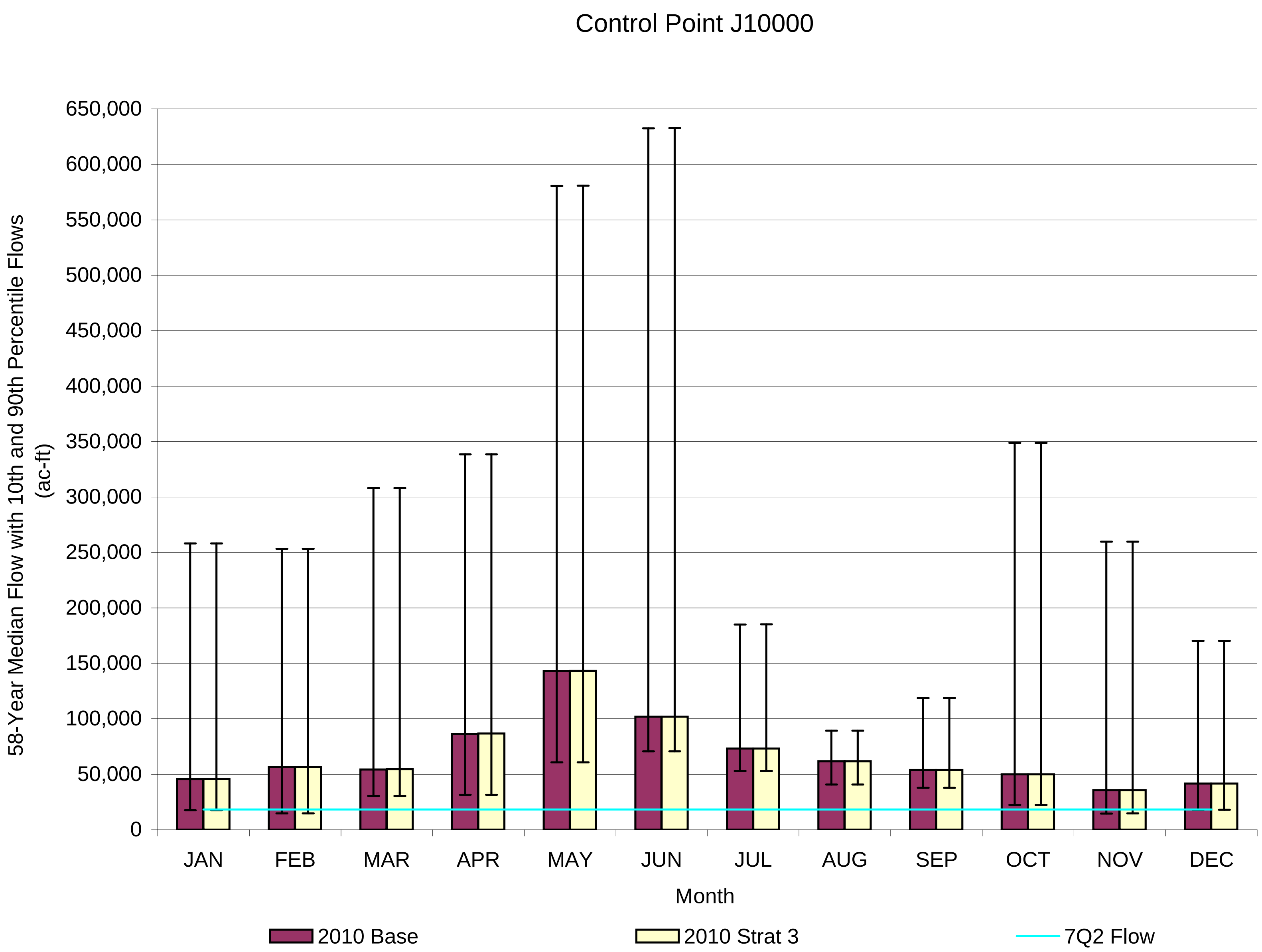
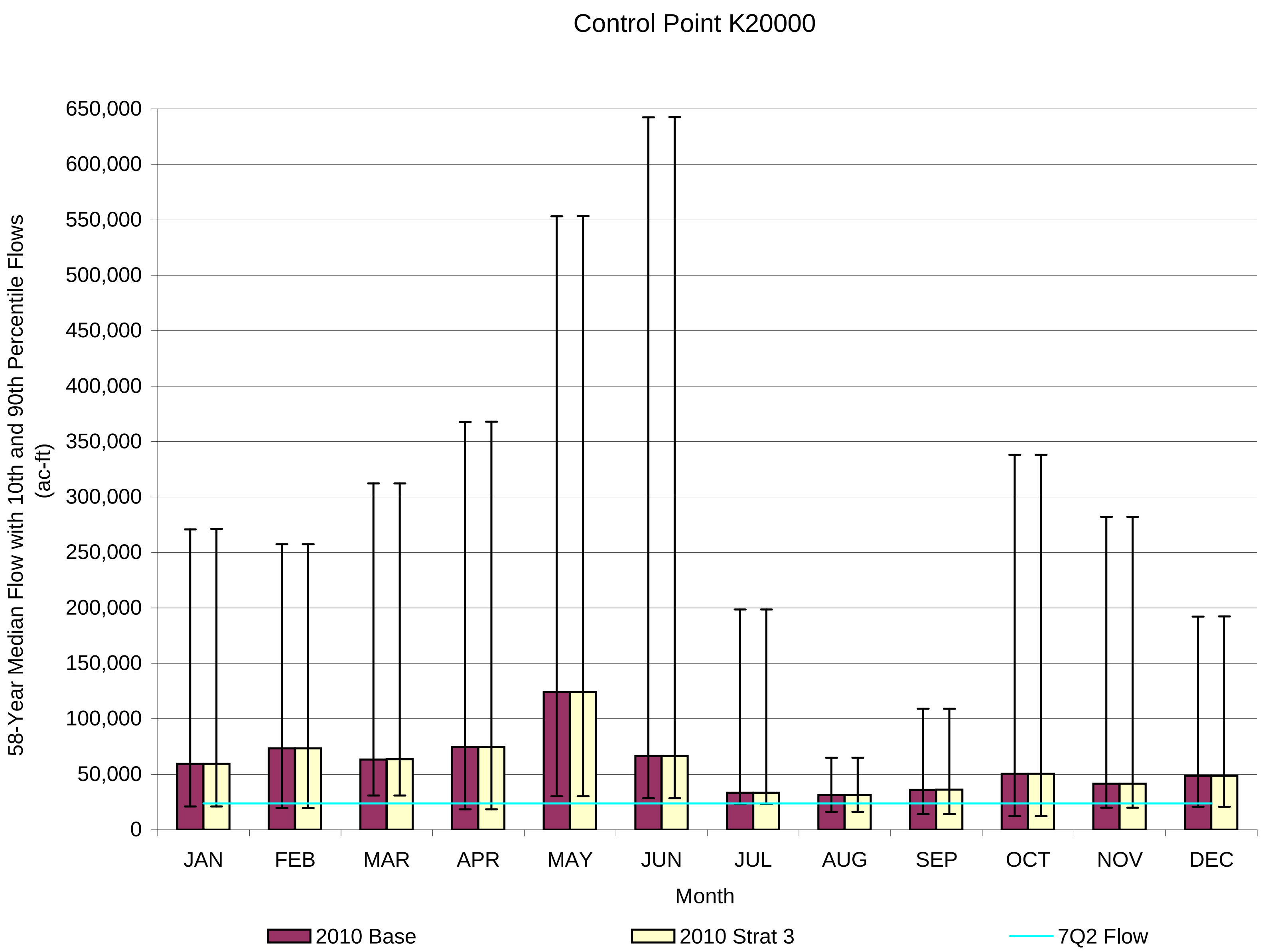
NOV
DEC
Month
2010 Base
2010 Strat 3
7Q2 Flow


Control Point J40060
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
0
10
20
30
40
50
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 3


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 3
7Q2 Flow


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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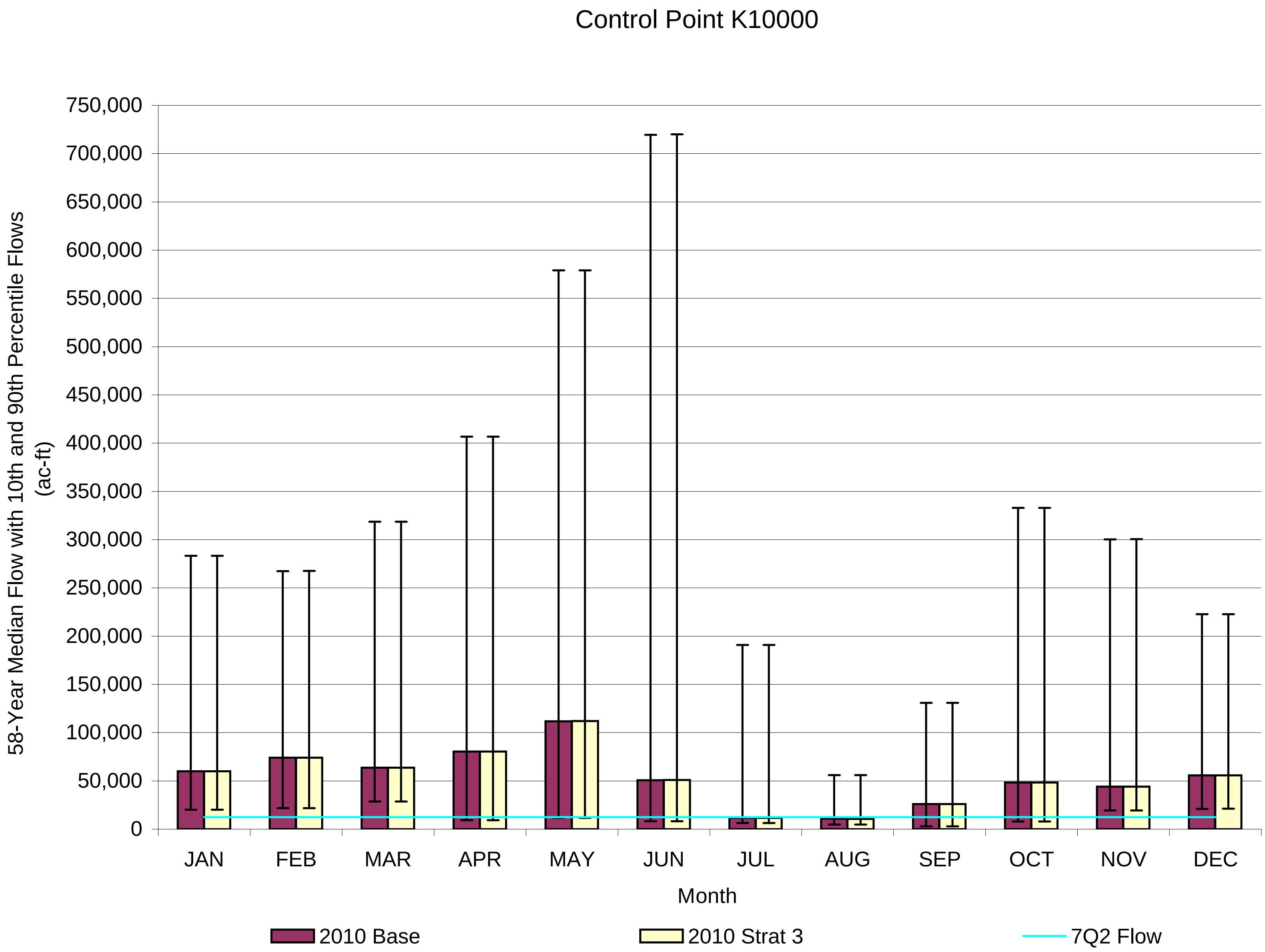
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 3
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
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JUN
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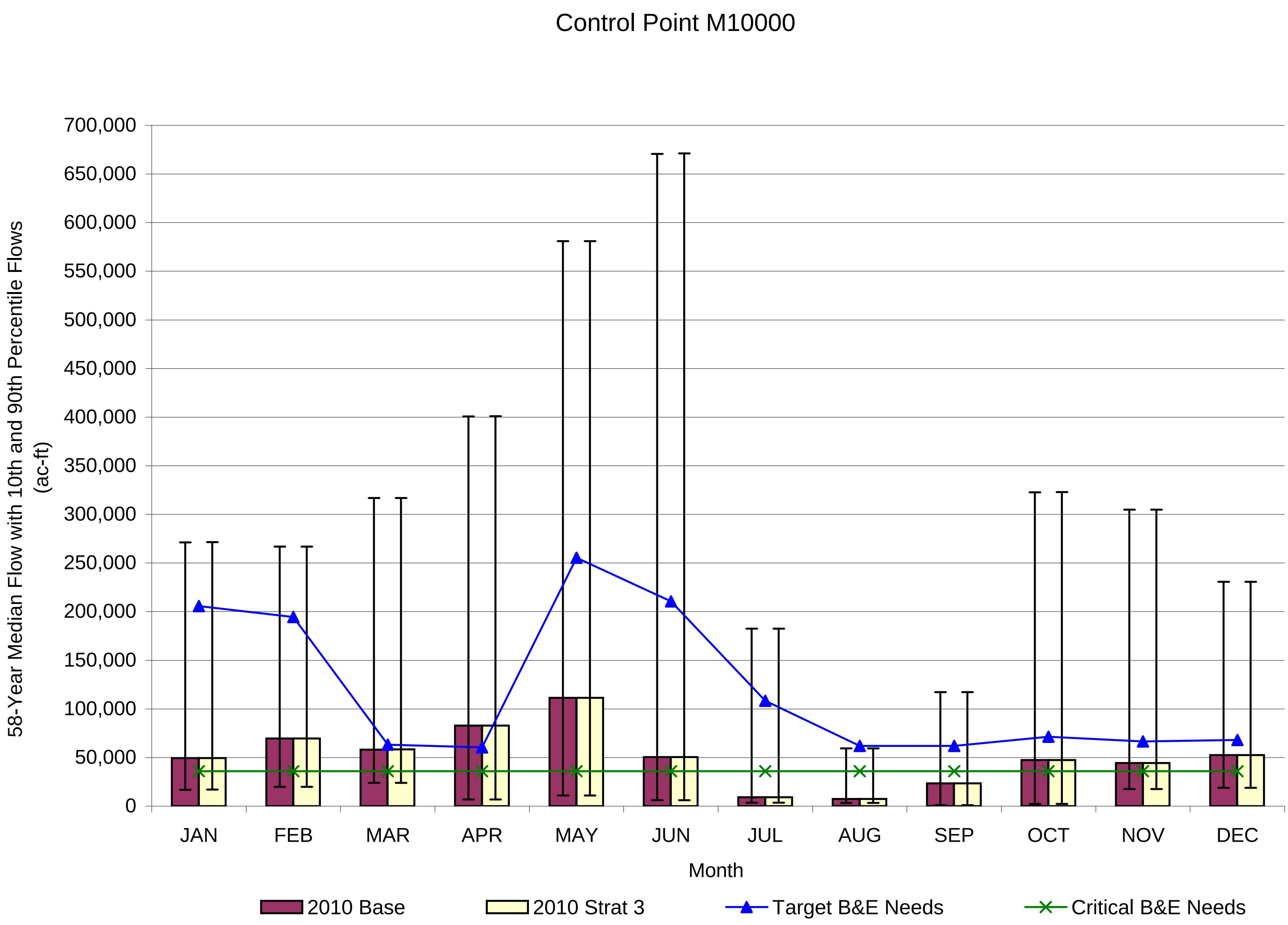
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 3
7Q2 Flow



Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
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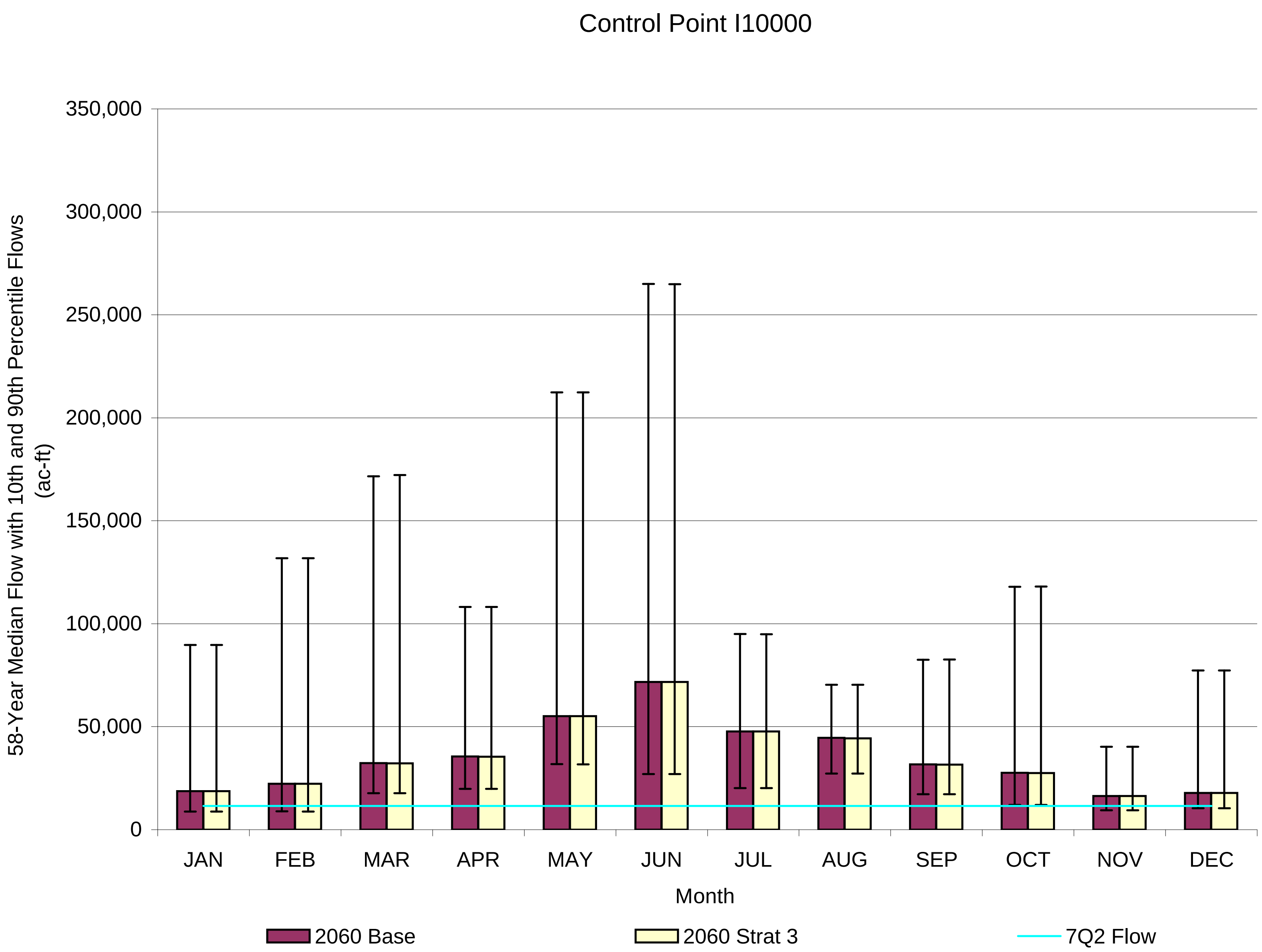
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 3
Target B&E Needs
Critical B&E Needs


Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
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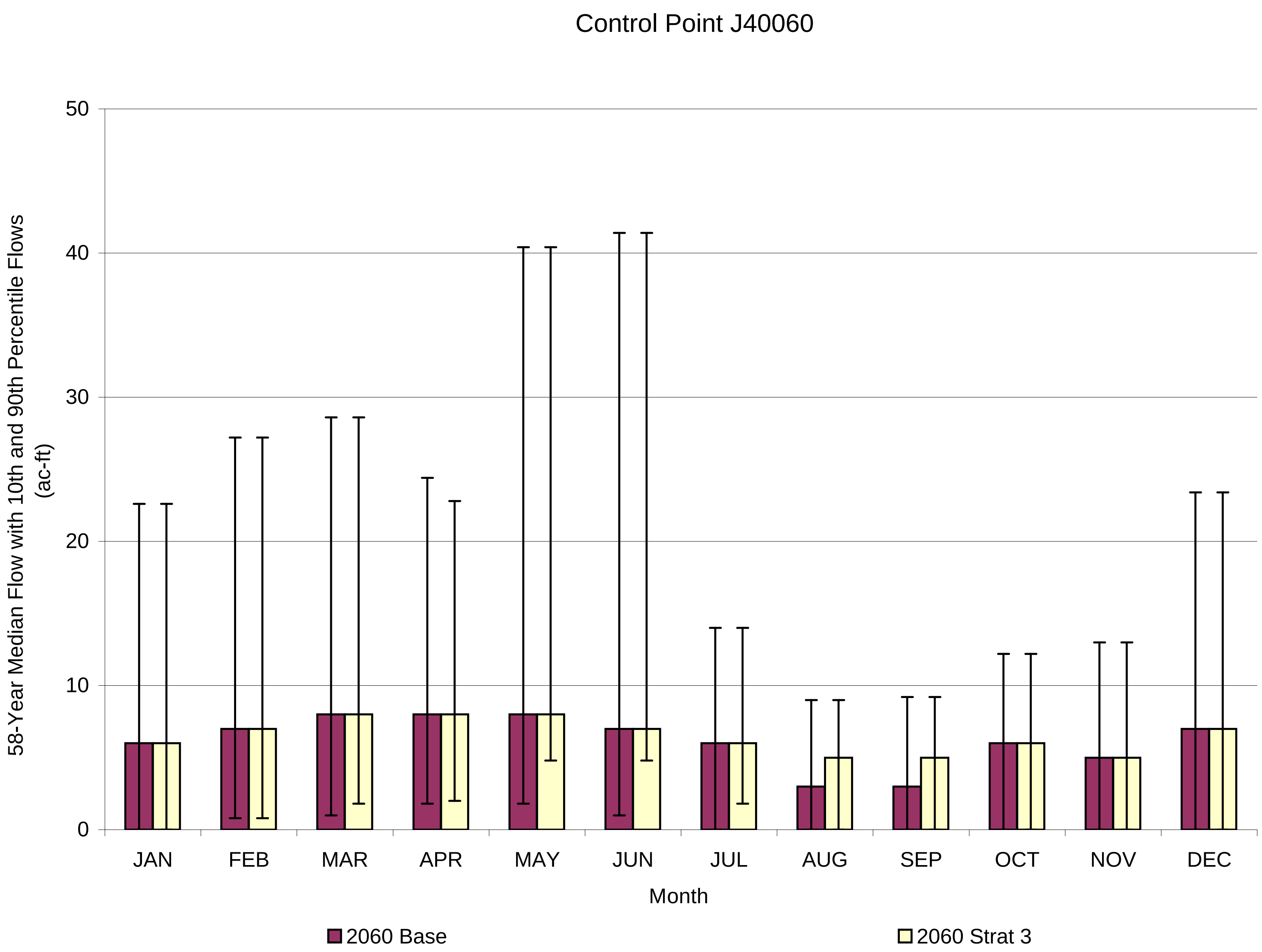
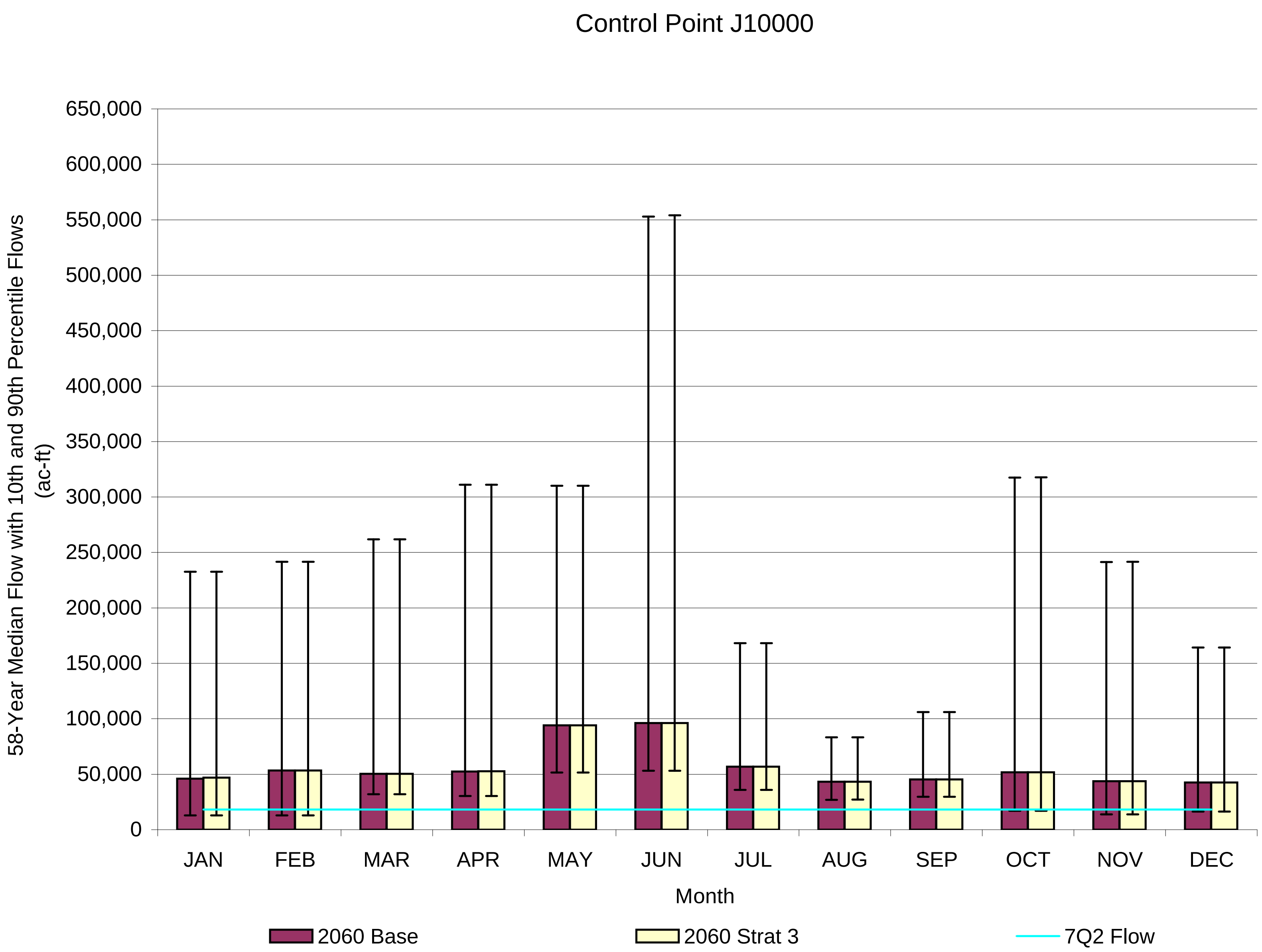
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 3
7Q2 Flow


Control Point J40060
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
0
10
20
30
40
50
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 3



Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
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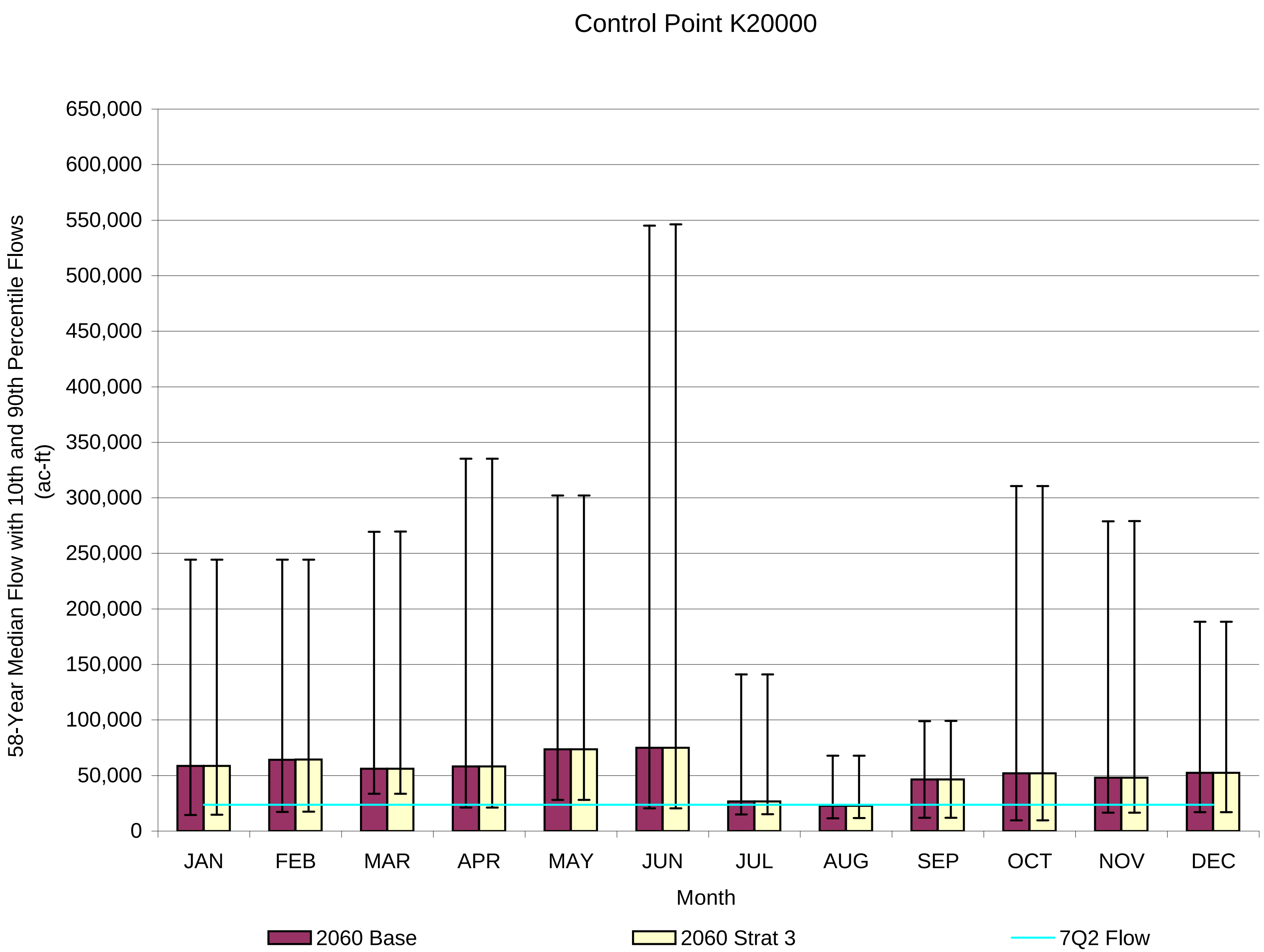
OCT
NOV
DEC
Month
2060 Base
2060 Strat 3
7Q2 Flow


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
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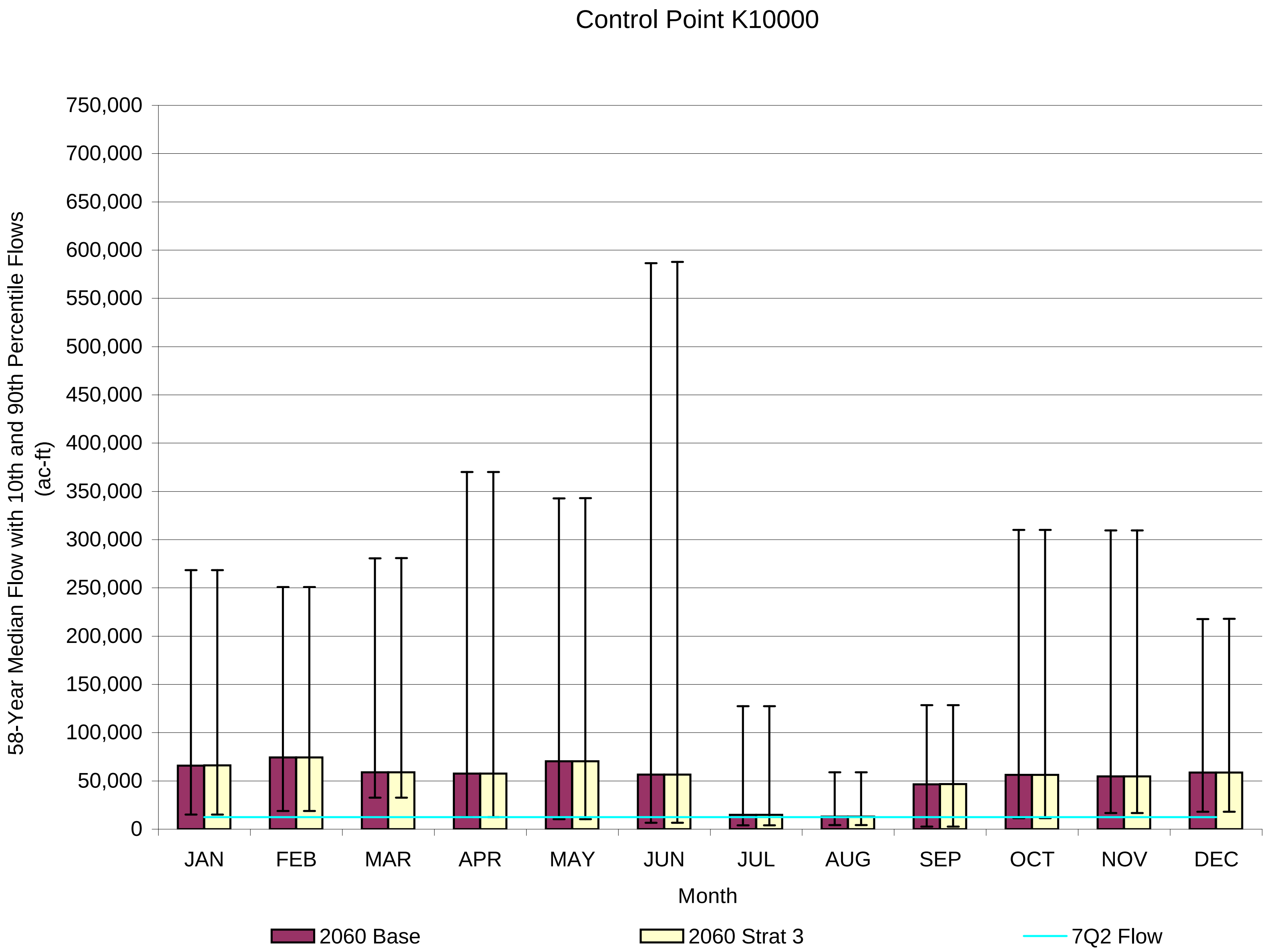
DEC
Month
2060 Base
2060 Strat 3
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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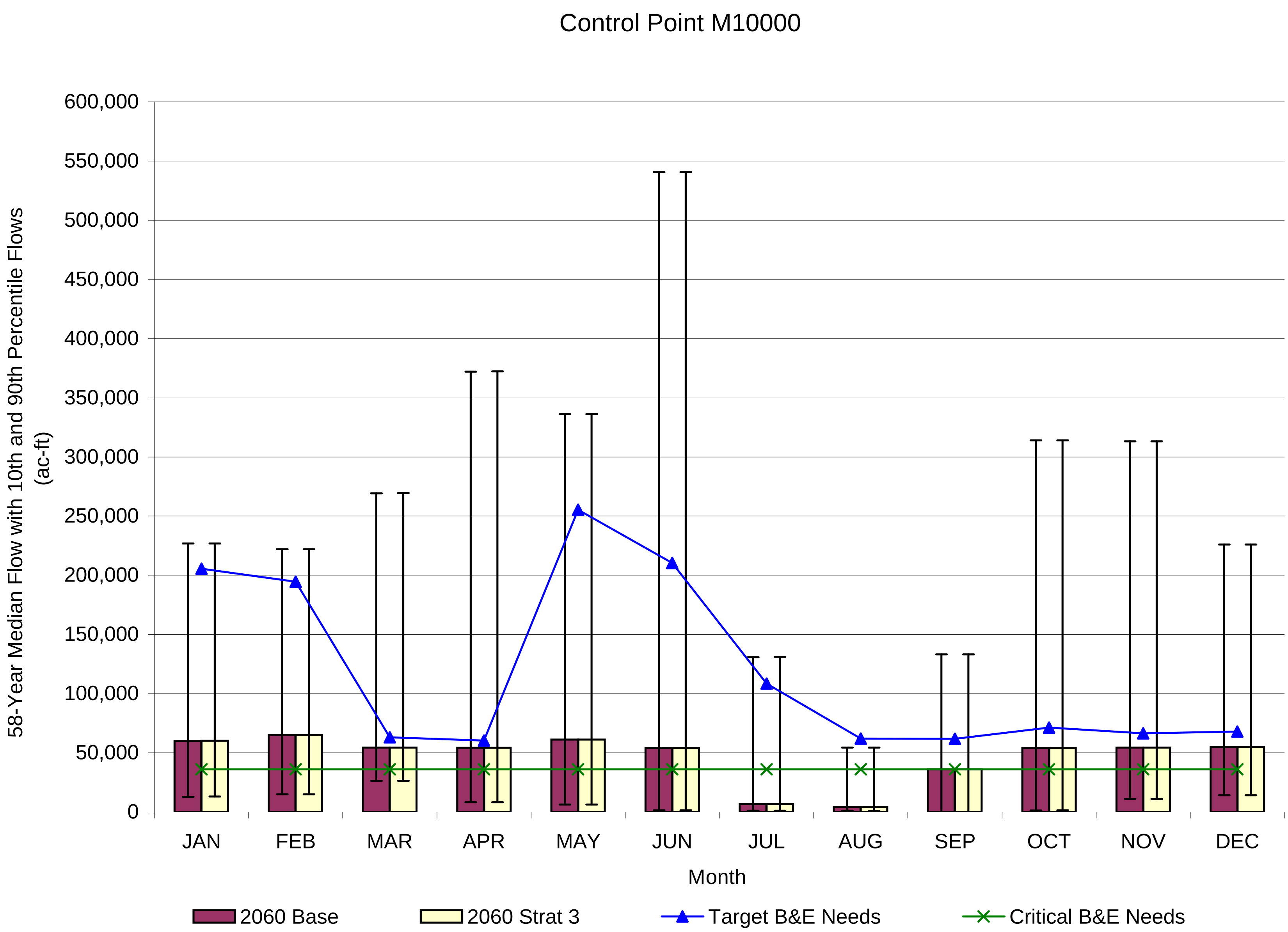
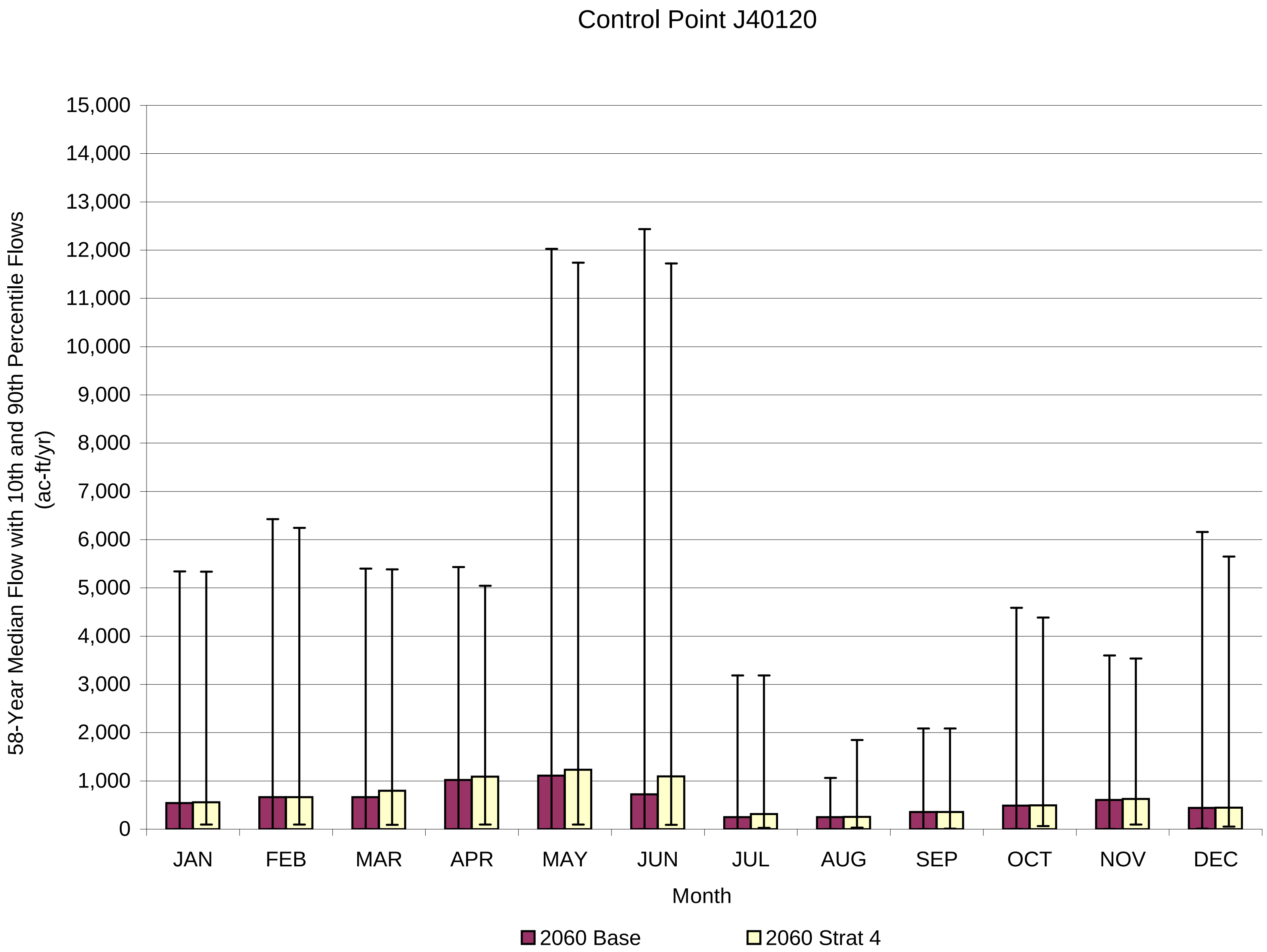
DEC
Month
2060 Base
2060 Strat 3
7Q2 Flow


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 3
Target B&E Needs
Critical B&E Needs

STRATEGY 4
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2060


Control Point J40120
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
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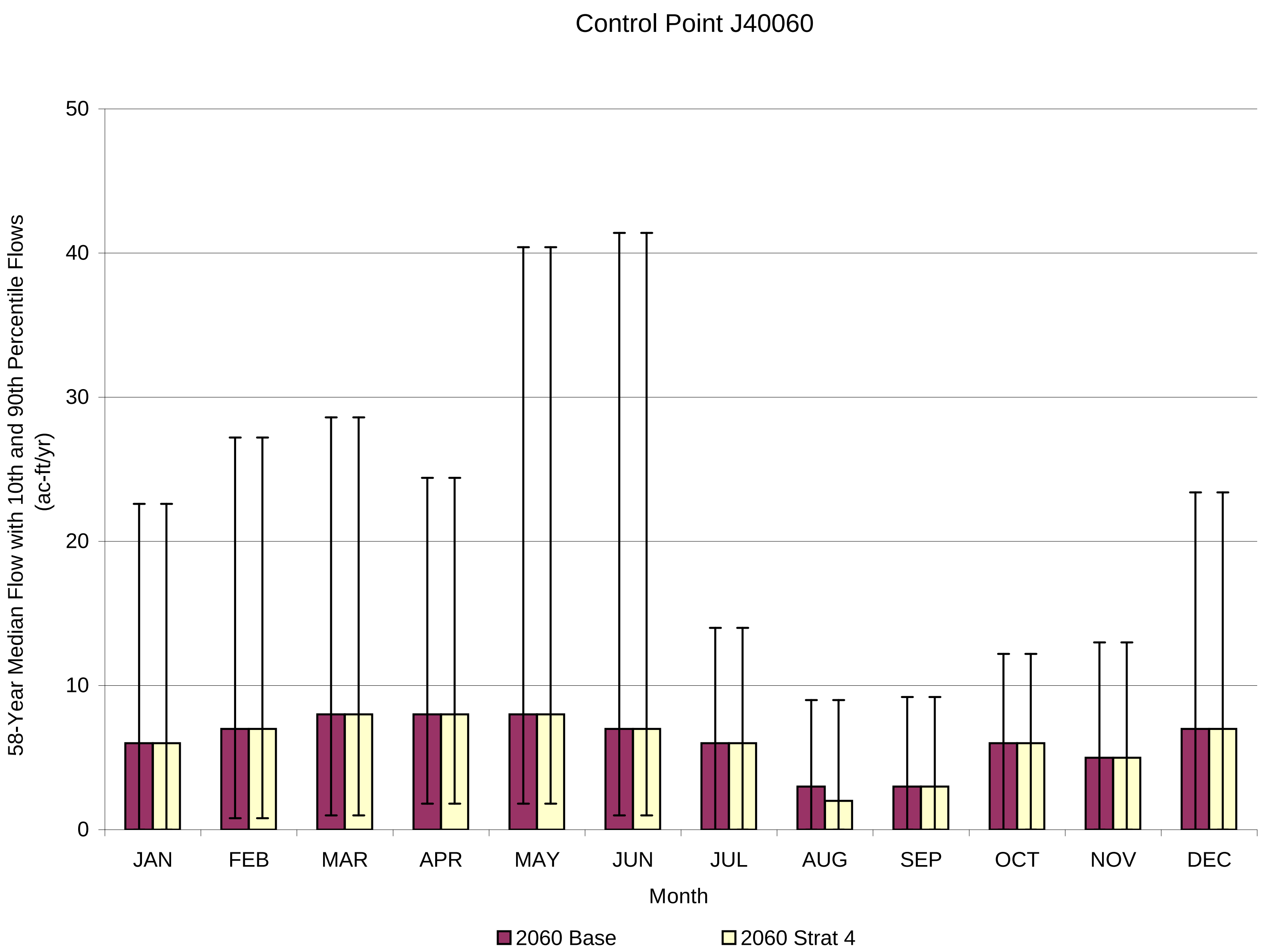
OCT
NOV
DEC
Month
2060 Base
2060 Strat 4


Control Point J40060
58-Year Median Flow with 10th and 90th Percentile Flows
(ac-ft/yr)
0
10
20
30
40
50
JAN
FEB
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MAY
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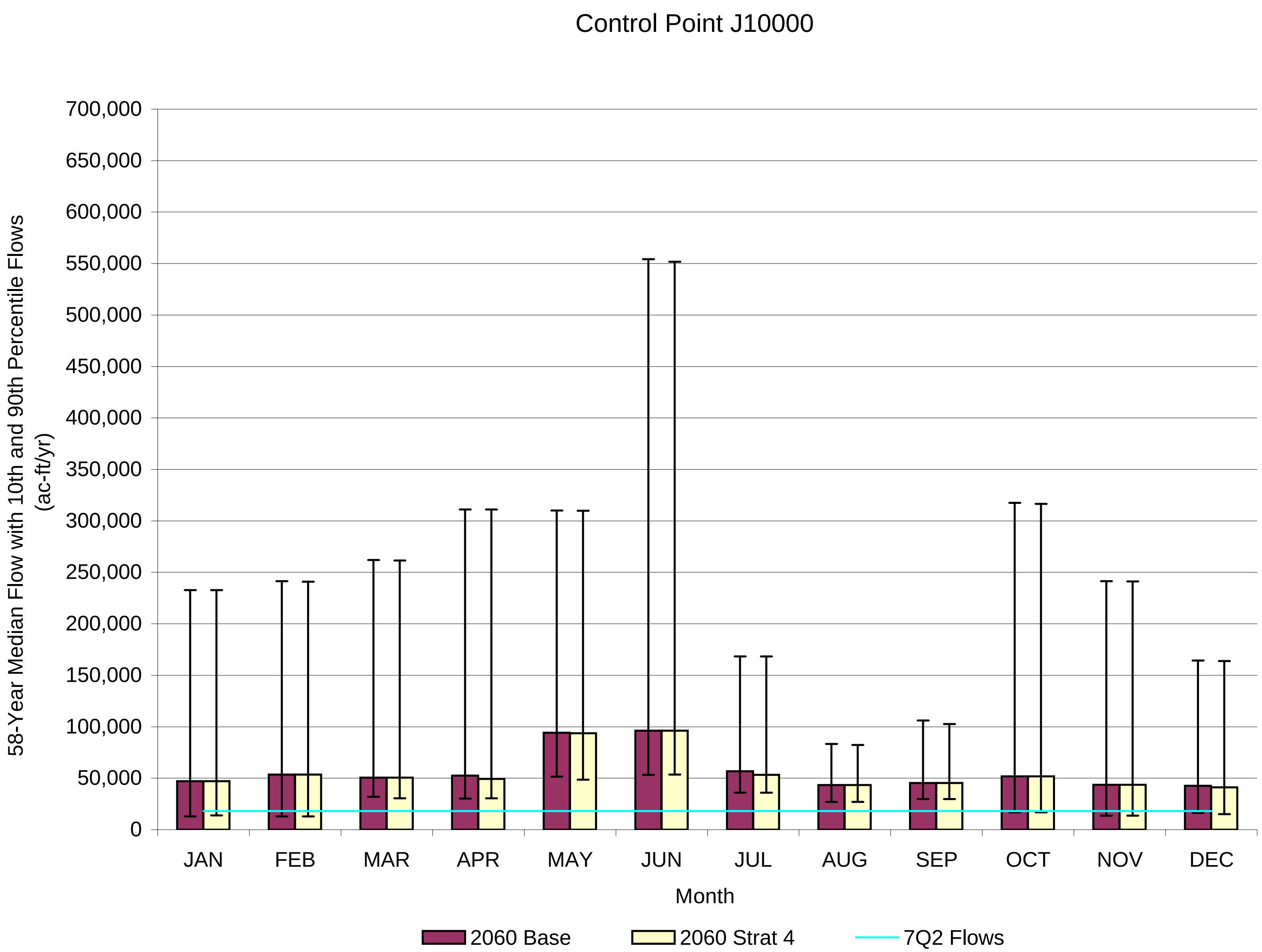
OCT
NOV
DEC
Month
2060 Base
2060 Strat 4


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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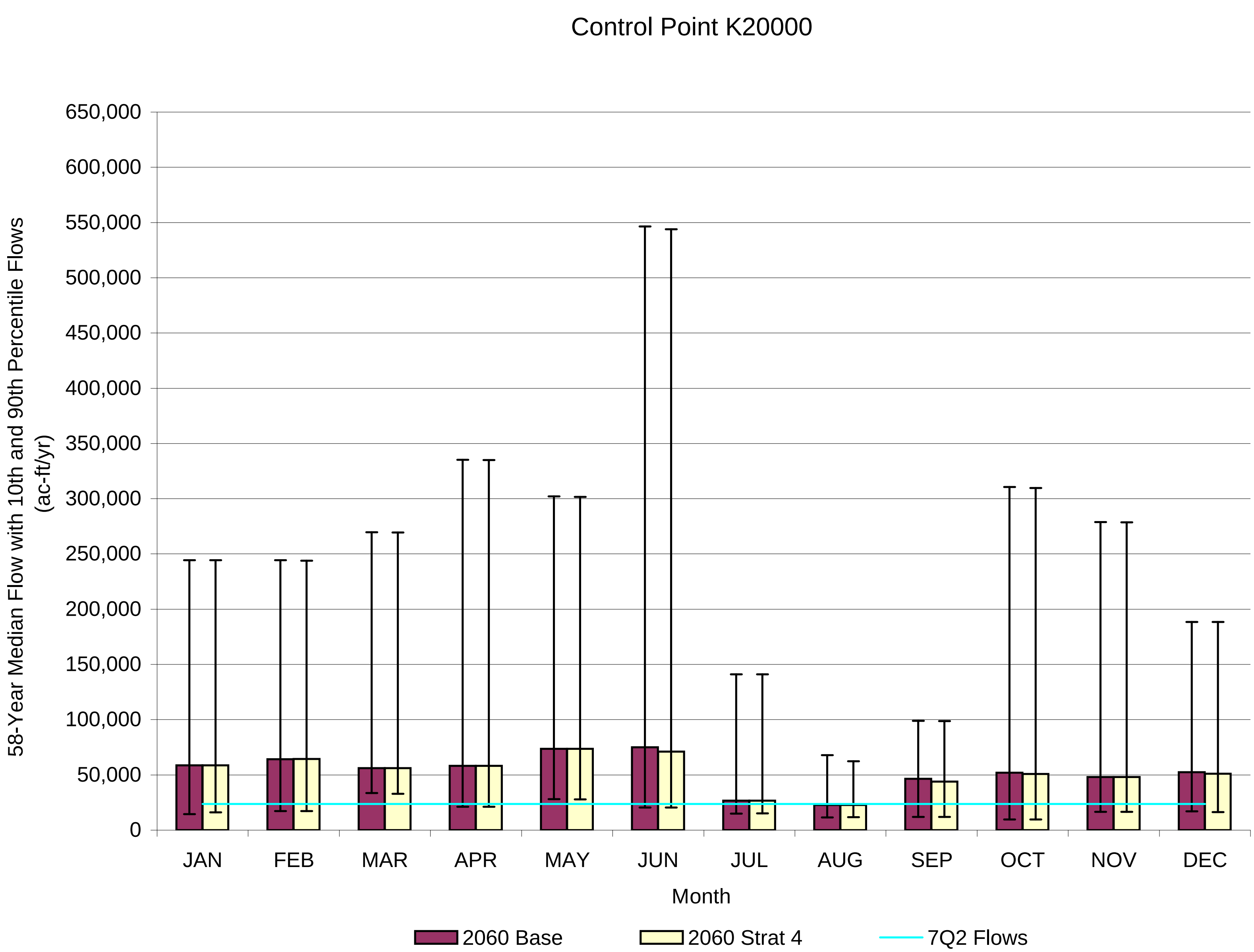
NOV
DEC
Month
2060 Base
2060 Strat 4
7Q2 Flows


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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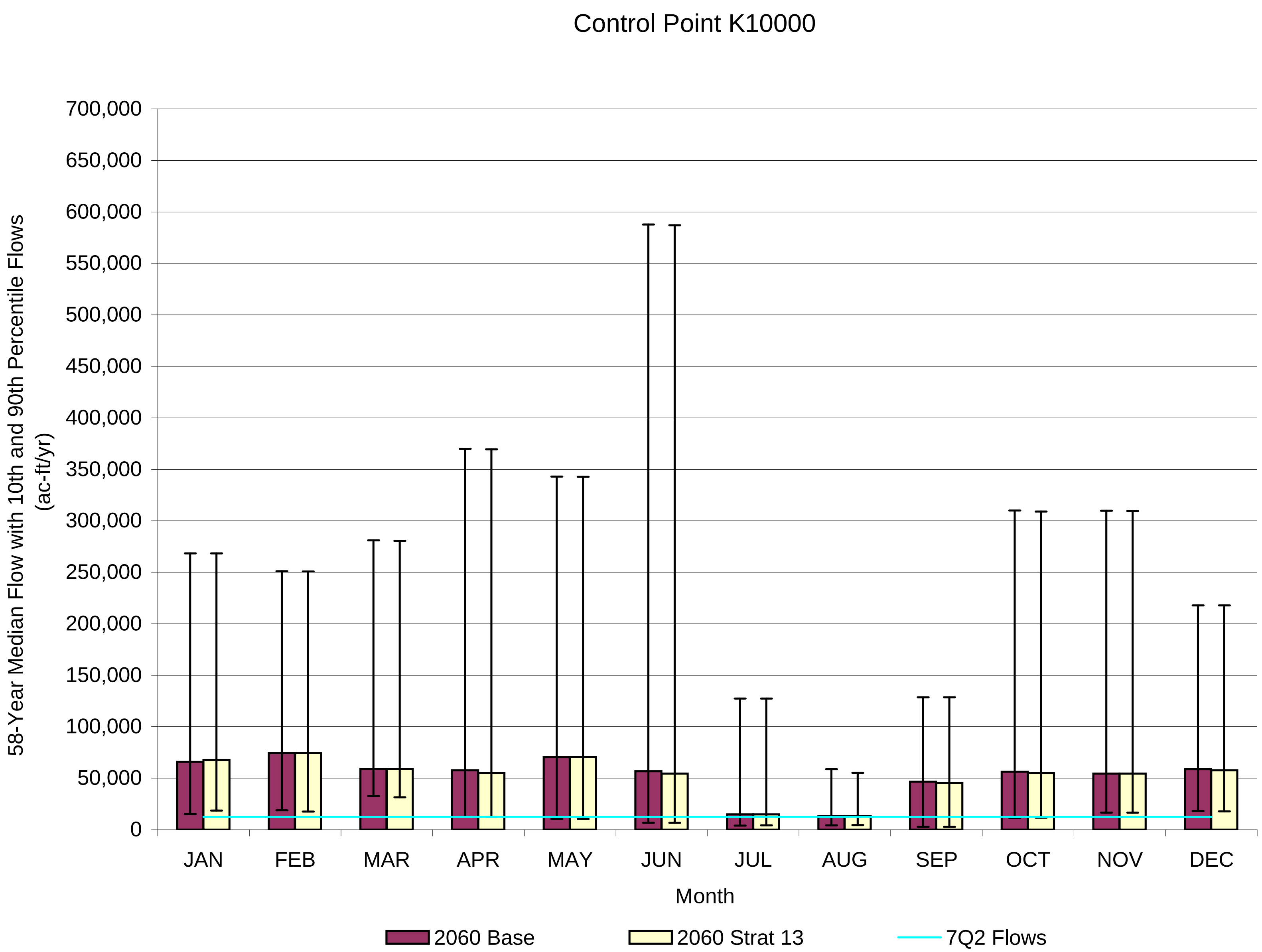
NOV
DEC
Month
2060 Base
2060 Strat 4
7Q2 Flows


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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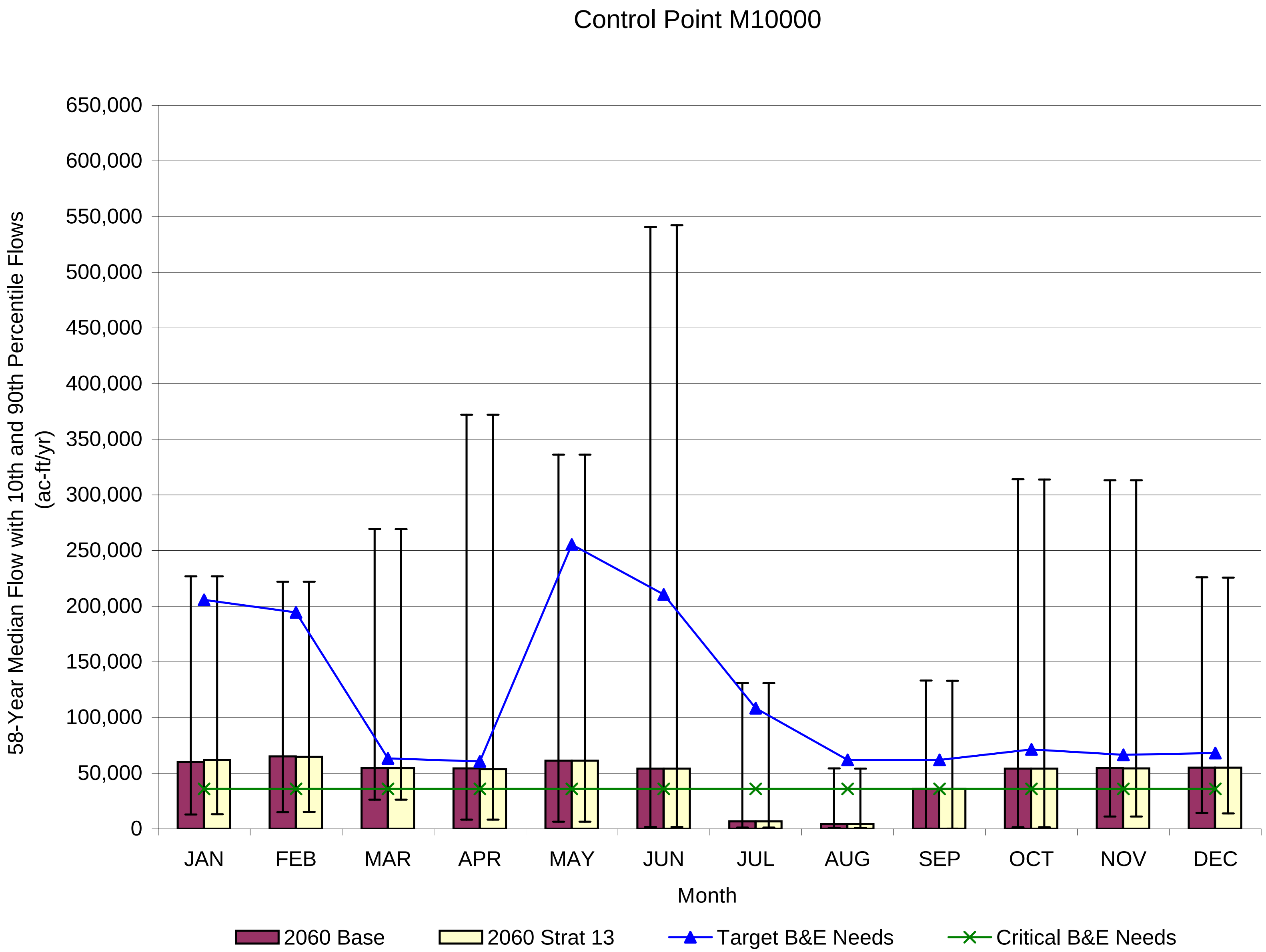
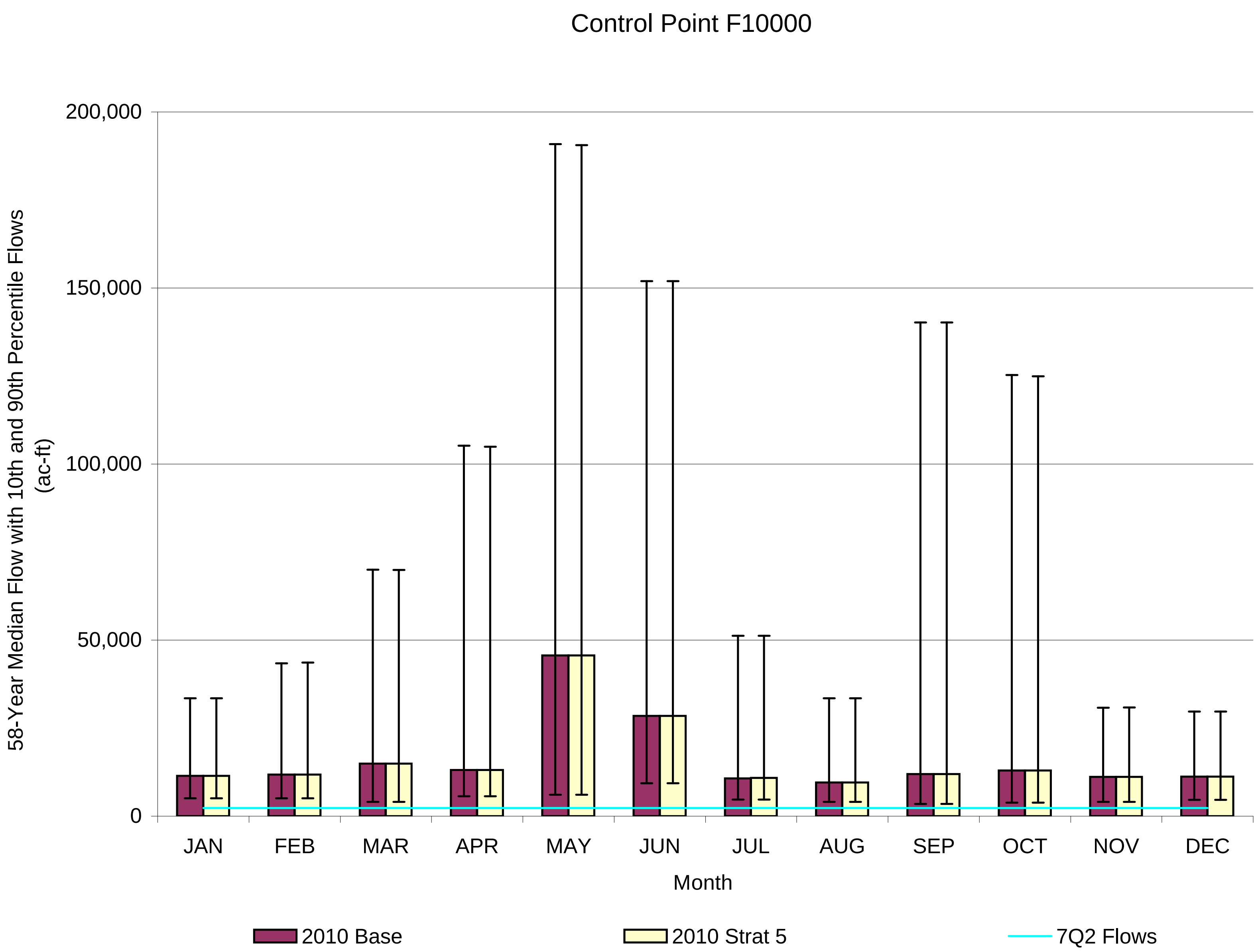
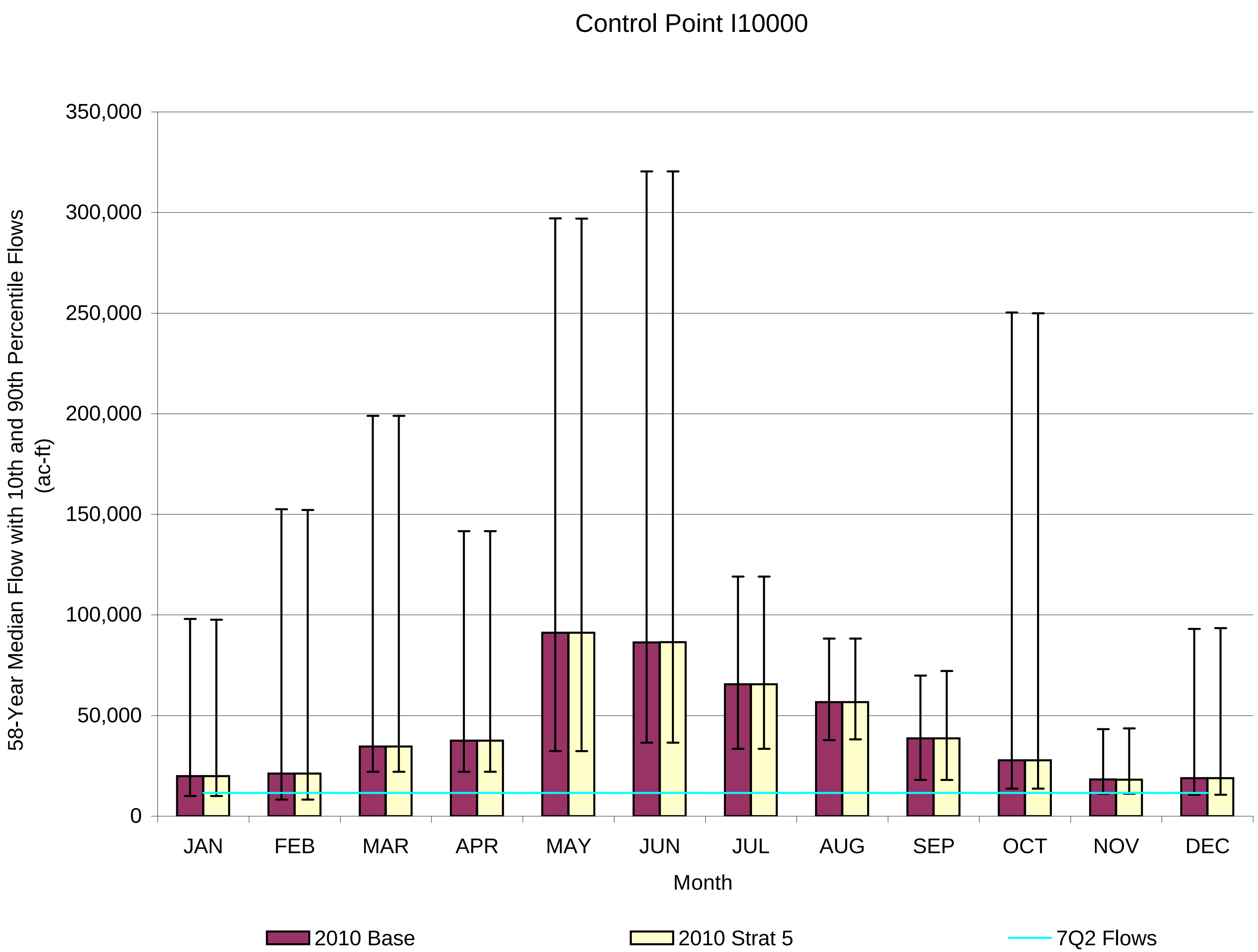
DEC
Month
2060 Base
2060 Strat 13
7Q2 Flows


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 13
Target B&E Needs
Critical B&E Needs

STRATEGY 5
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2010 AND 2060


Control Point F10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 5
7Q2 Flows


Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
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OCT
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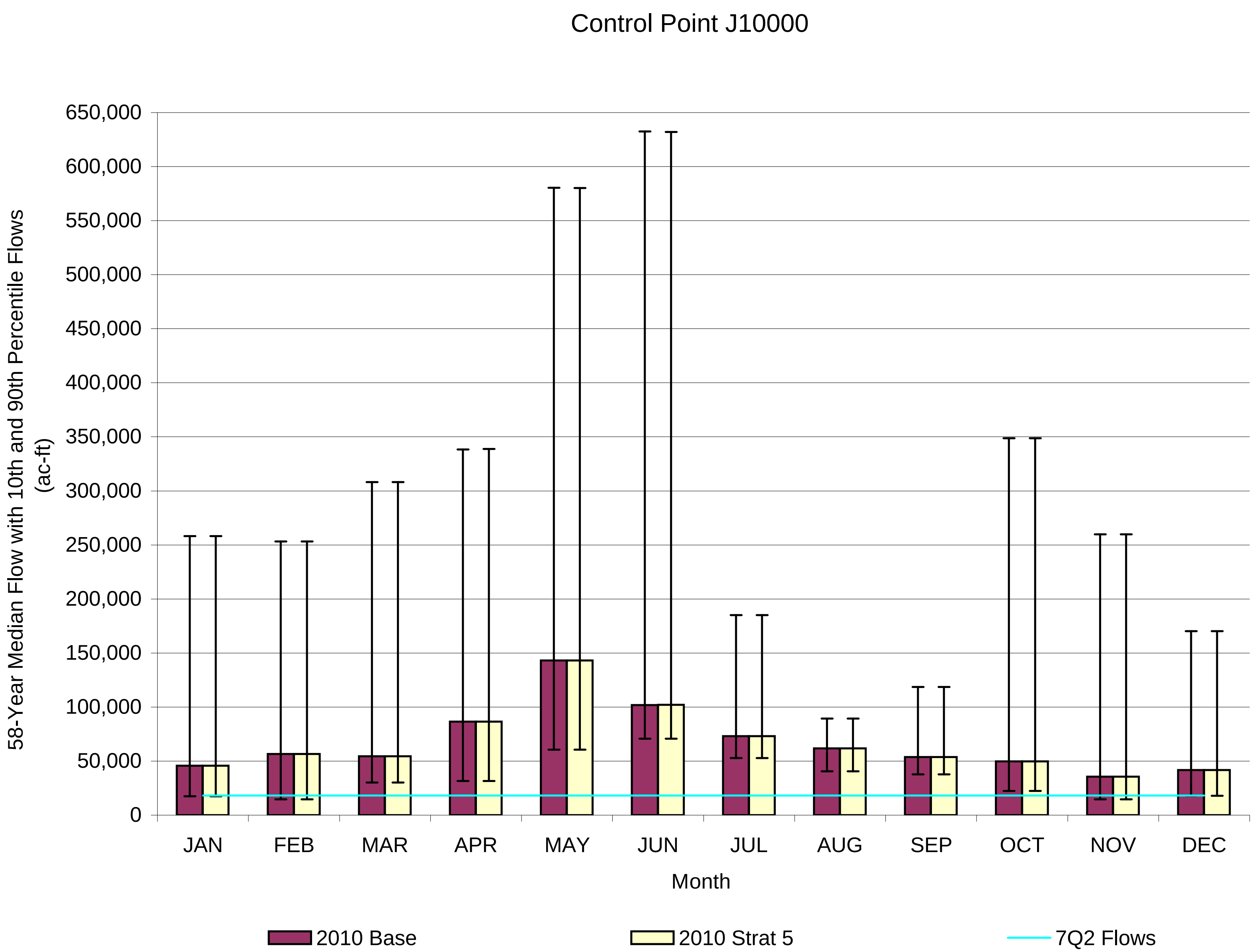
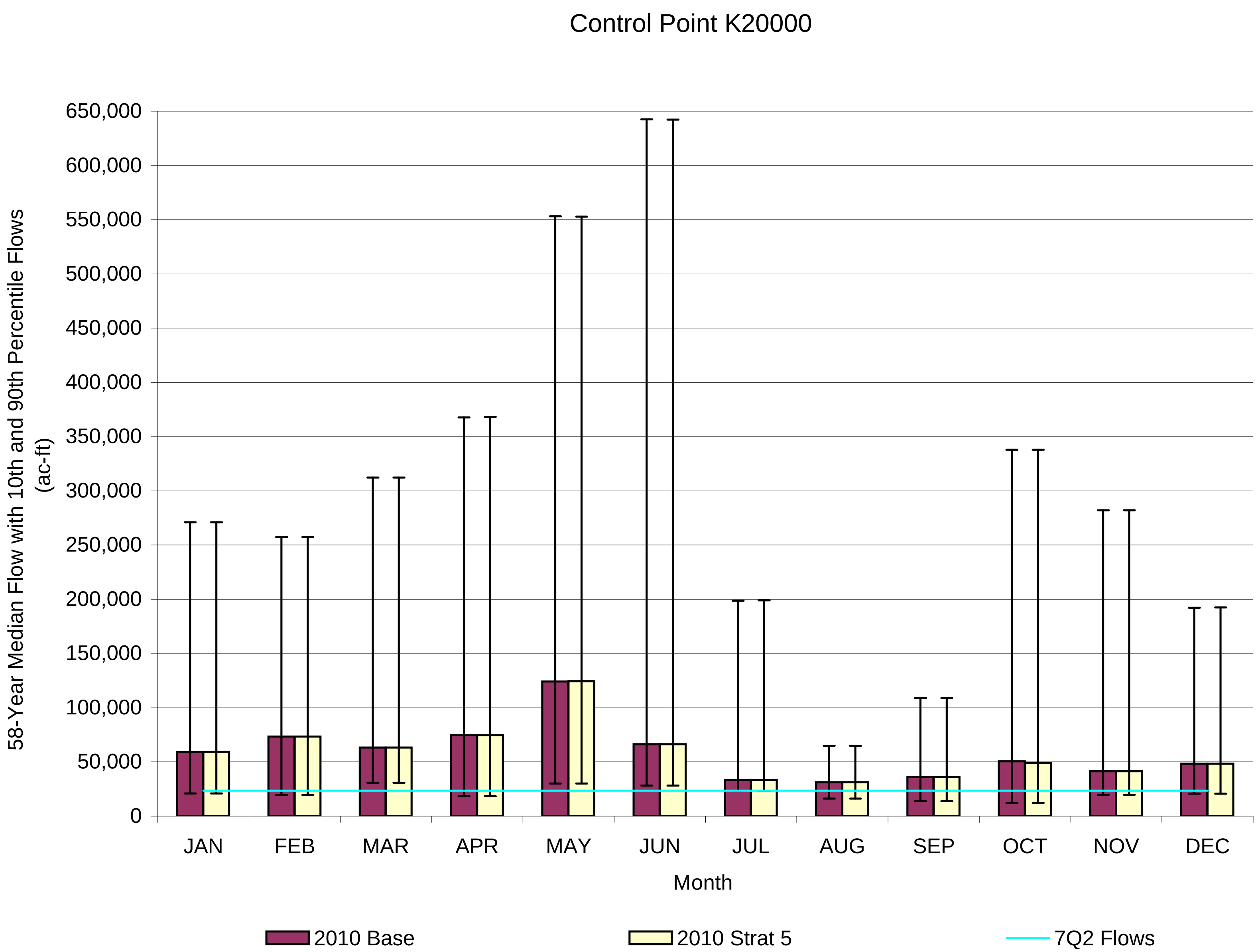
DEC
Month
2010 Base
2010 Strat 5
7Q2 Flows


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2010 Base
2010 Strat 5
7Q2 Flows


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
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450,000
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350,000
300,000
250,000
200,000
150,000
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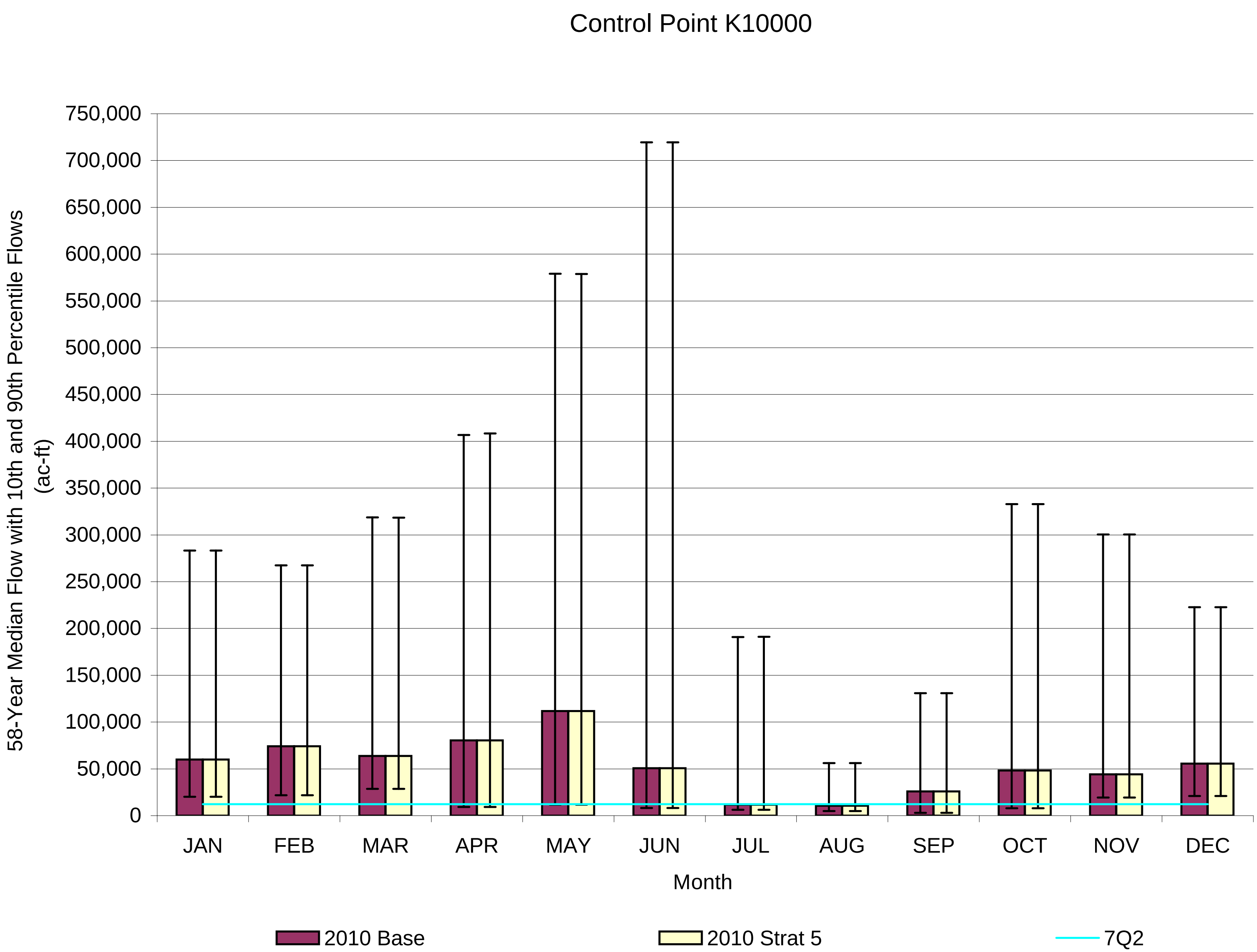
Month
2010 Base
2010 Strat 5
7Q2 Flows


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
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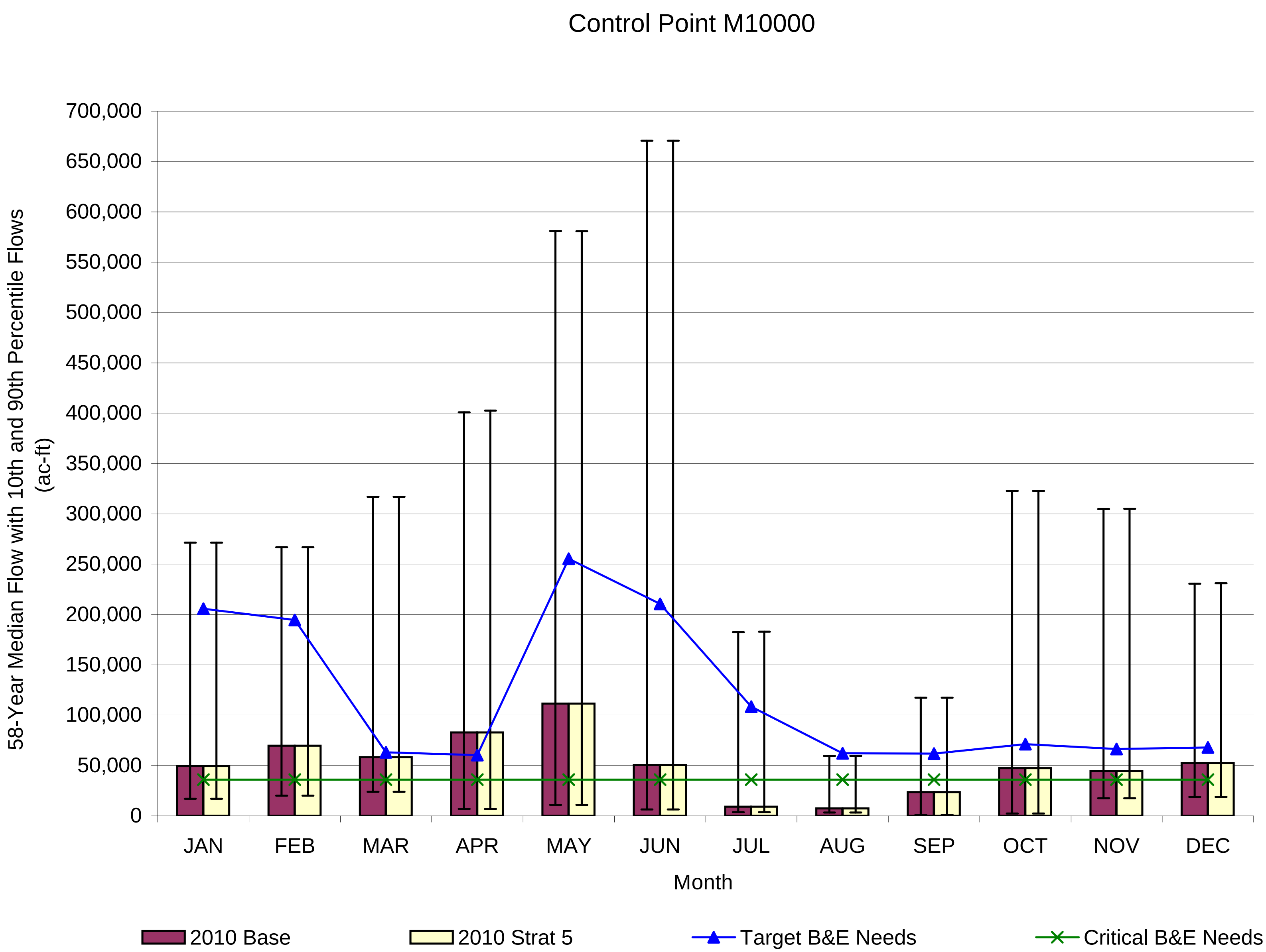
Month
2010 Base
2010 Strat 5
7Q2


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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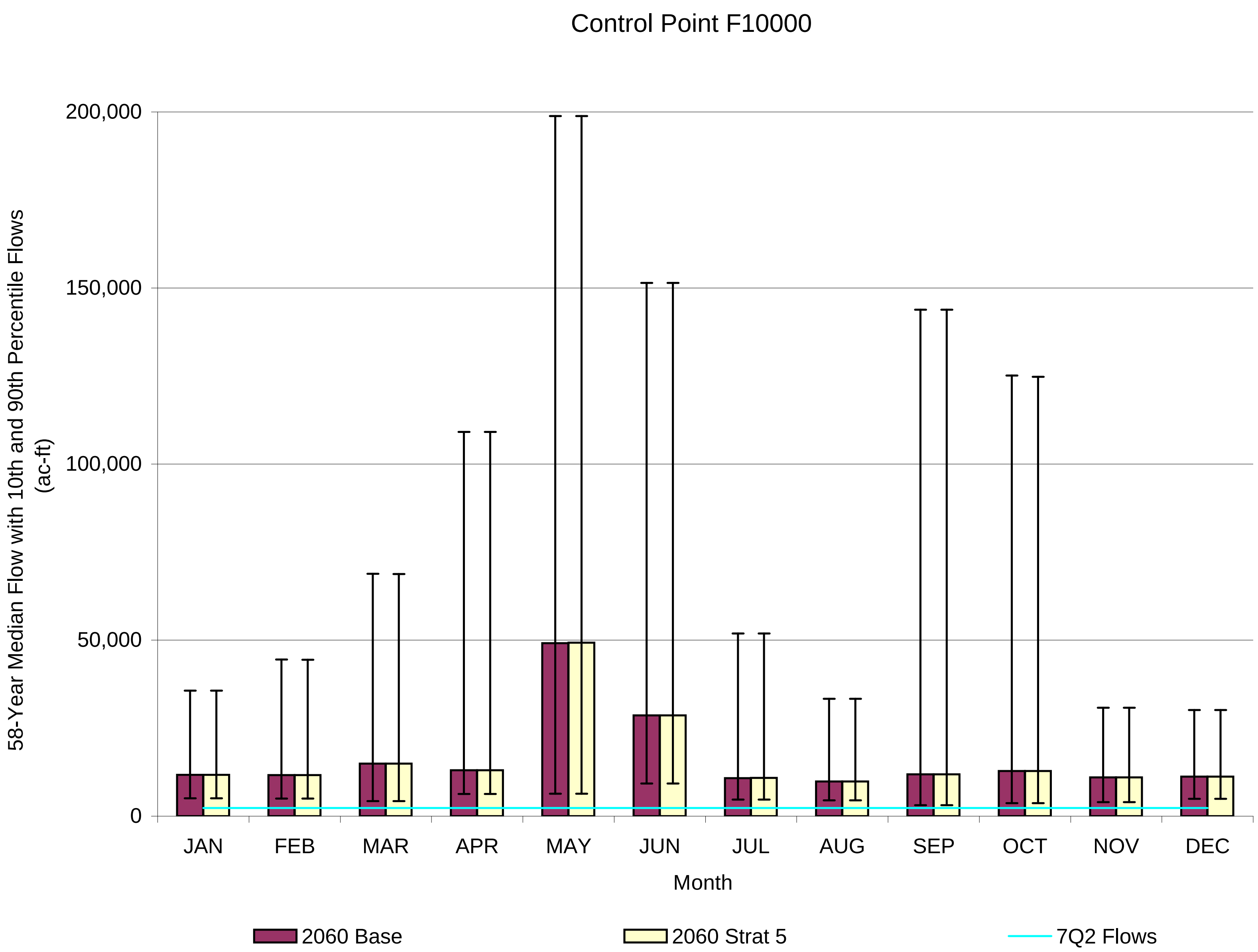
NOV
DEC
Month
2010 Base
2010 Strat 5
Target B&E Needs
Critical B&E Needs


Control Point F10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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150,000
100,000
50,000
0
JAN
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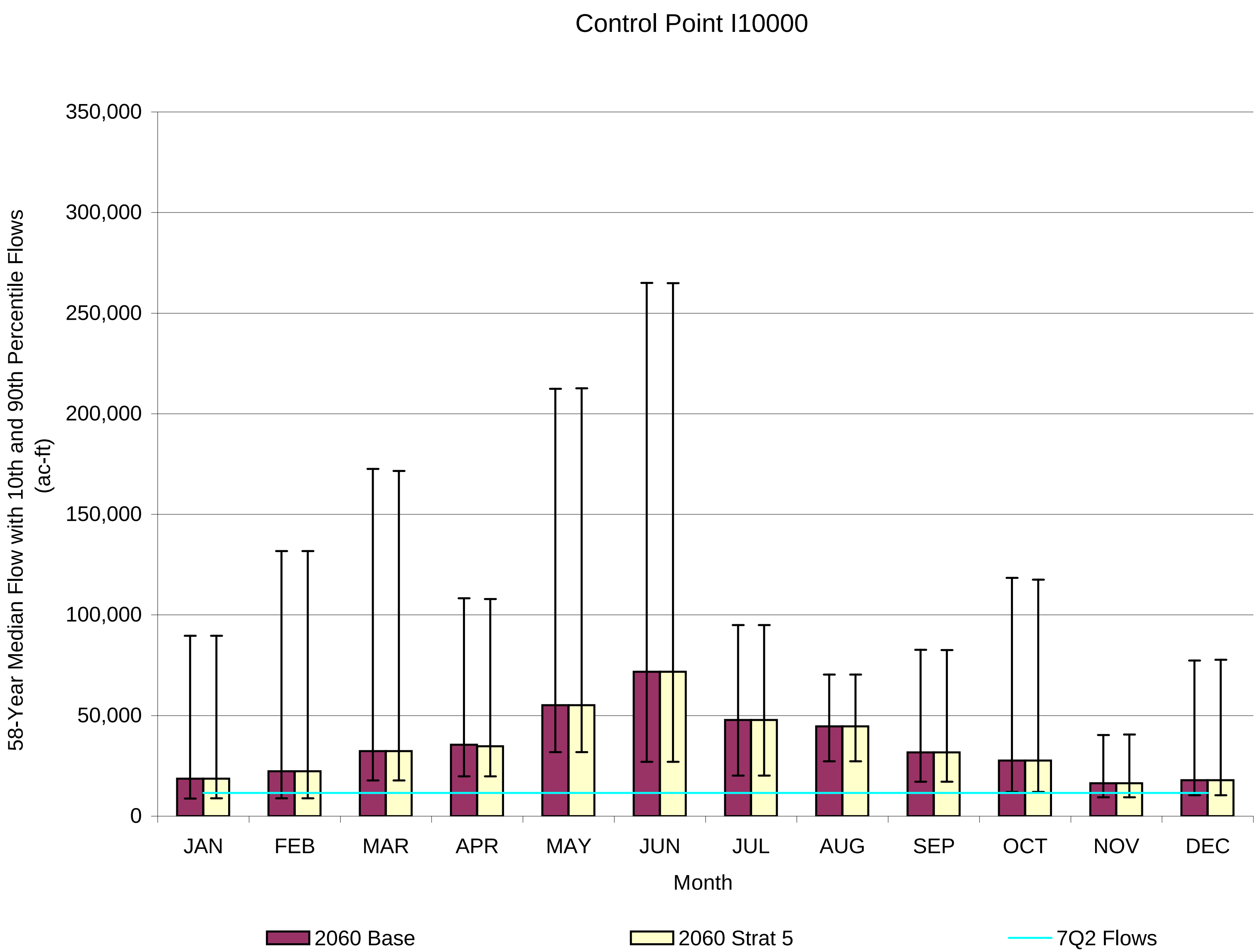
DEC
Month
2060 Base
2060 Strat 5
7Q2 Flows


Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
350,000
300,000
250,000
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150,000
100,000
50,000
0
JAN
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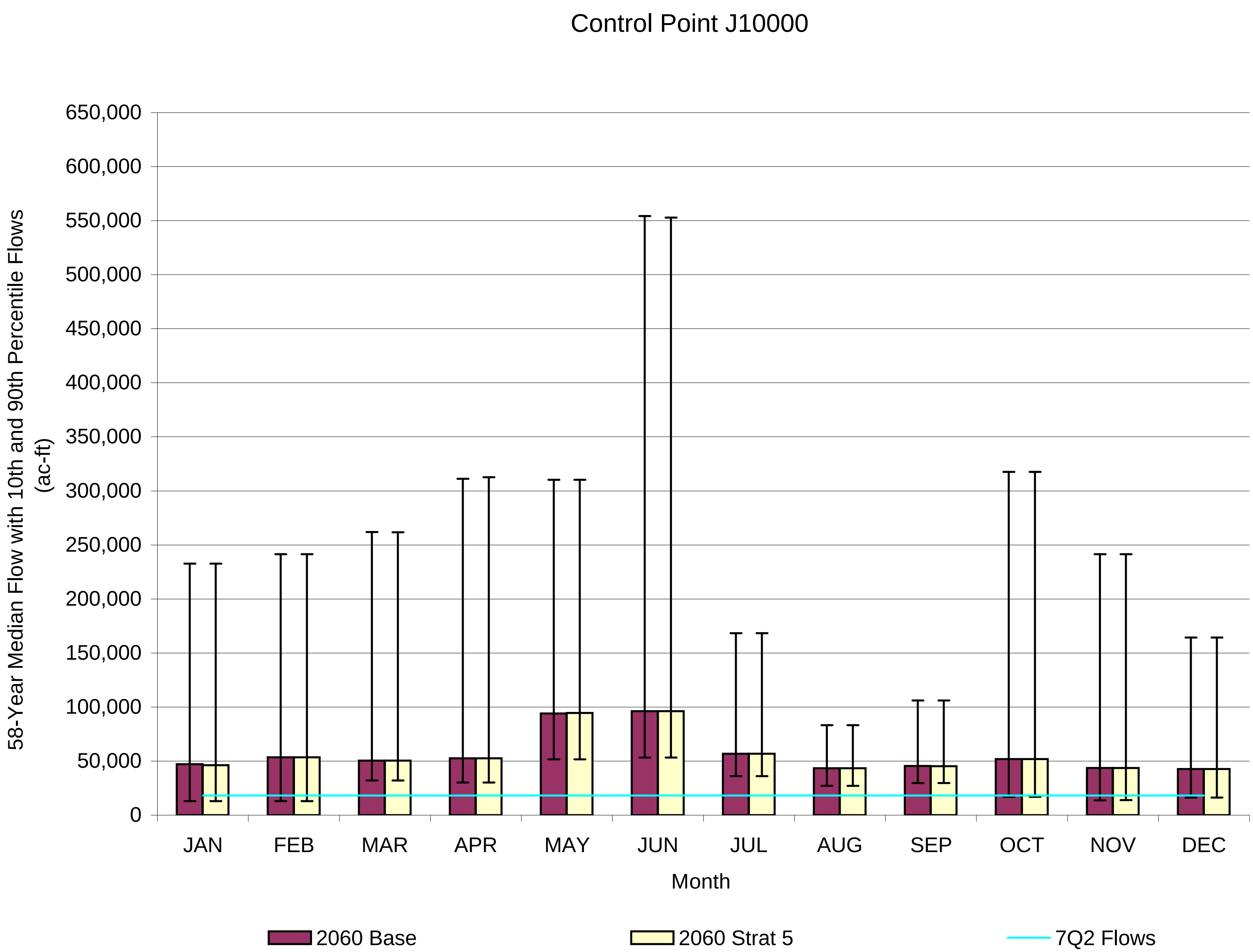
7Q2 Flows


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
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450,000
400,000
350,000
300,000
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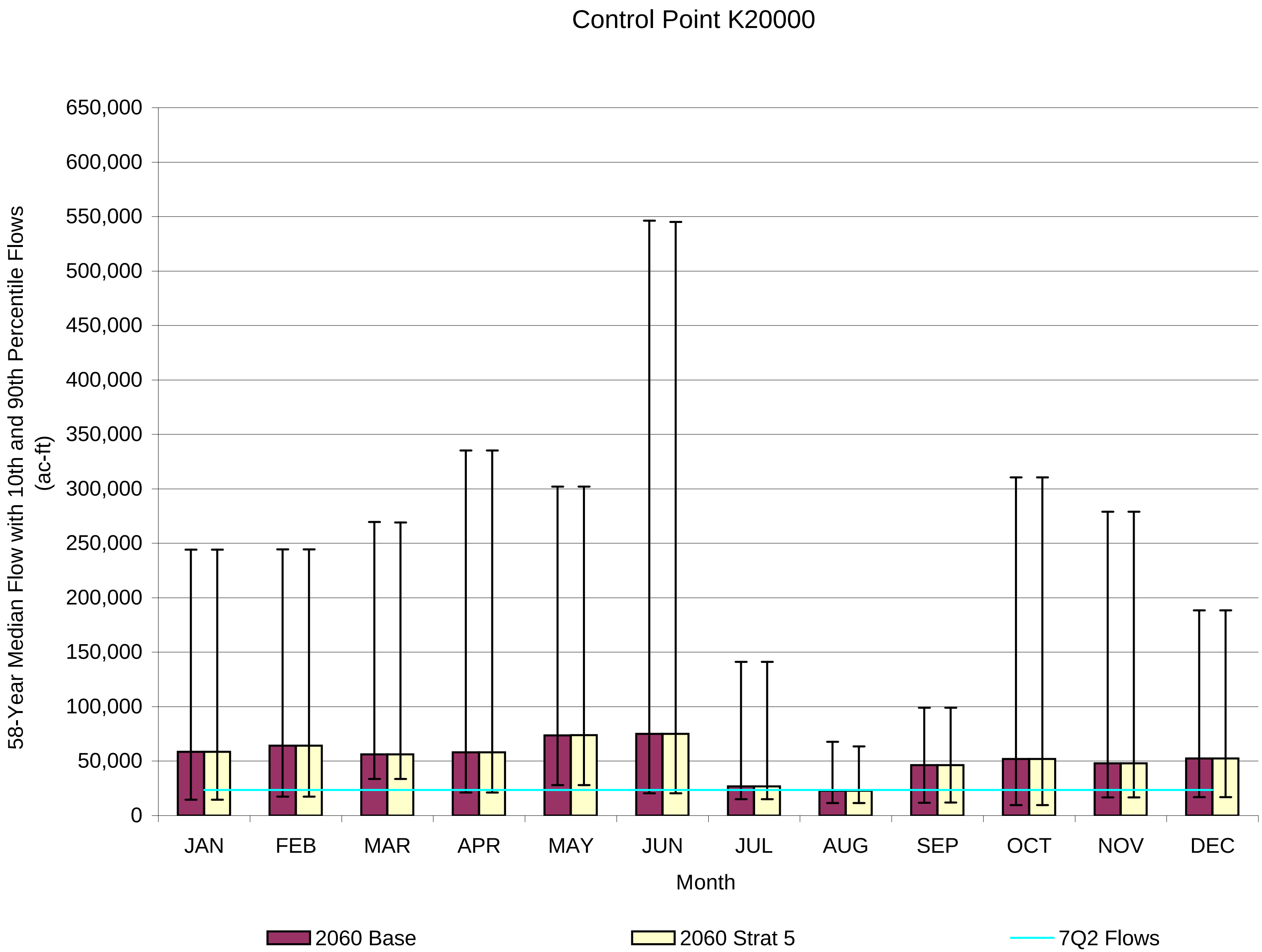
7Q2 Flows


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
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400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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Month
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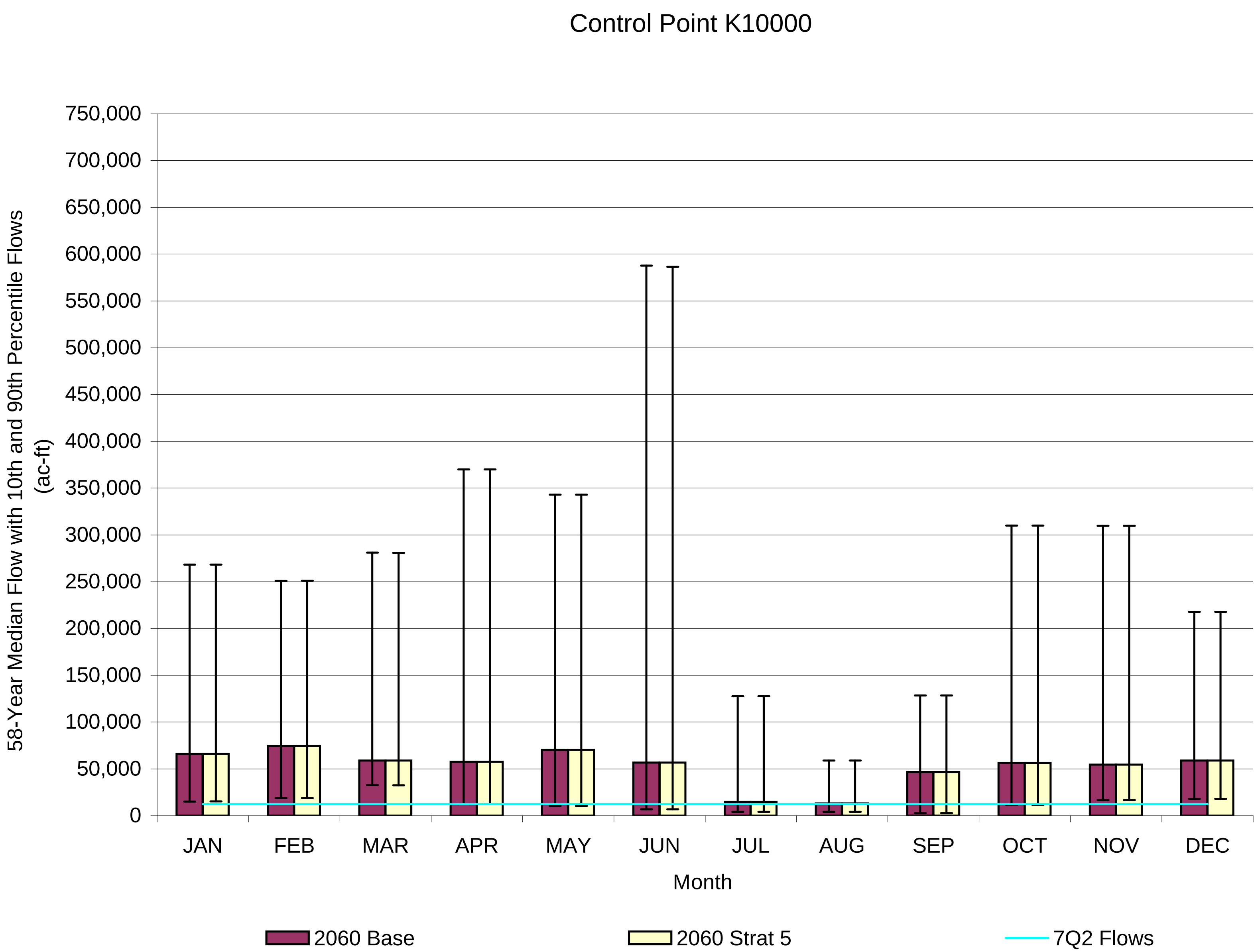
7Q2 Flows


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
750,000
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450,000
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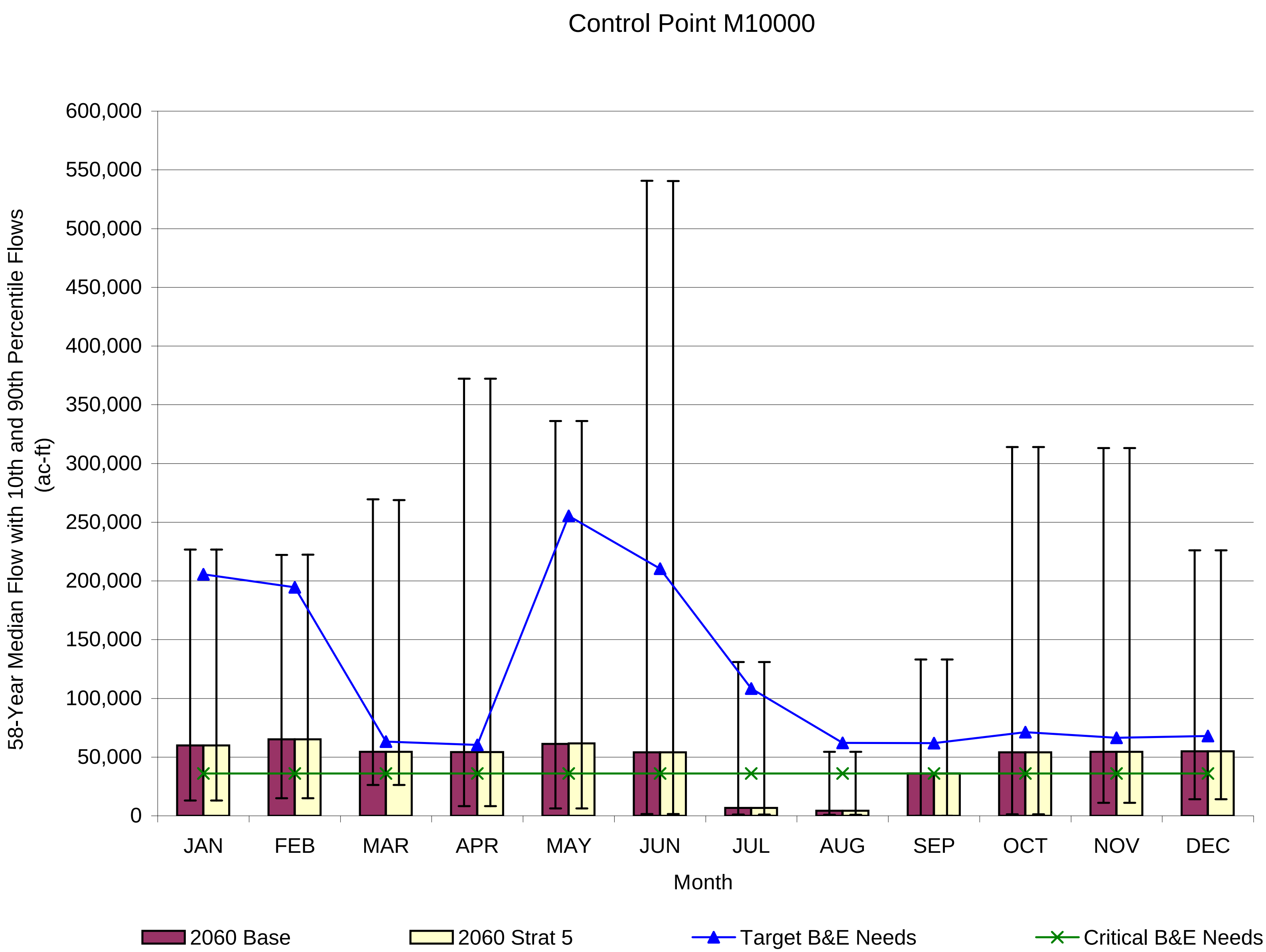
7Q2 Flows


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
600,000
550,000
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450,000
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350,000
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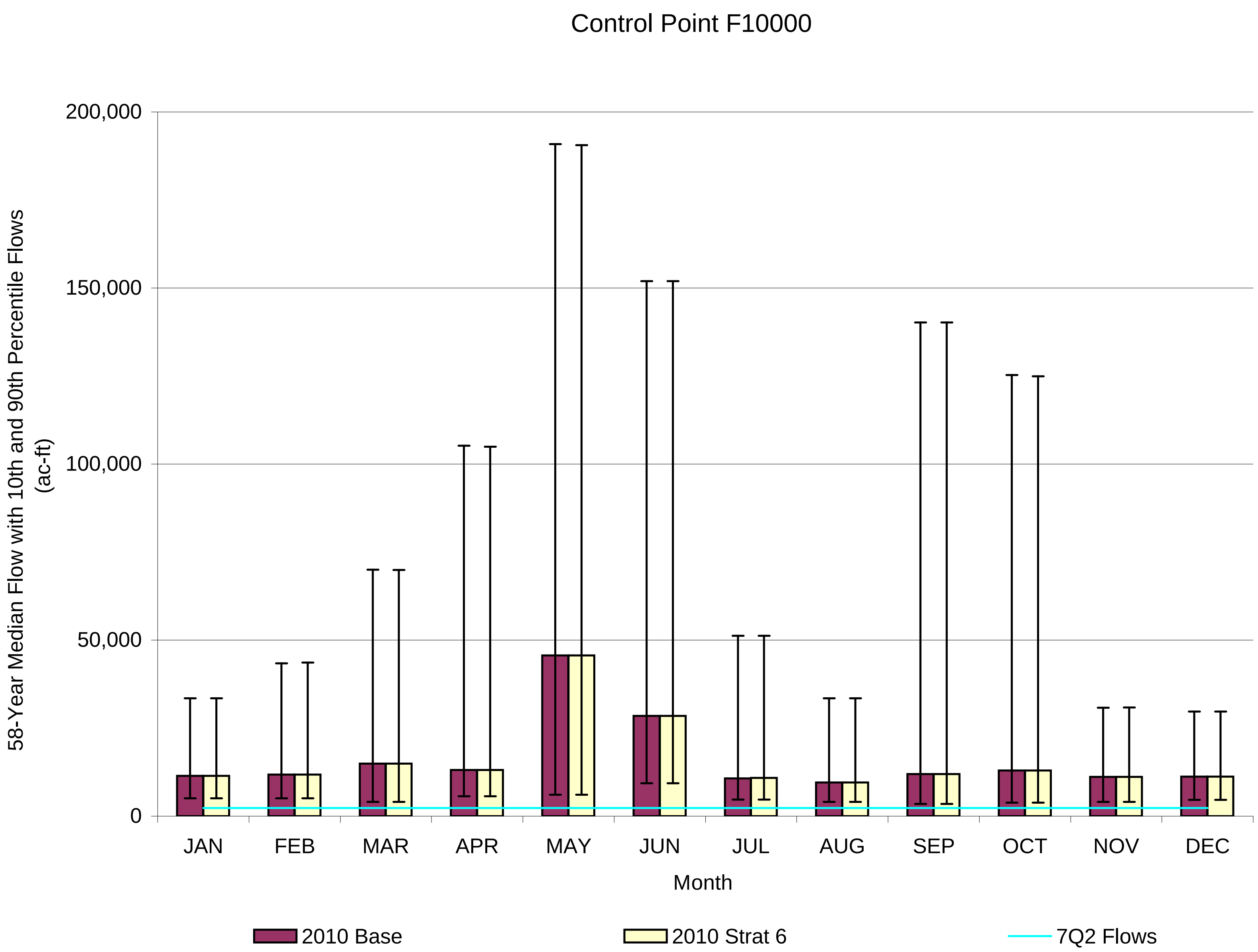
Month
2060 Base
2060 Strat 5
Target B&E Needs
Critical B&E Needs

STRATEGY 6
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2010 AND 2060


Control Point F10000
200,000
150,000
100,000
50,000
0
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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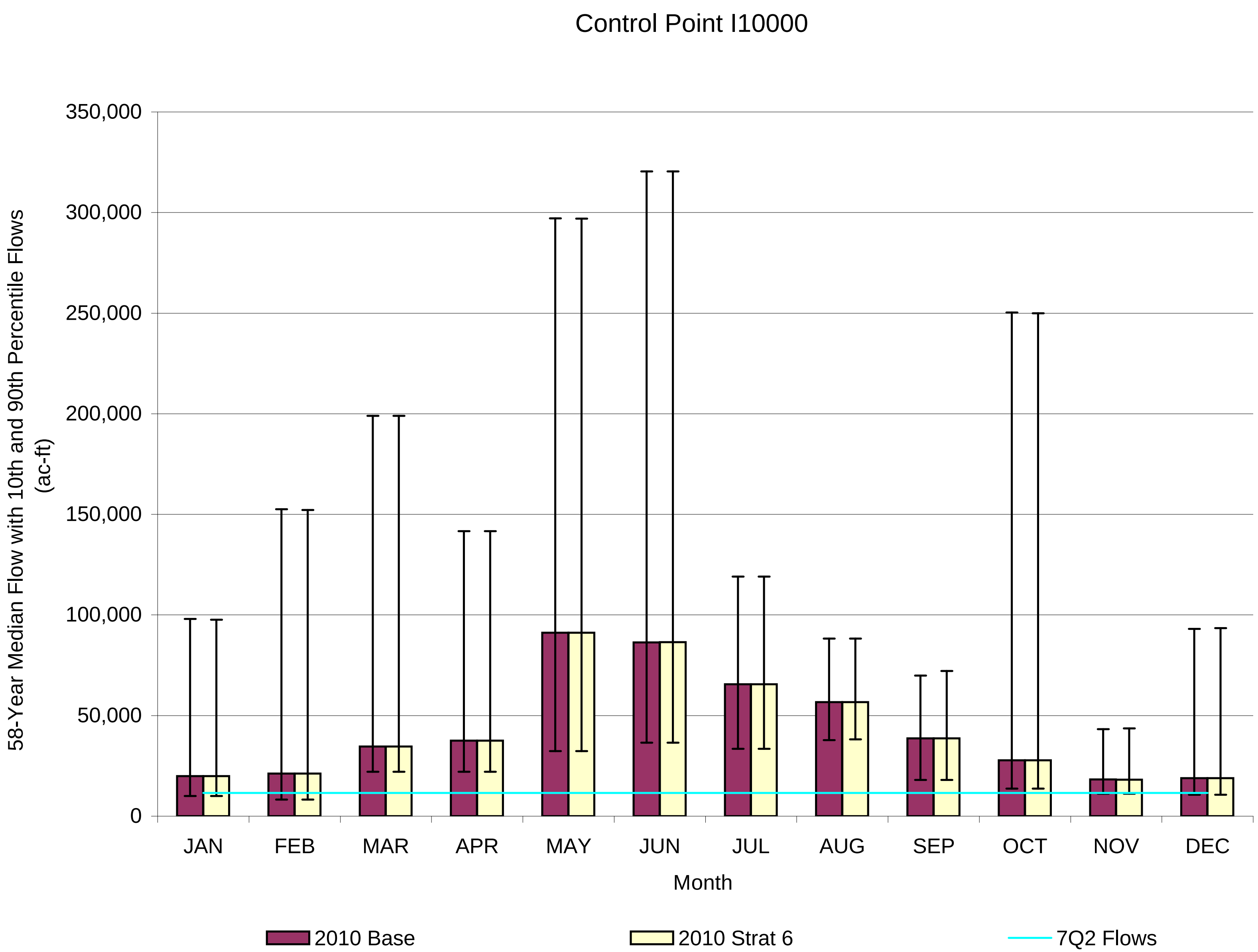
NOV
DEC
Month
2010 Base
2010 Strat 6
7Q2 Flows


Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows
(ac-ft)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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Month
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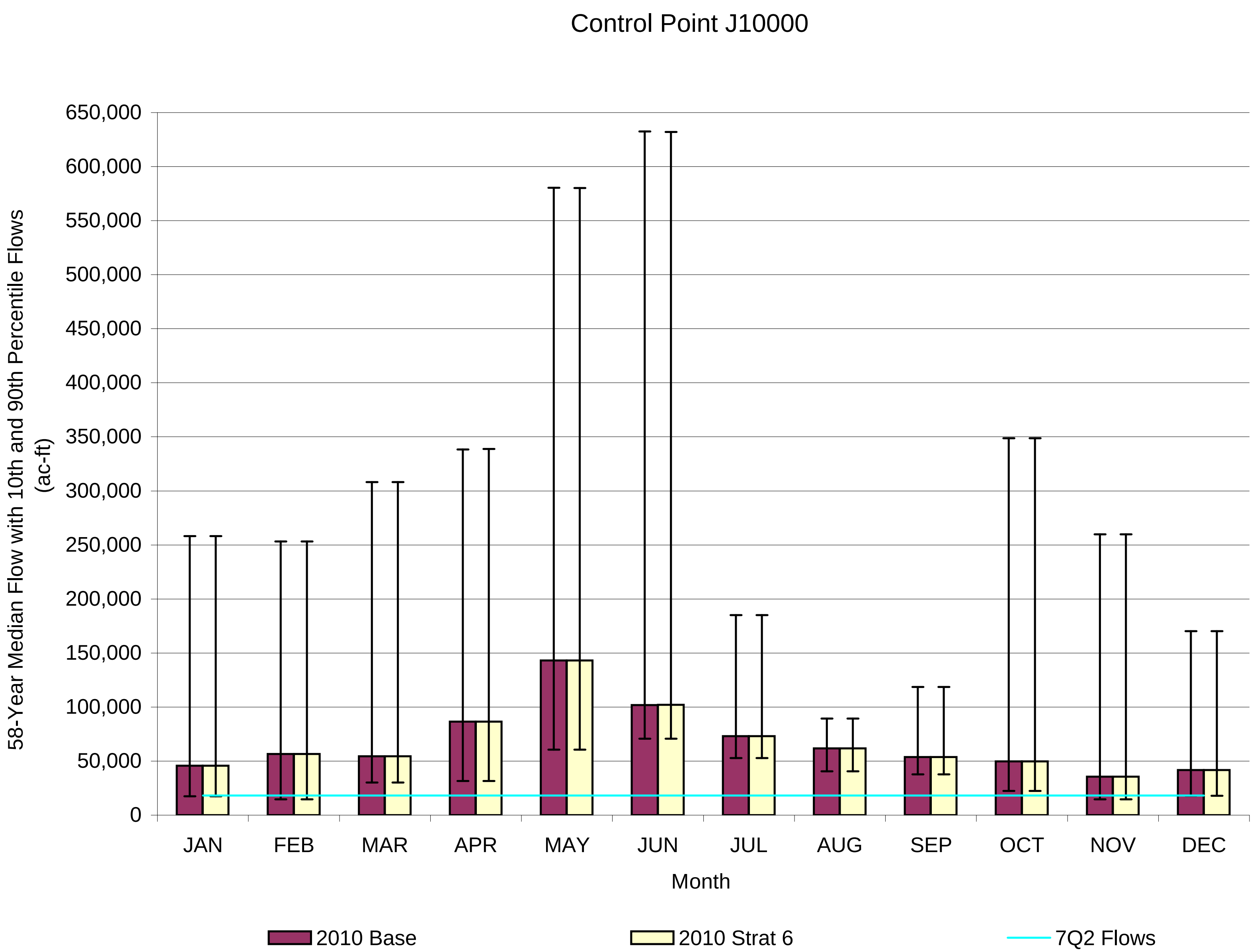
2010 Strat 6
7Q2 Flows


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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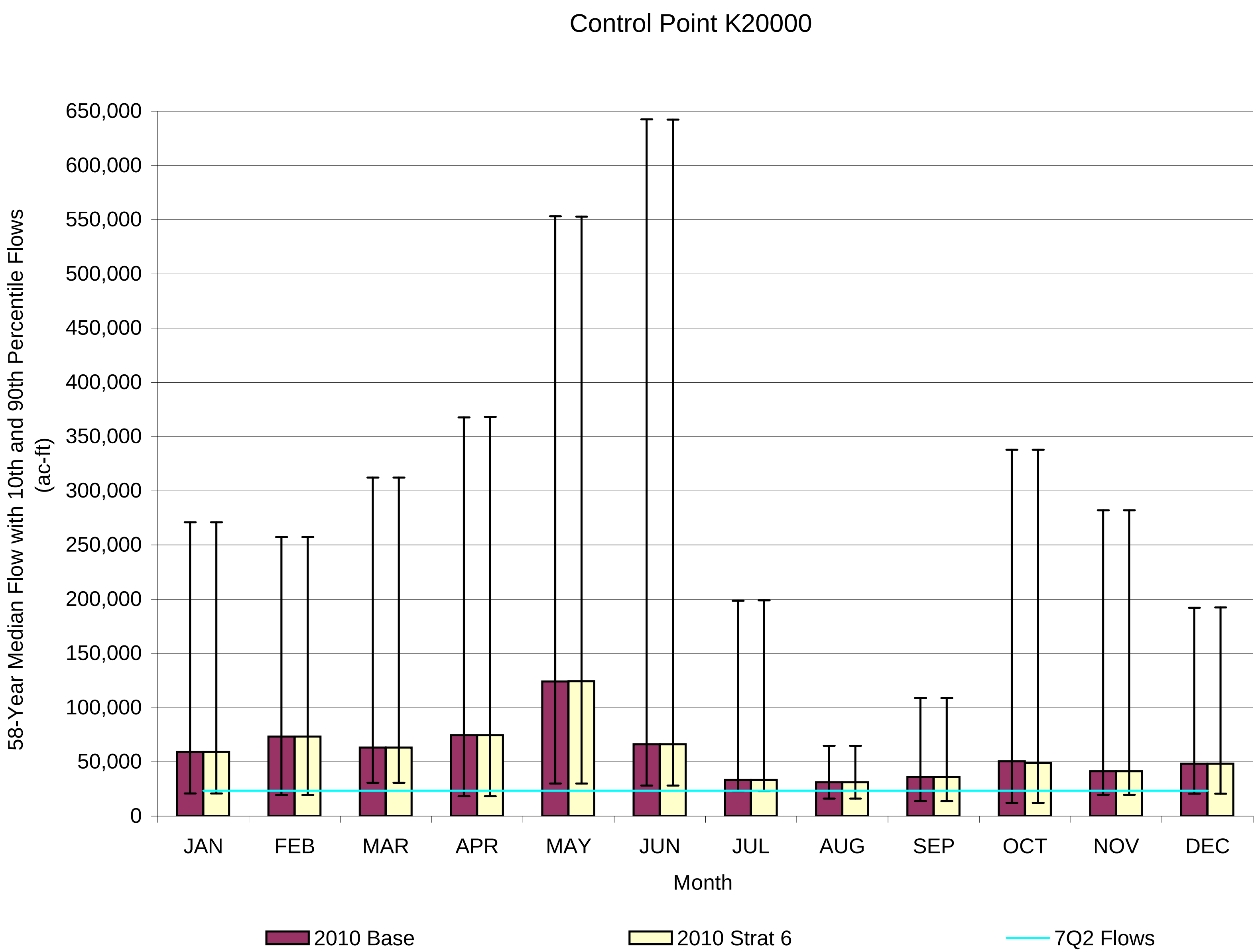
Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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2010 Base
2010 Strat 6
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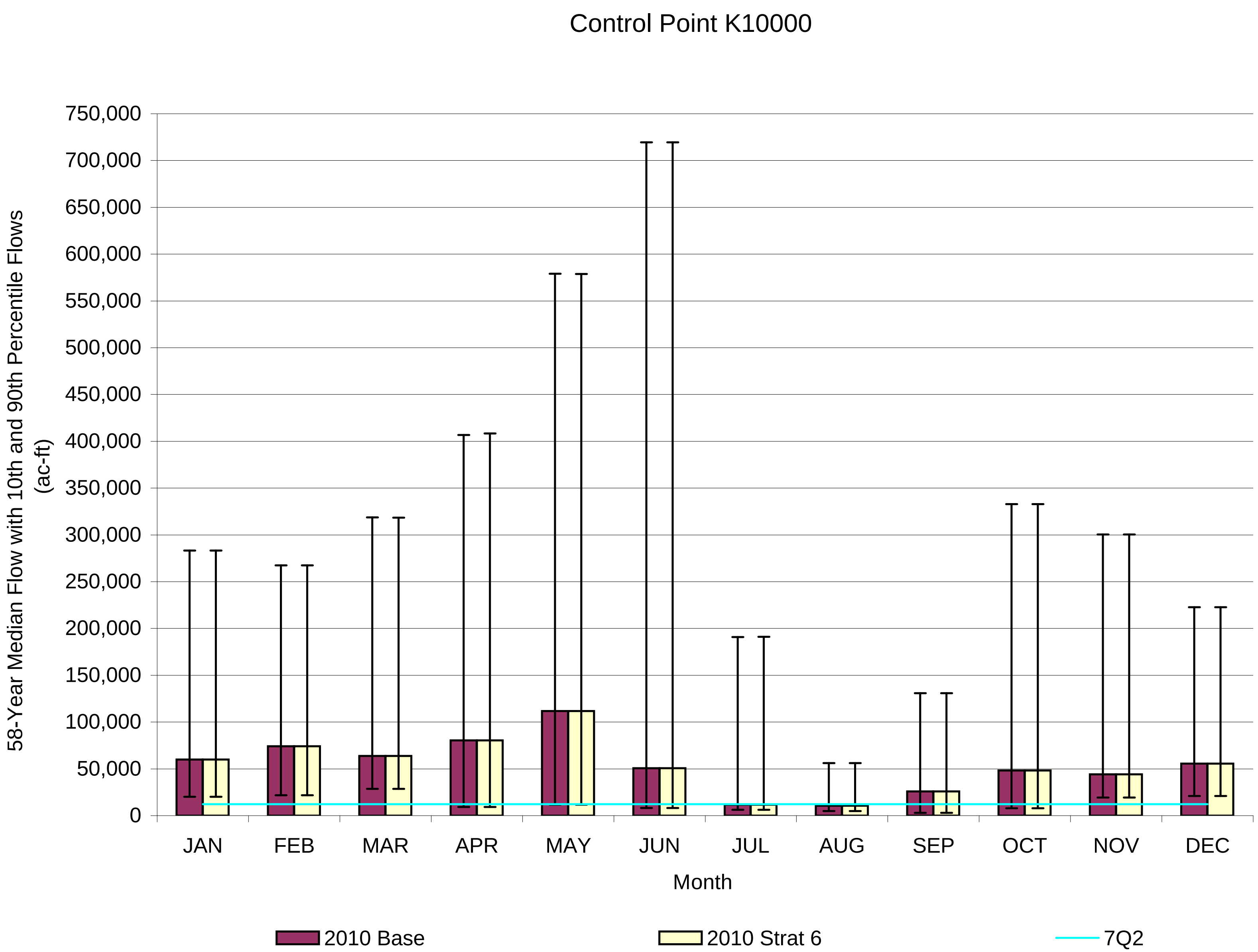
Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
750,000
700,000
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450,000
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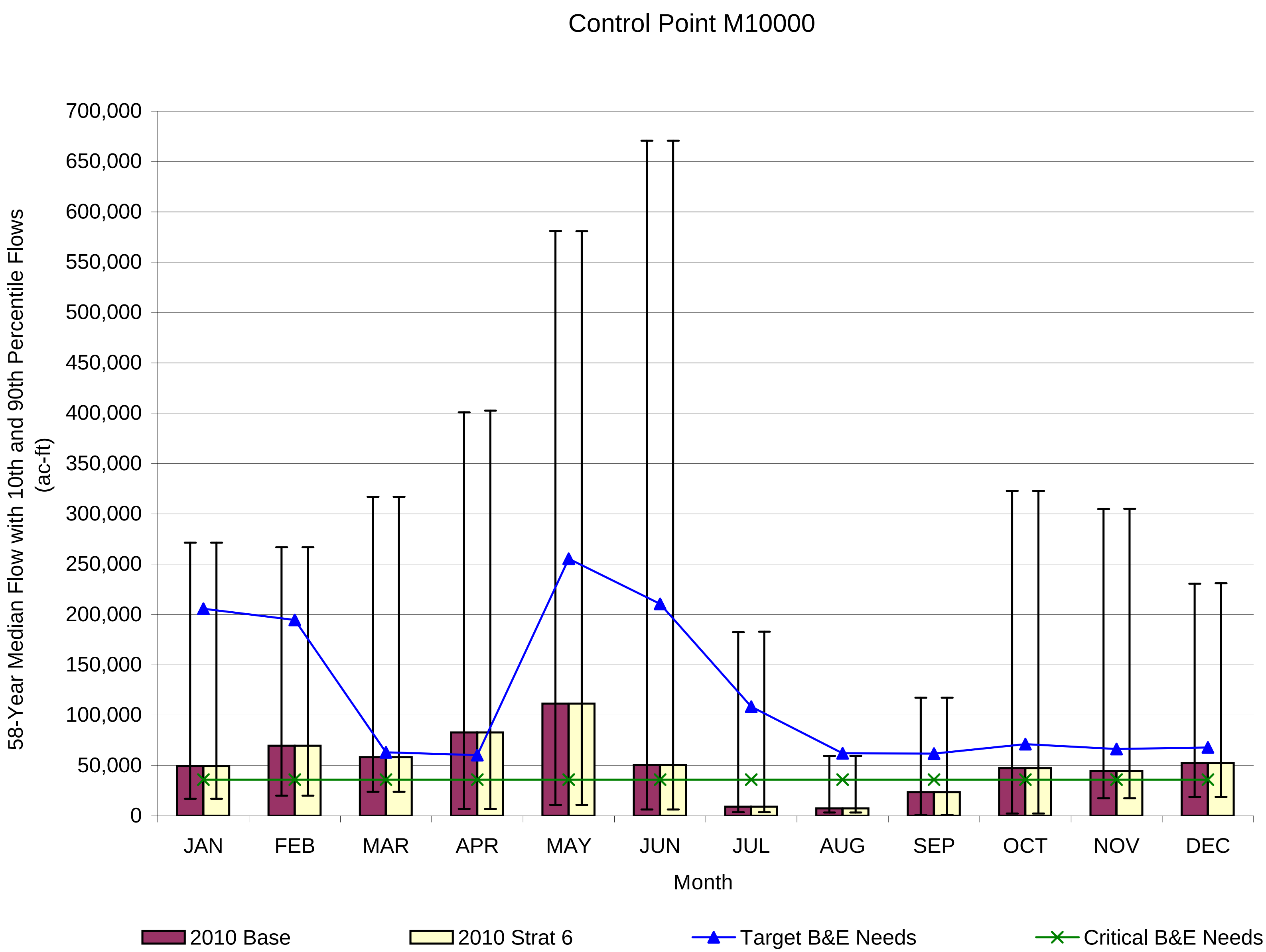
7Q2


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
700,000
650,000
600,000
550,000
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450,000
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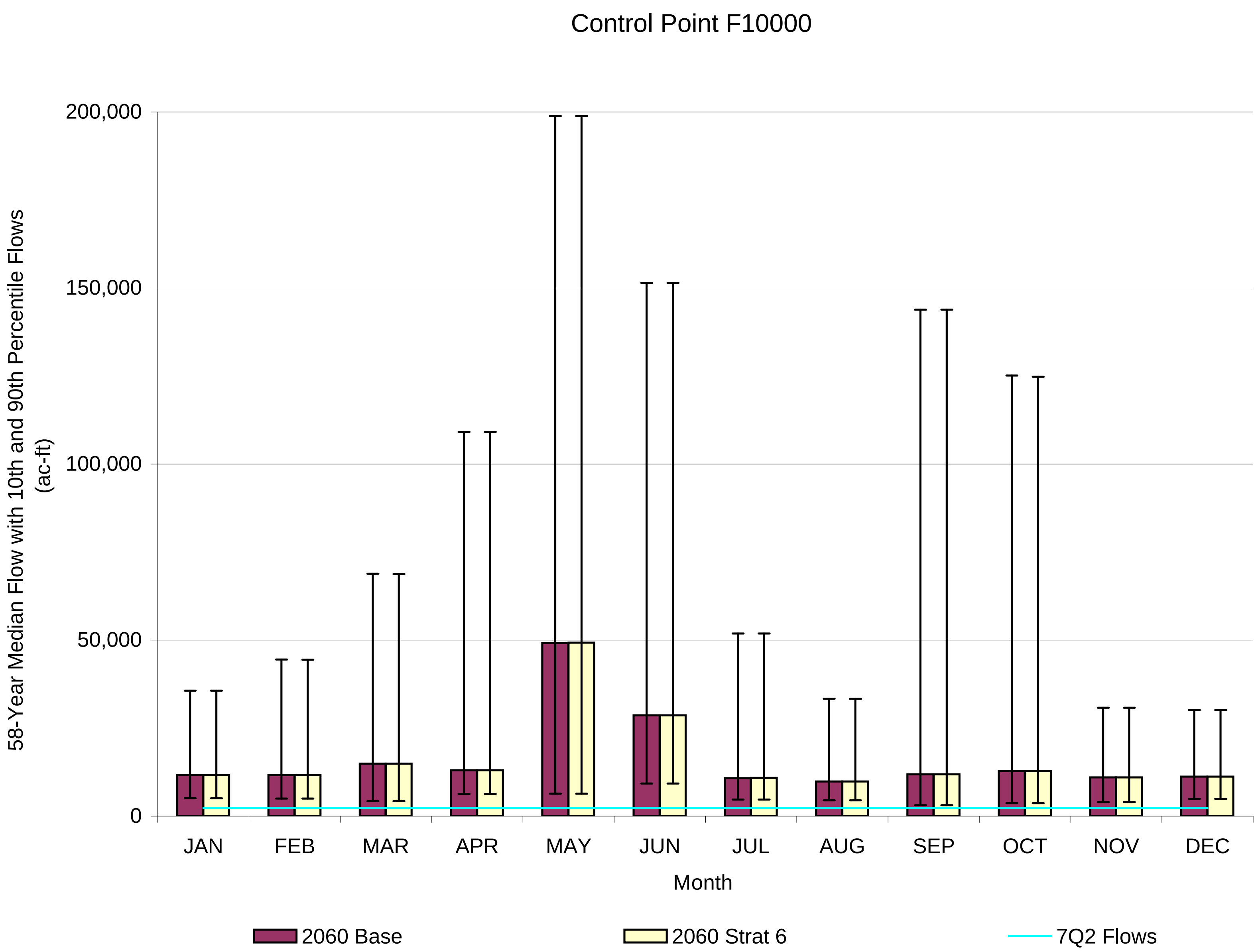
2010 Base
2010 Strat 6
Target B&E Needs
Critical B&E Needs


Control Point F10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
200,000
150,000
100,000
50,000
0
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2060 Base
2060 Strat 6
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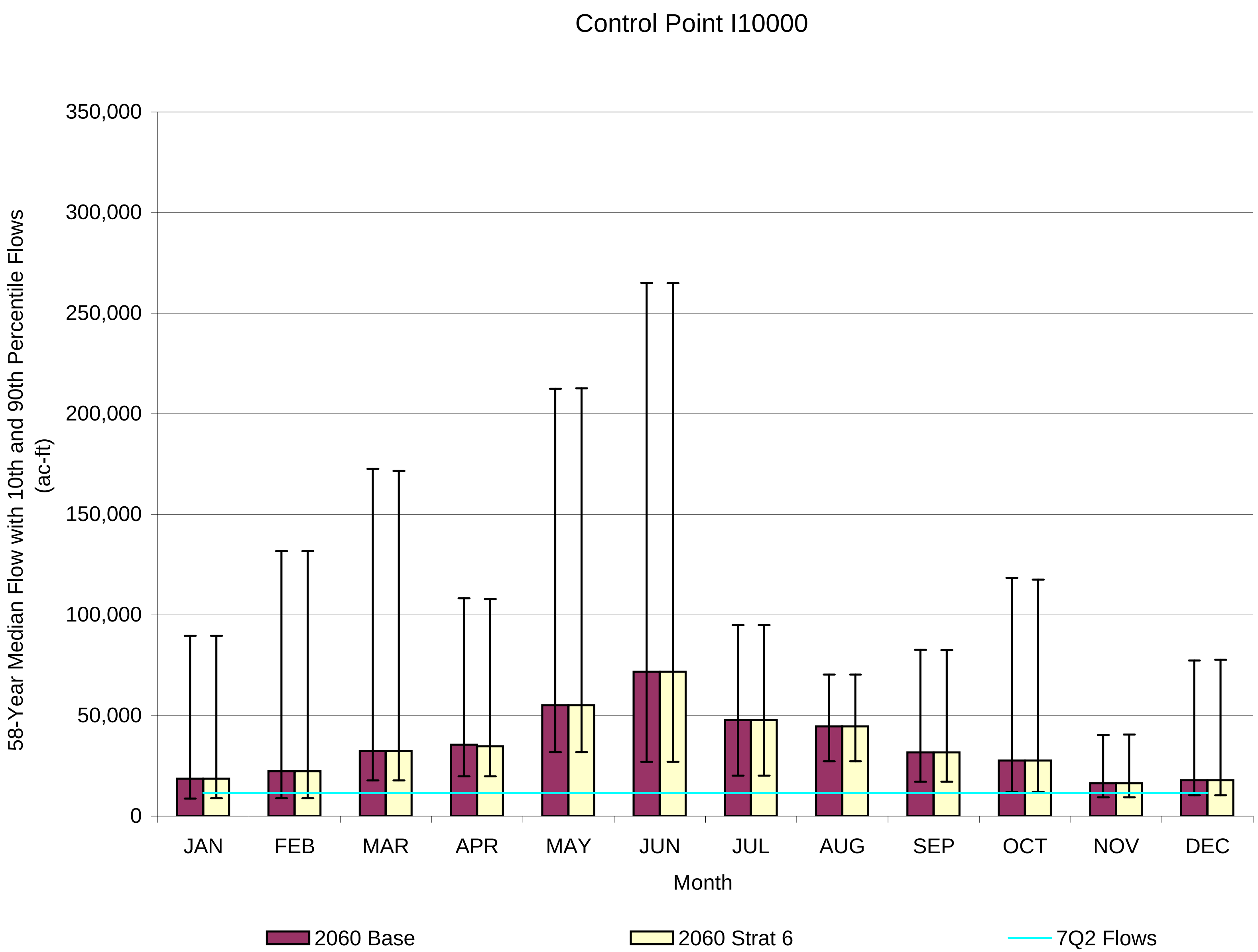

Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
350,000
300,000
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200,000
150,000
100,000
50,000
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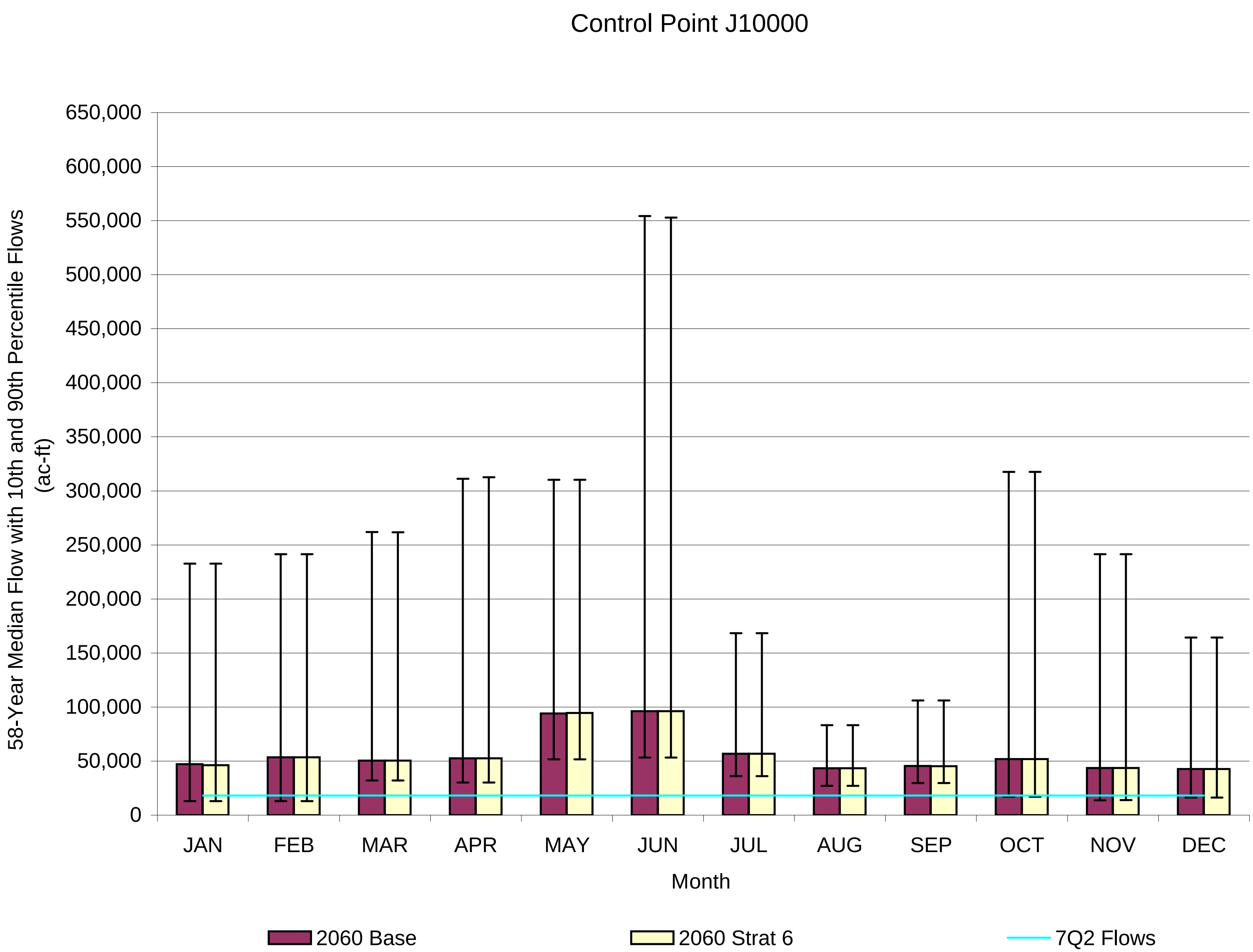
2060 Strat 6
7Q2 Flows


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
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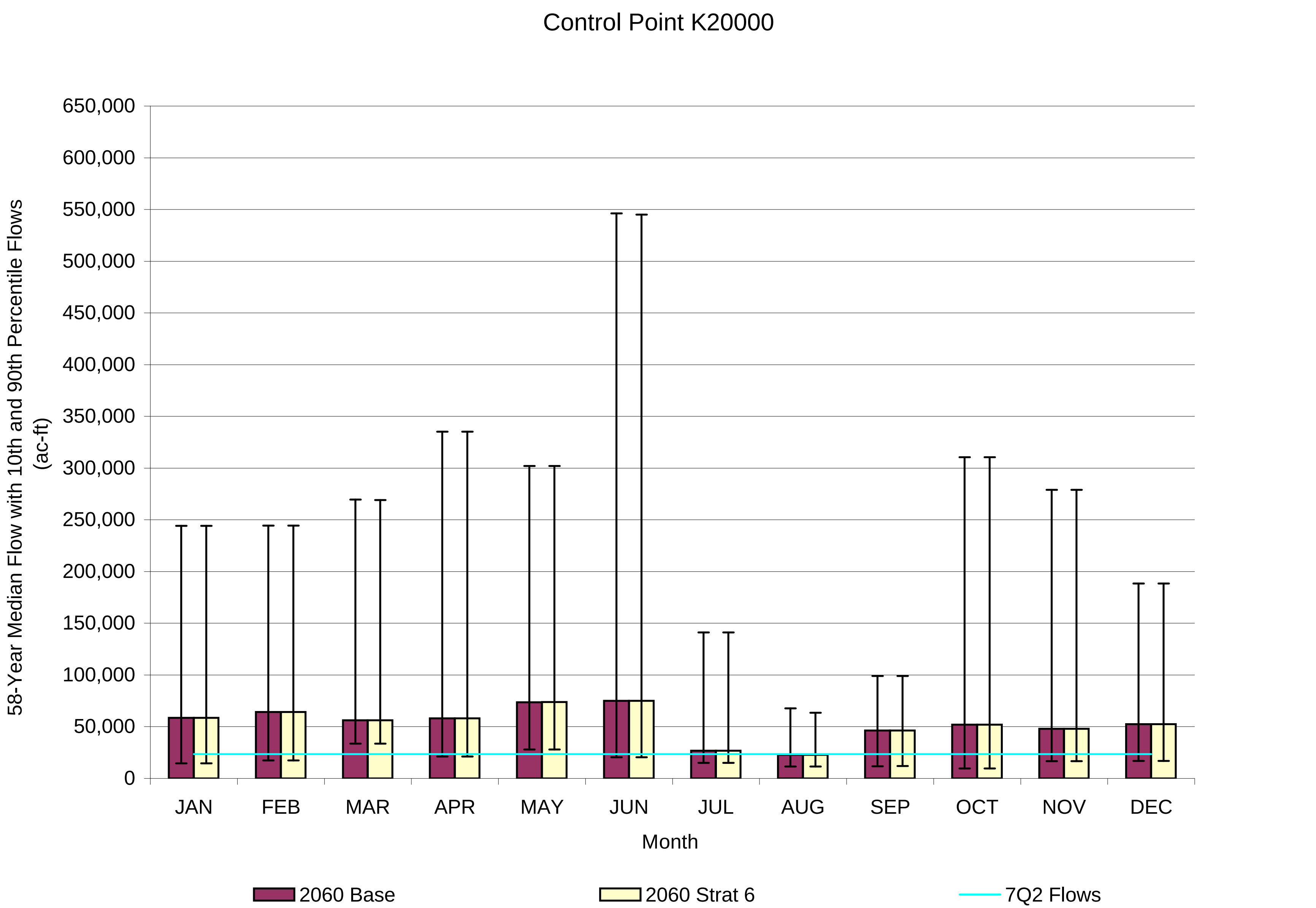
Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
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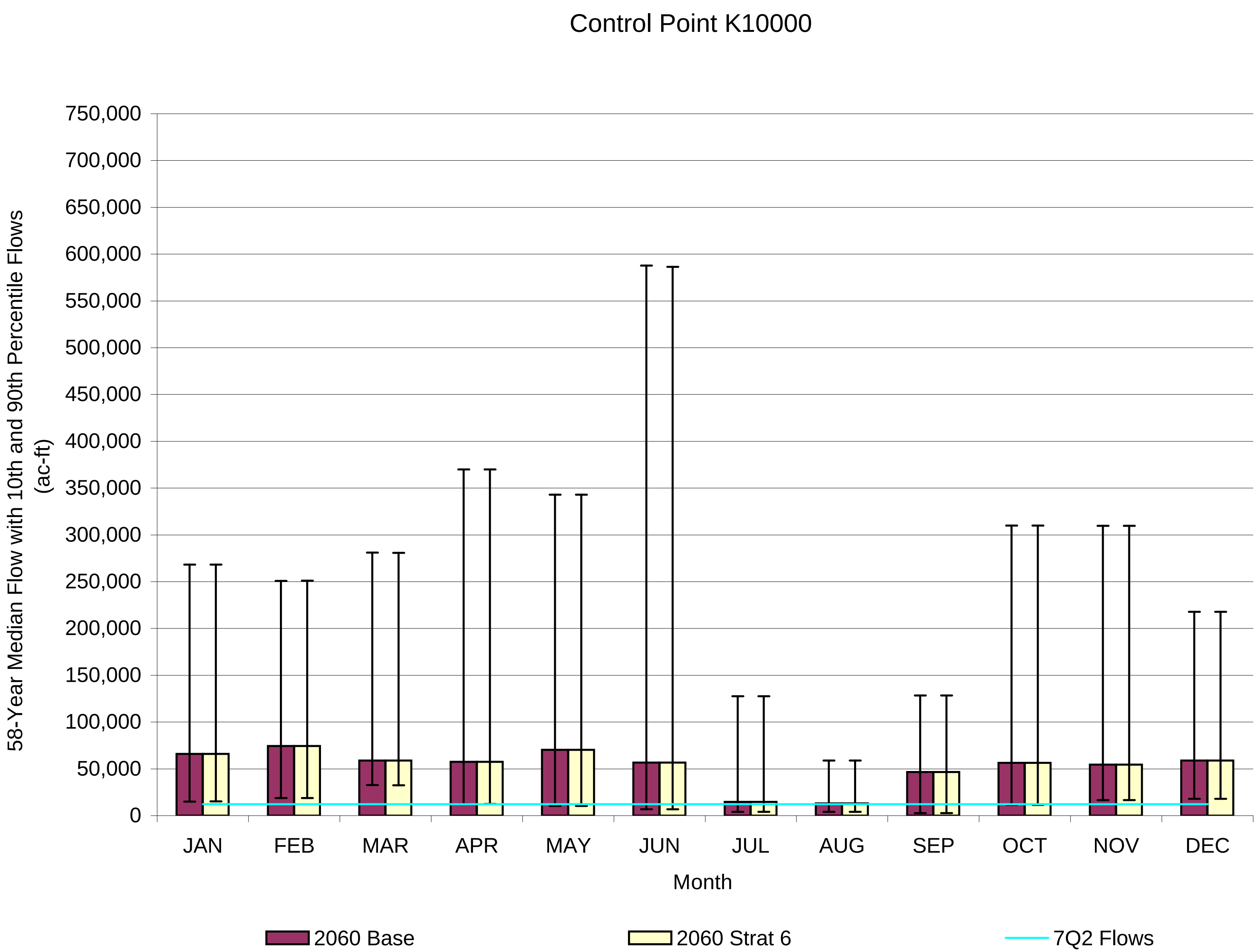
Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
750,000
700,000
650,000
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450,000
400,000
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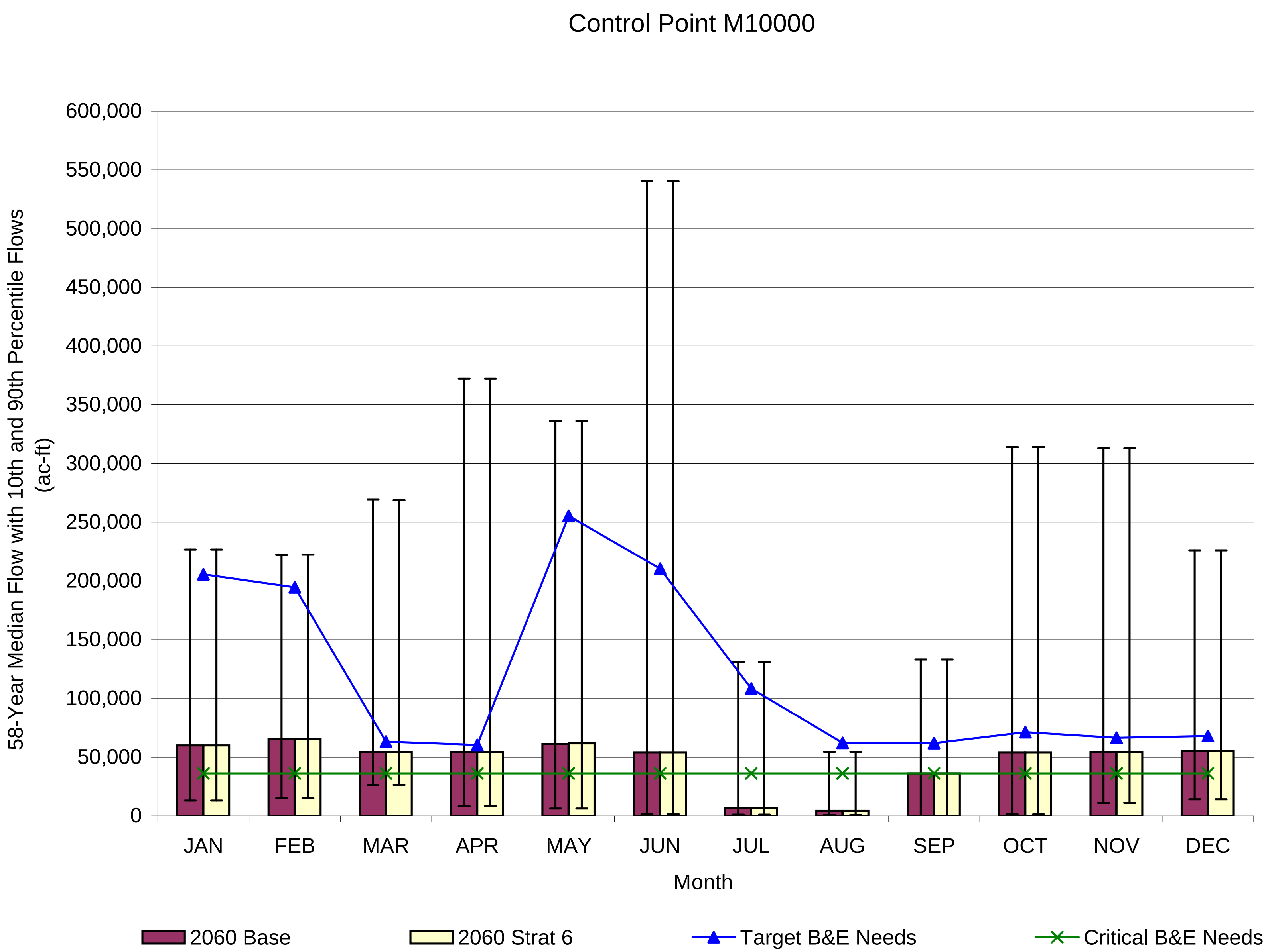
Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
600,000
550,000
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450,000
400,000
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300,000
250,000
200,000
150,000
100,000
50,000
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Month
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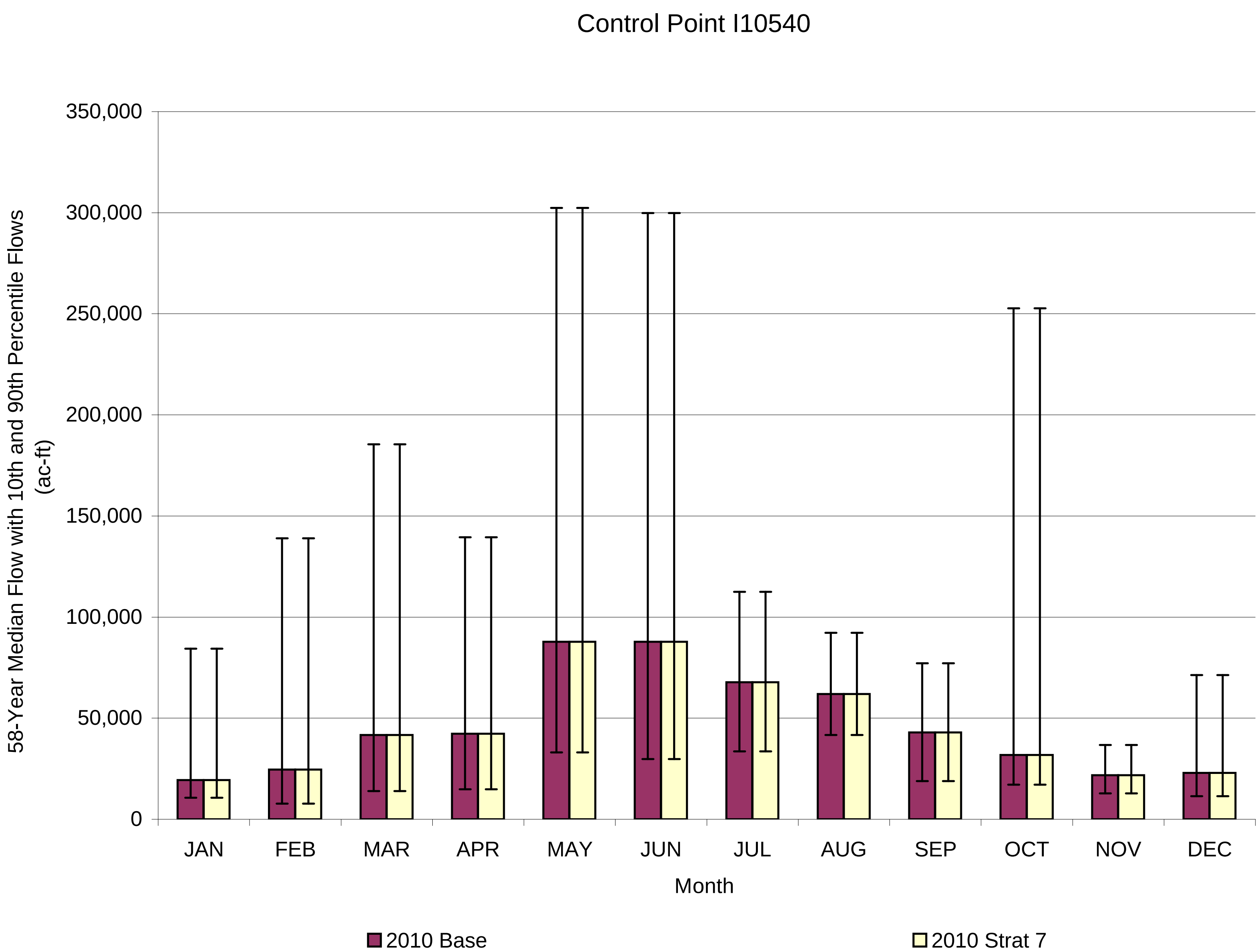
2060 Strat 6
Target B&E Needs
Critical B&E Needs

STRATEGY 7
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2010 AND 2060


Control Point I10540
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50,000
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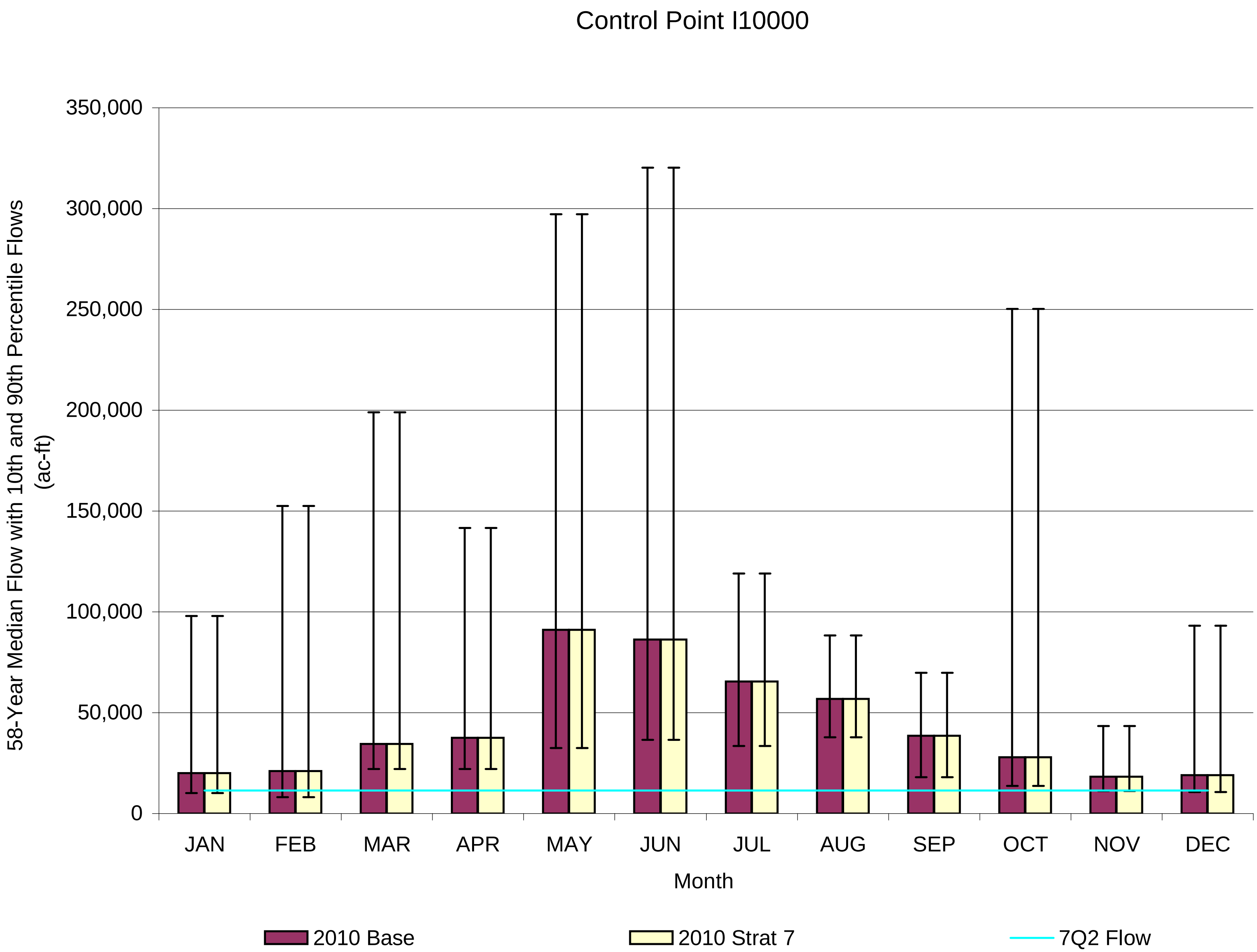
2010 Strat 7


Control Point I10000
350,000
300,000
250,000
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100,000
50,000
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58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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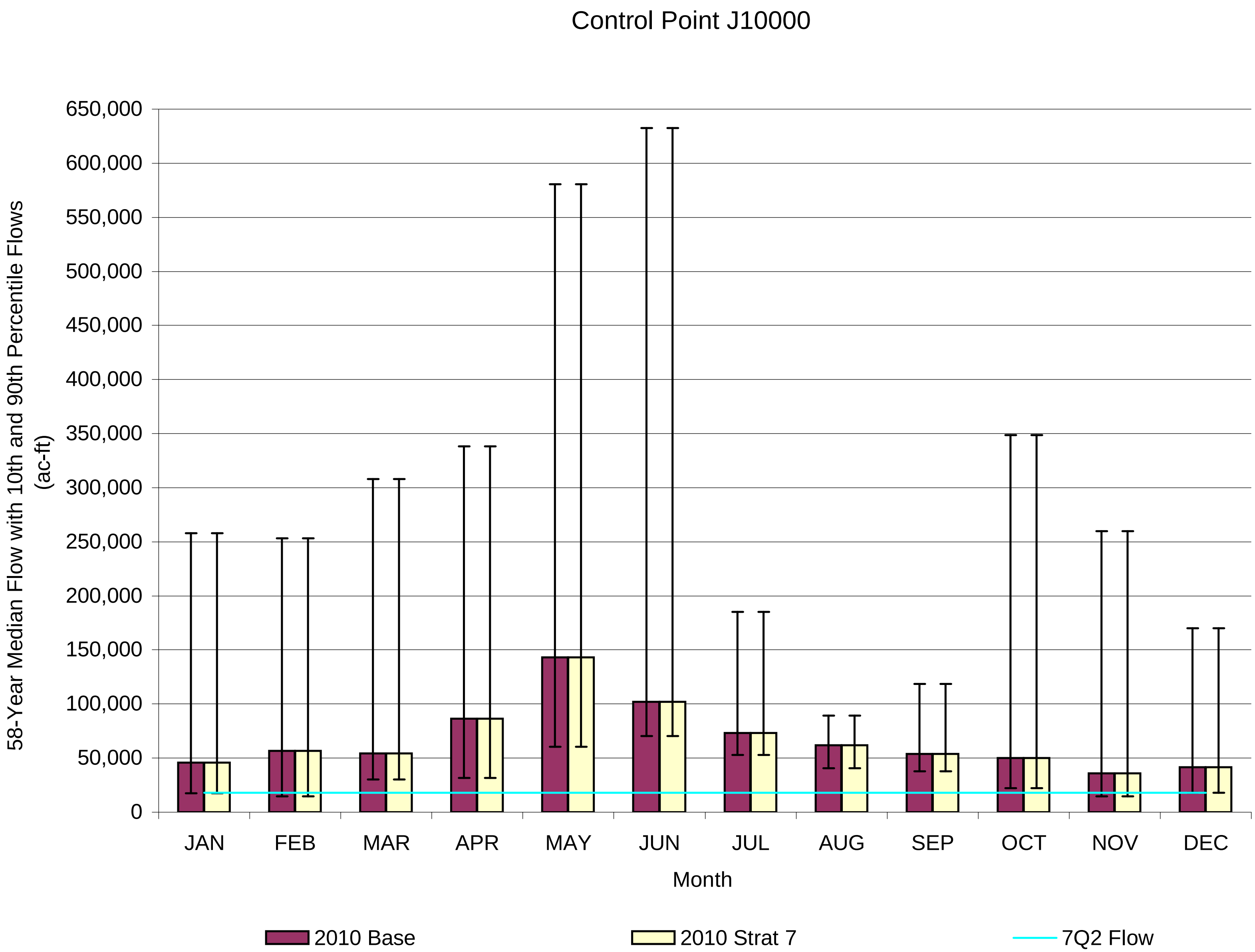
7Q2 Flow


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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600,000
550,000
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450,000
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300,000
250,000
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2010 Strat 7
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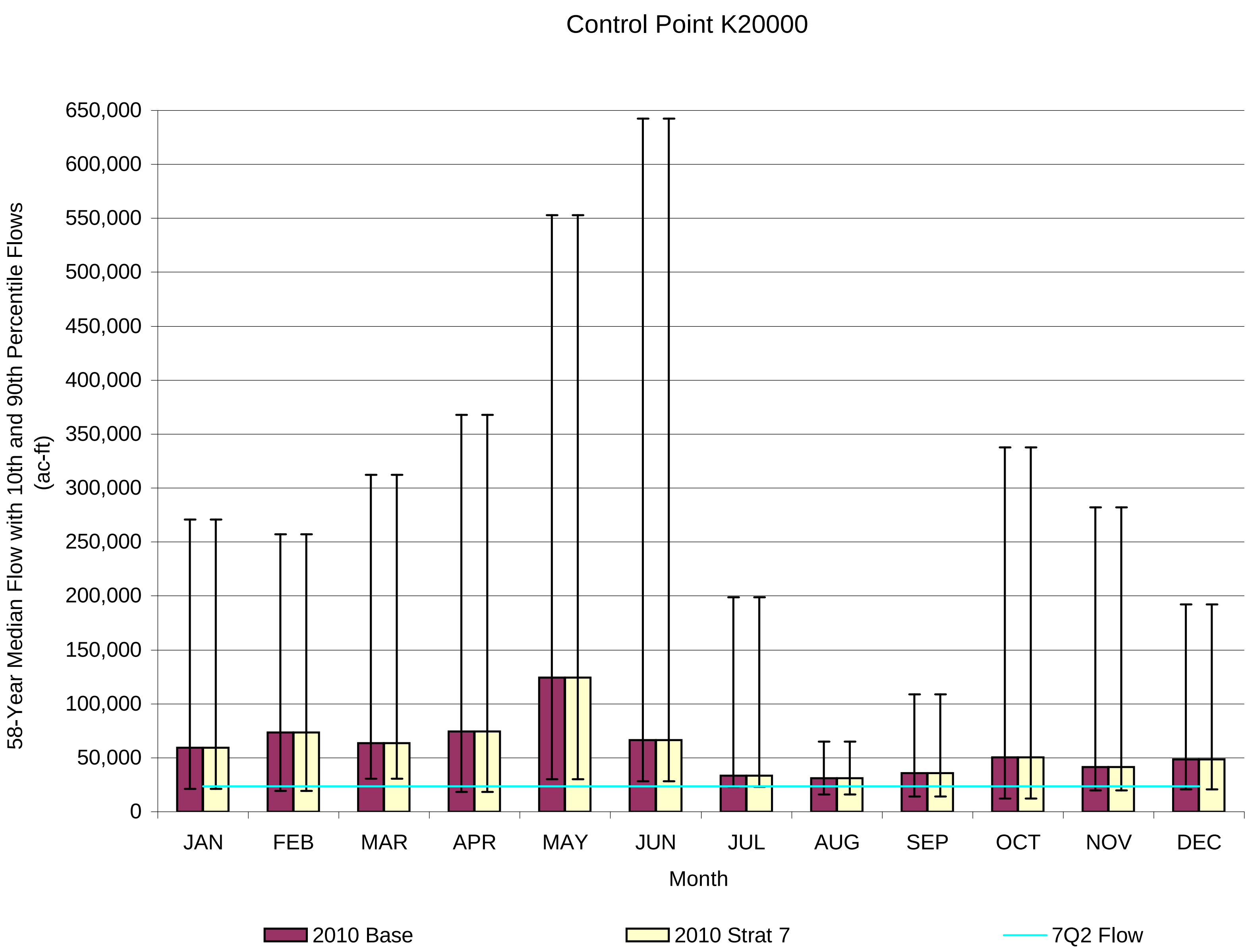
Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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600,000
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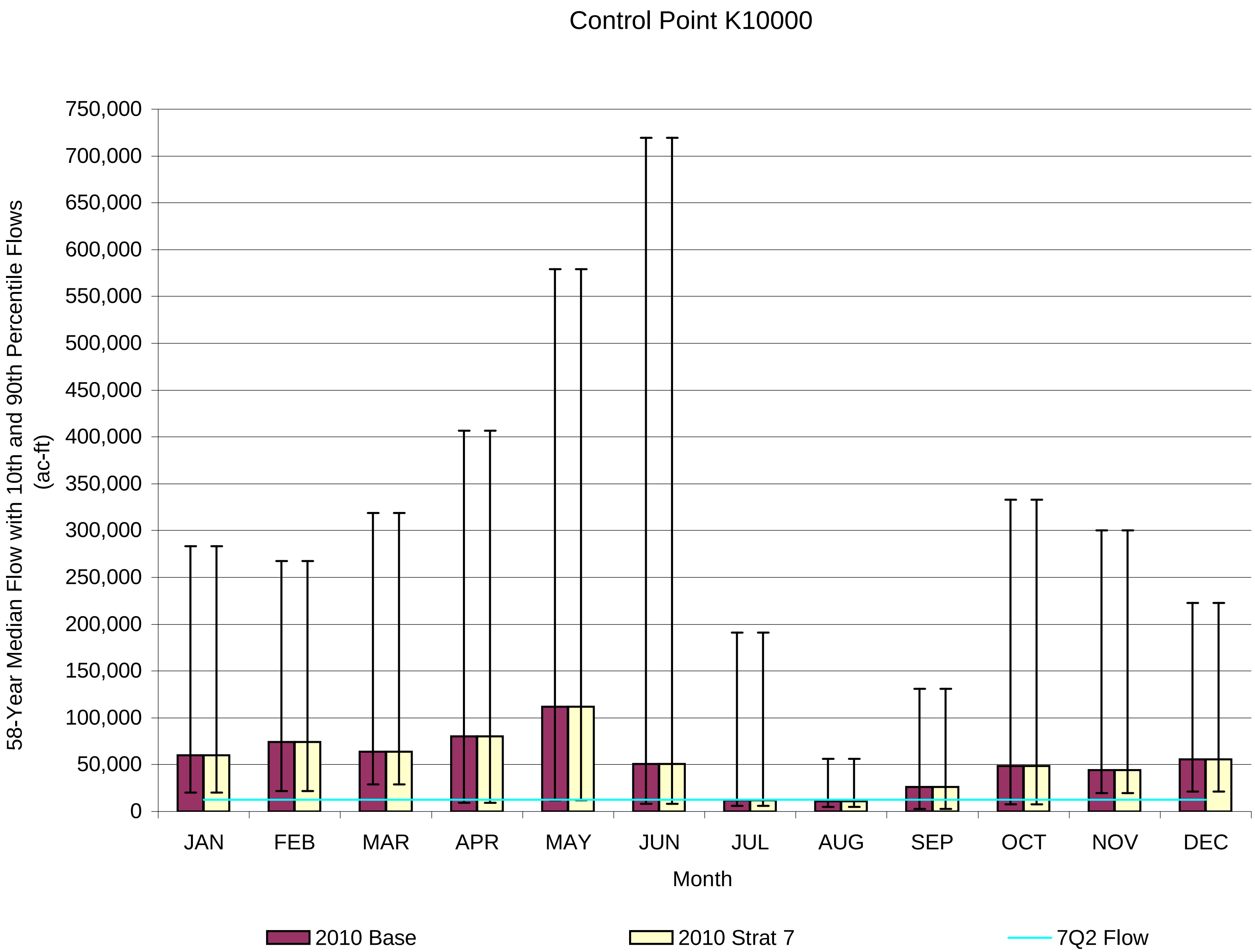
2010 Strat 7
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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700,000
650,000
600,000
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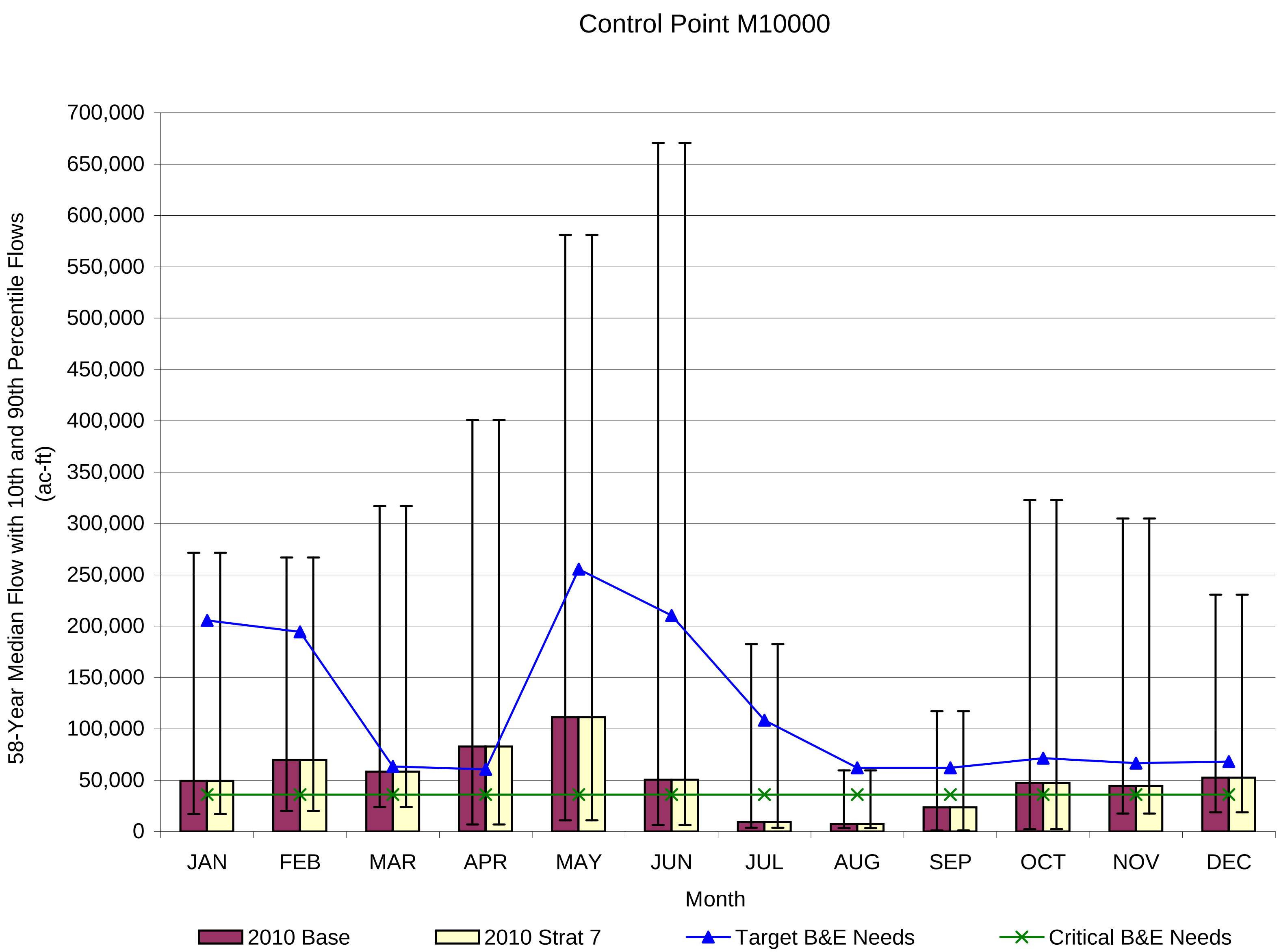
2010 Base
2010 Strat 7
7Q2 Flow



Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
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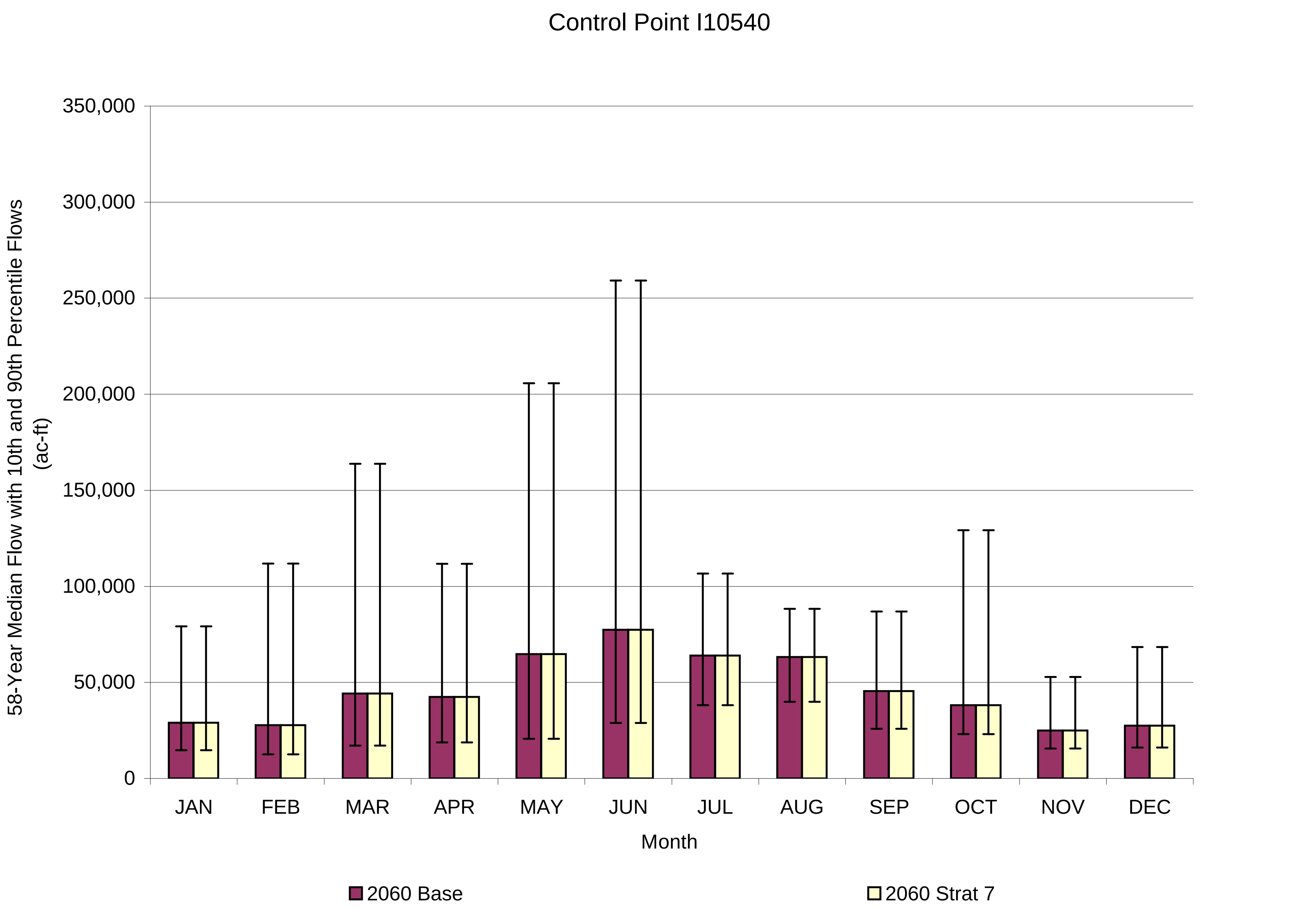
2010 Base
2010 Strat 7
Target B&E Needs
Critical B&E Needs


Control Point I10540
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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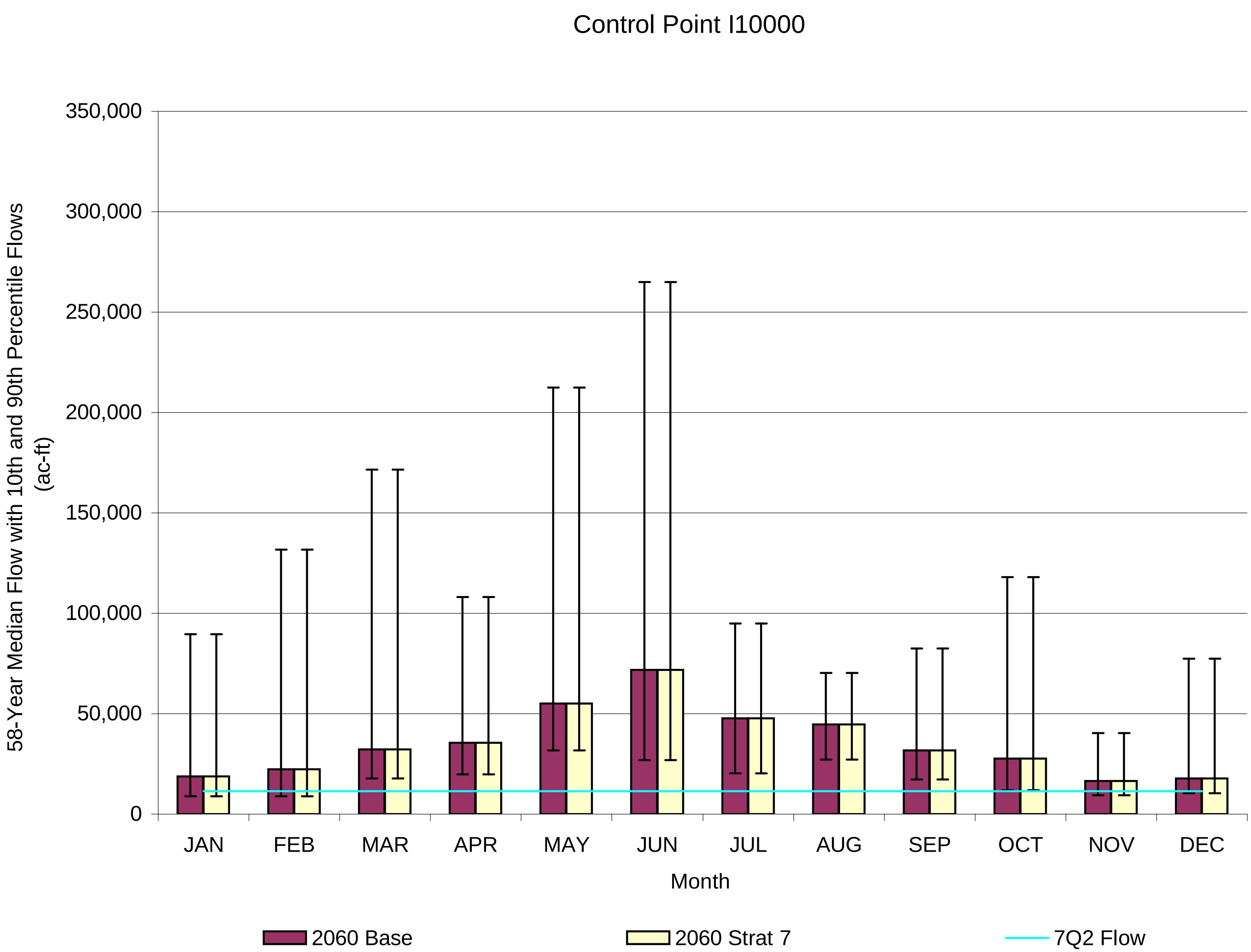
2060 Strat 7


Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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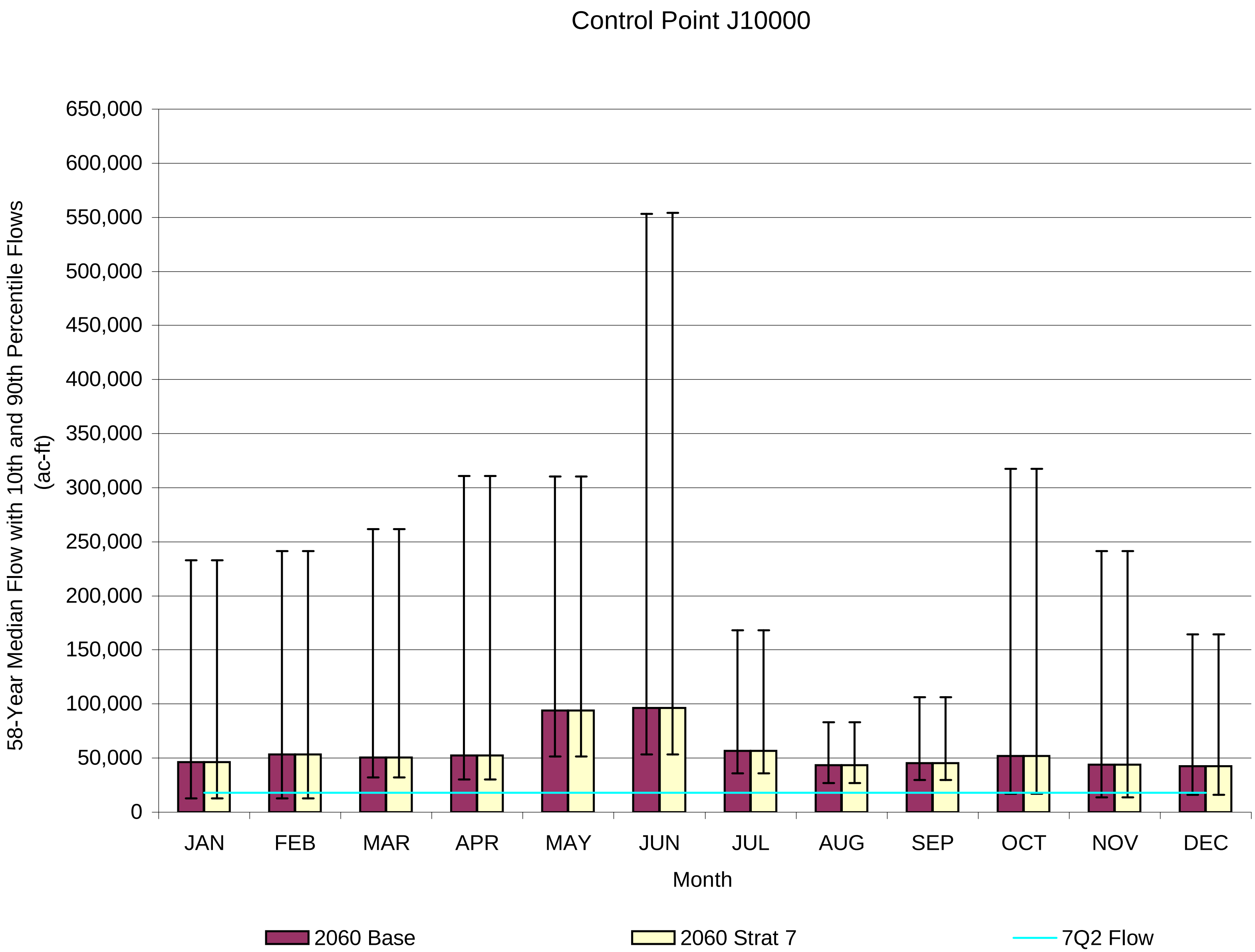
7Q2 Flow


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
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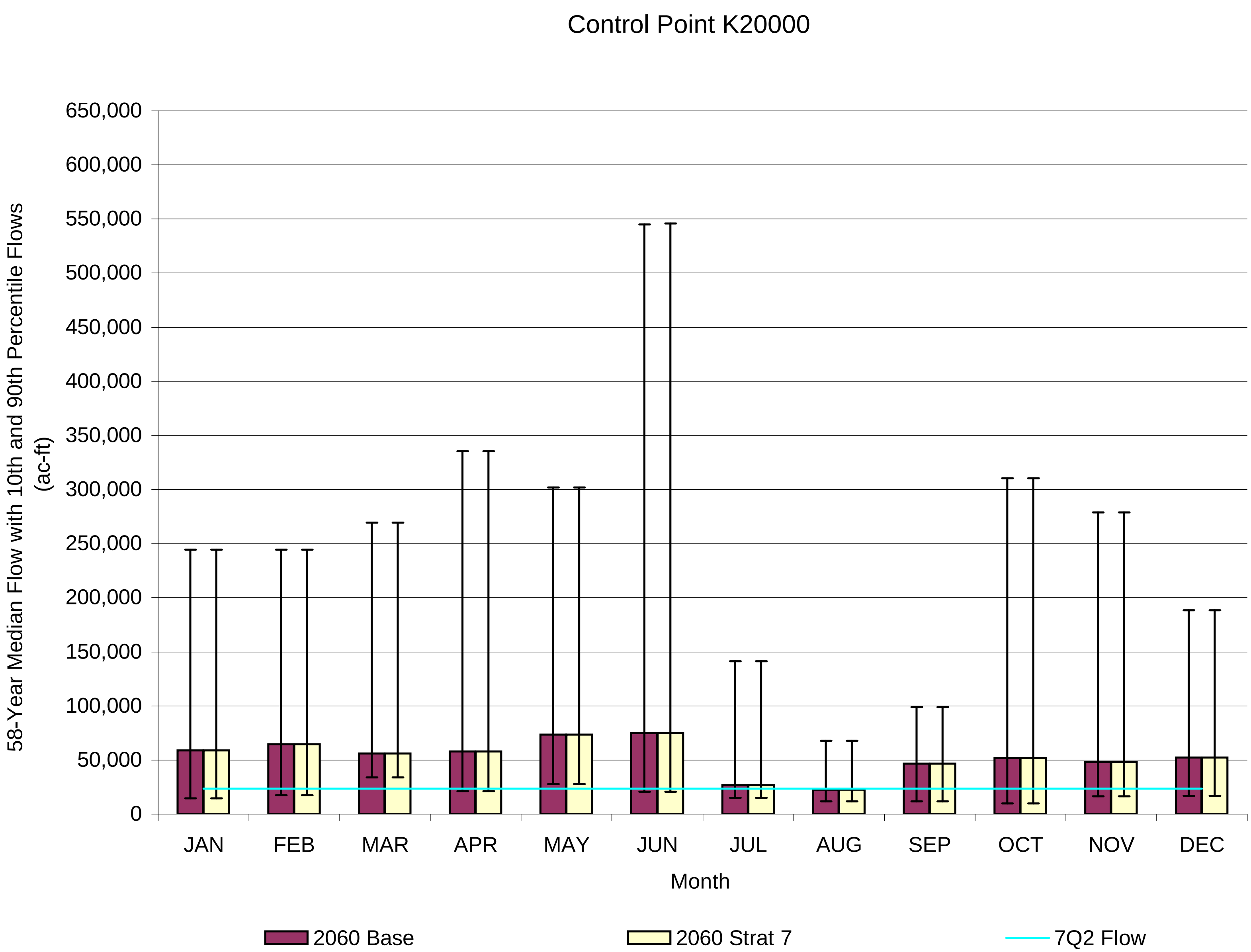
Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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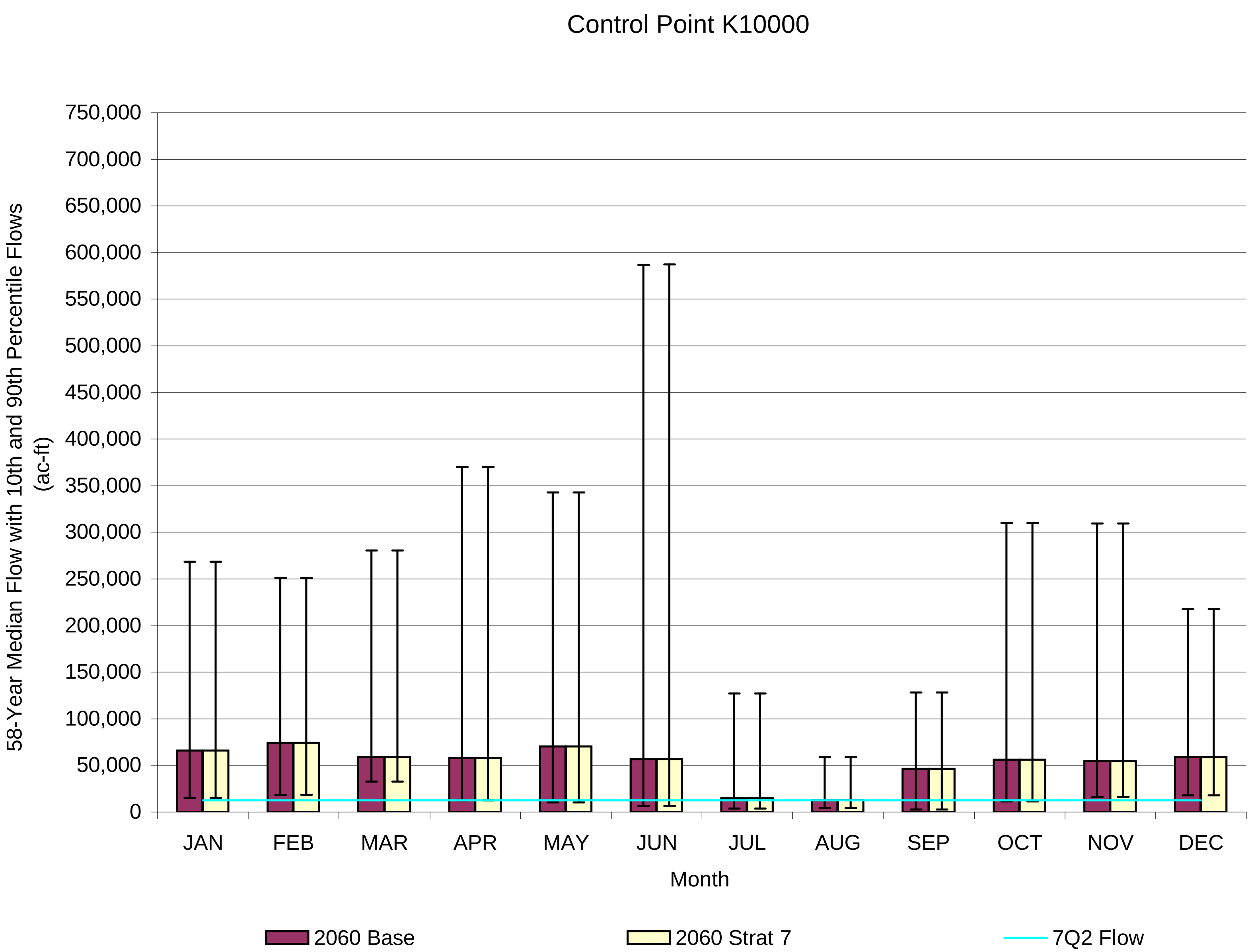
Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
750,000
700,000
650,000
600,000
550,000
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450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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JAN
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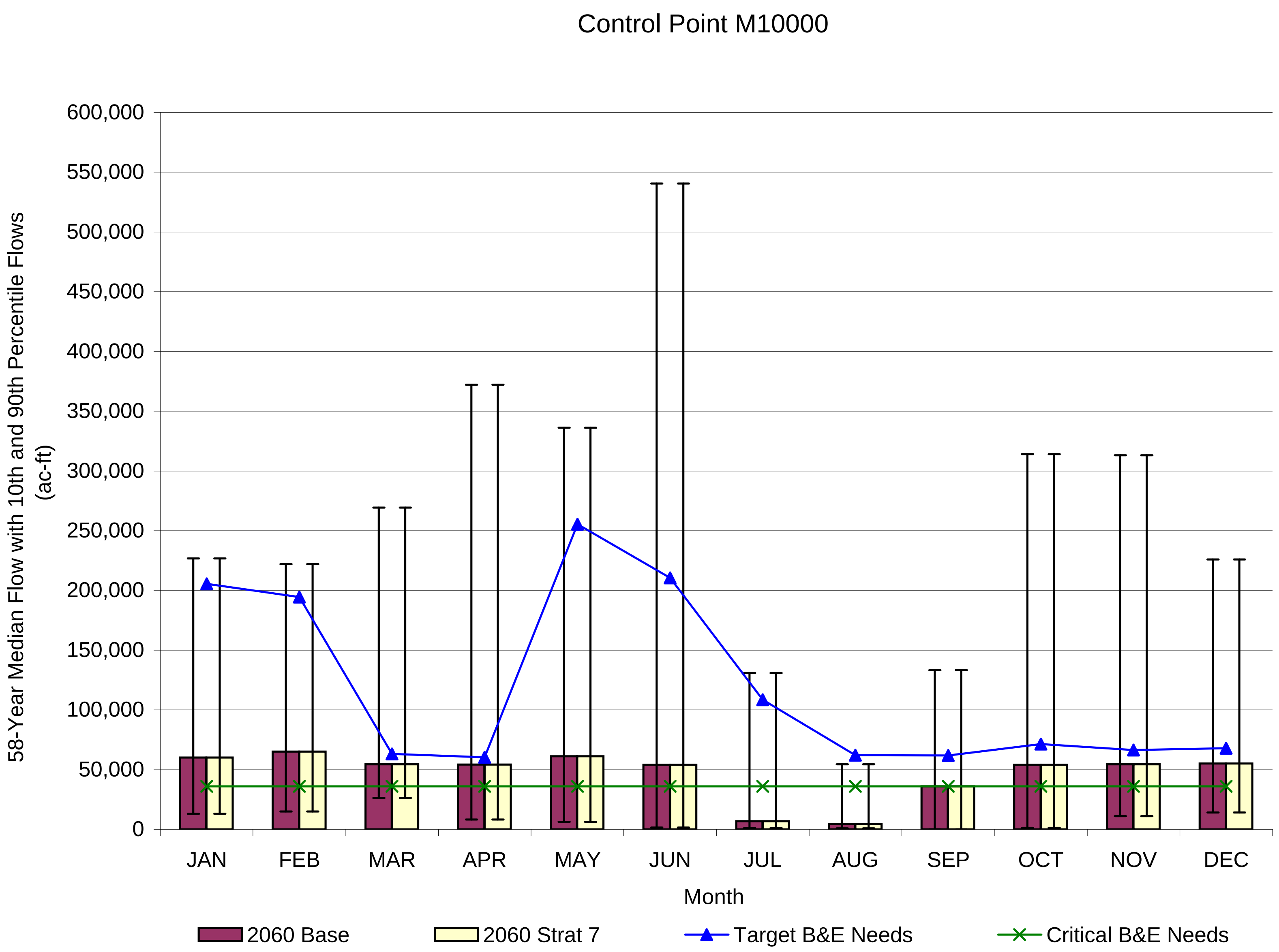
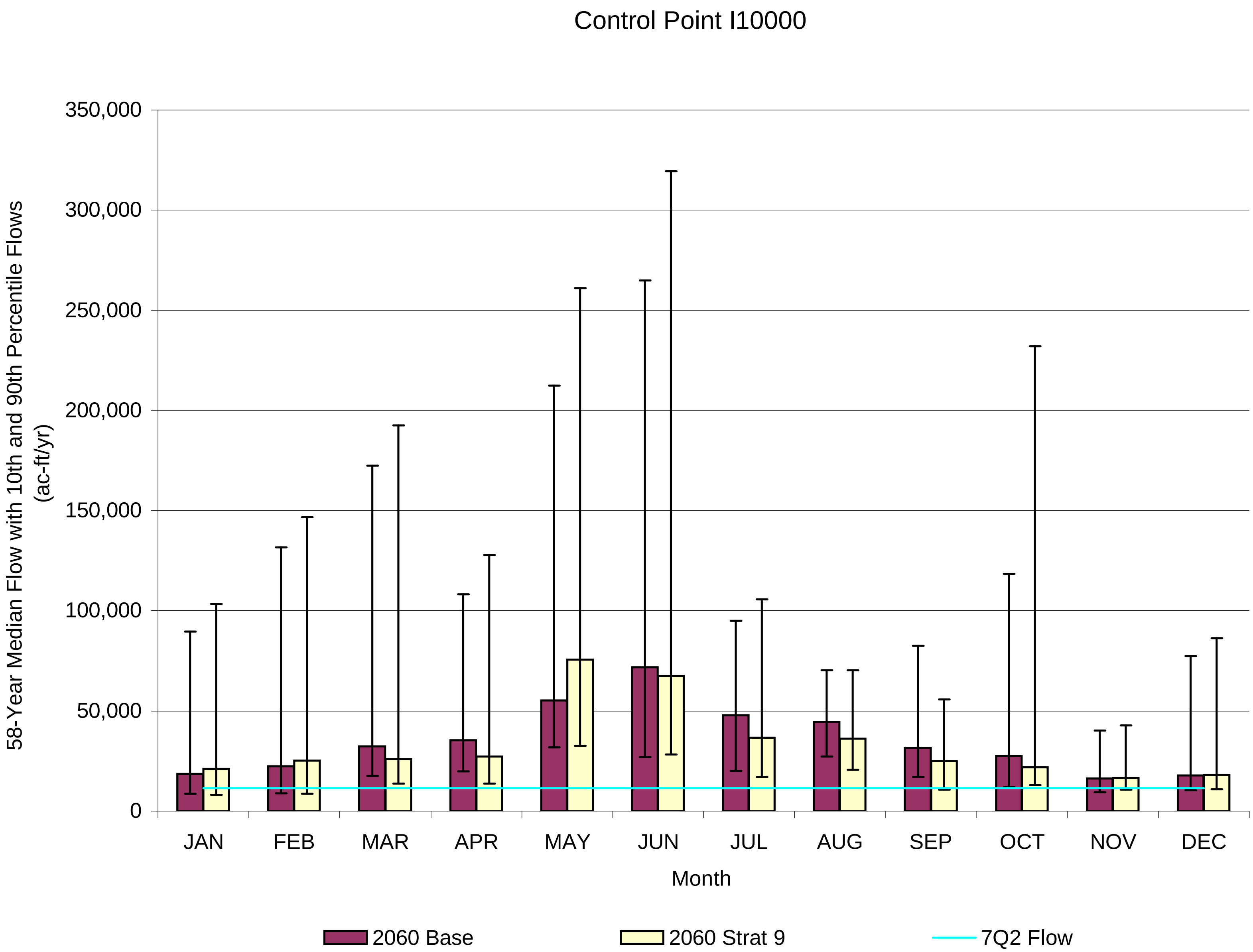
DEC
Month
2060 Base
2060 Strat 7
7Q2 Flow


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 7
Target B&E Needs
Critical B&E Needs

STRATEGY 9
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2060


Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
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MAY
JUN
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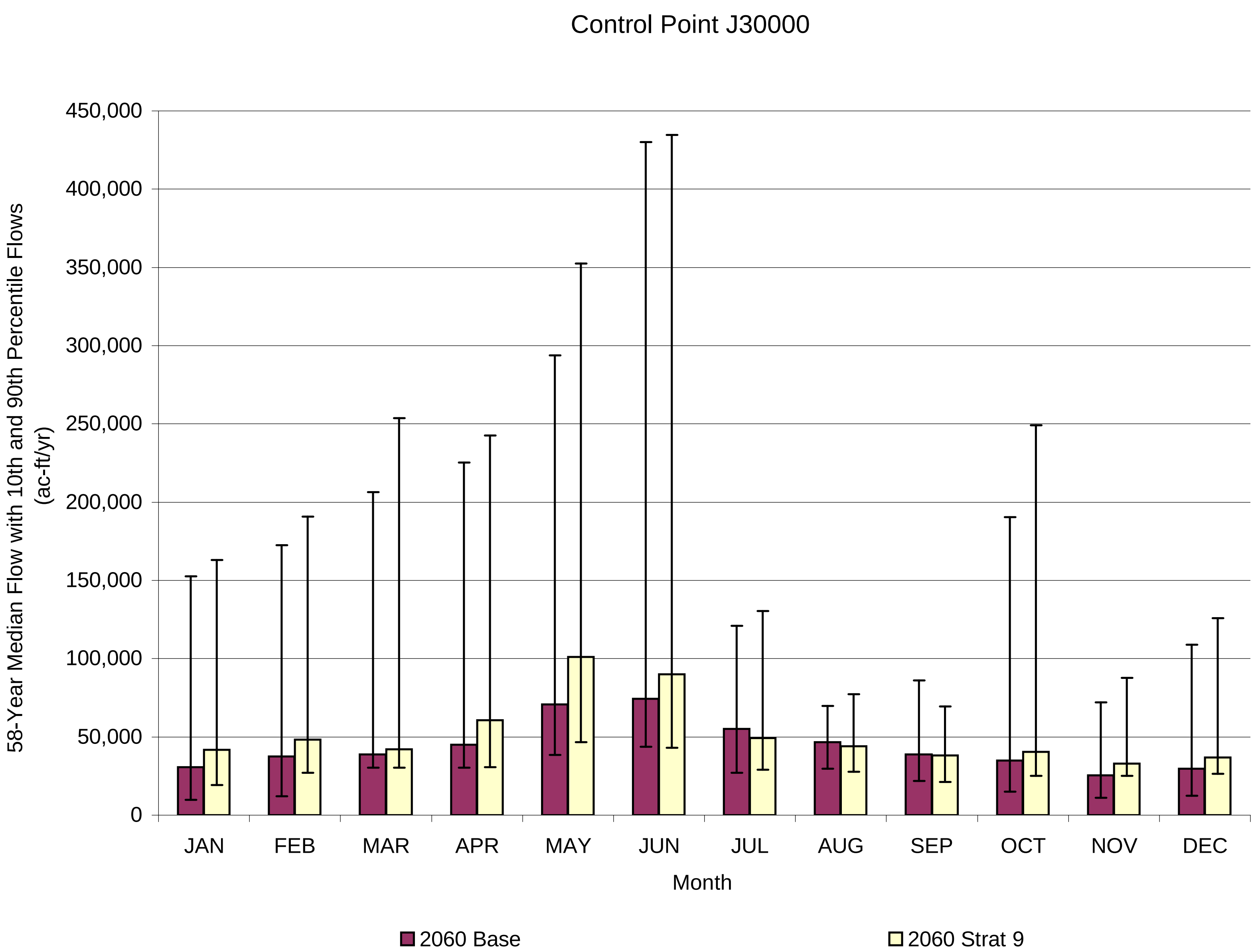
OCT
NOV
DEC
Month
2060 Base
2060 Strat 9
7Q2 Flow


Control Point J30000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
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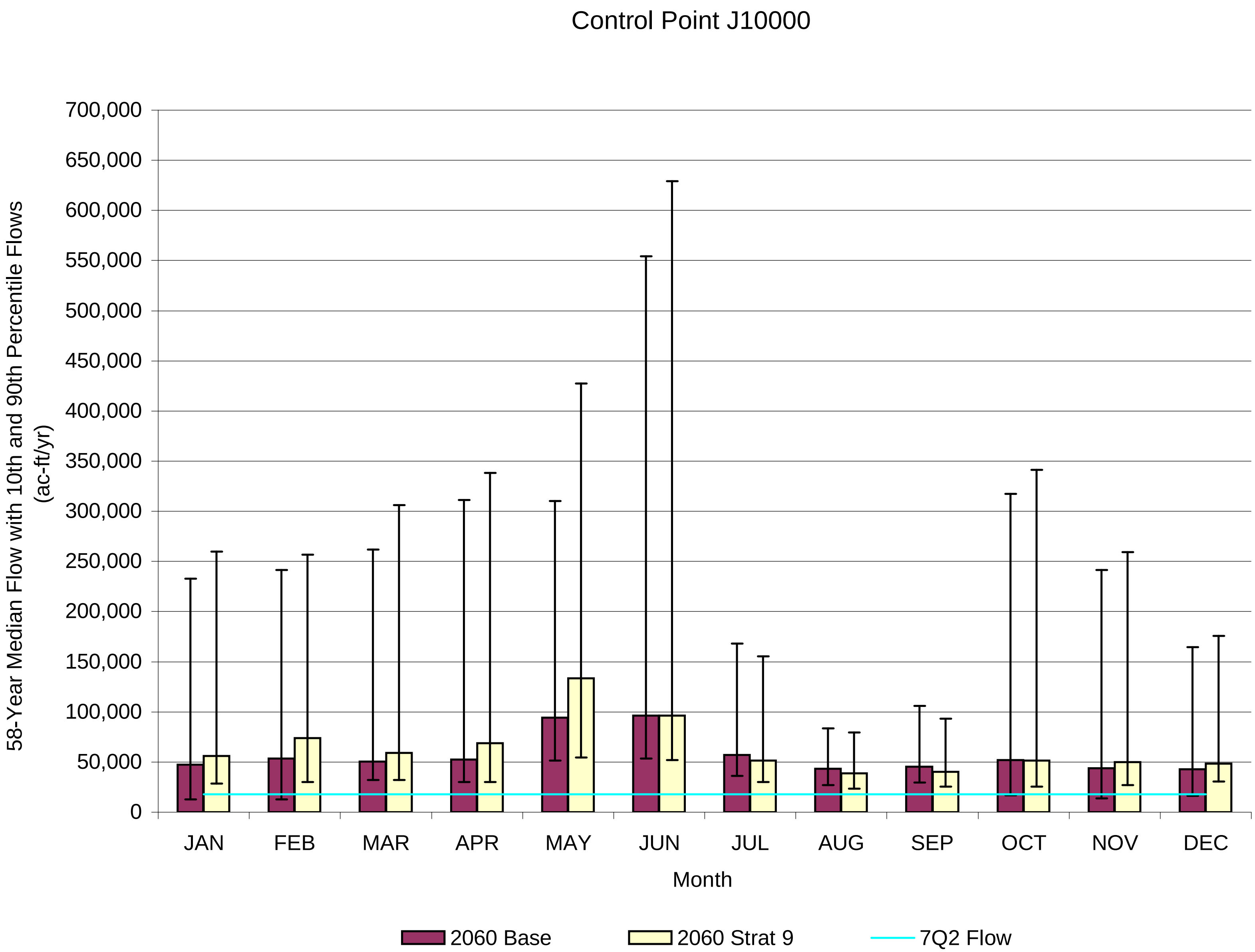
OCT
NOV
DEC
Month
2060 Base
2060 Strat 9


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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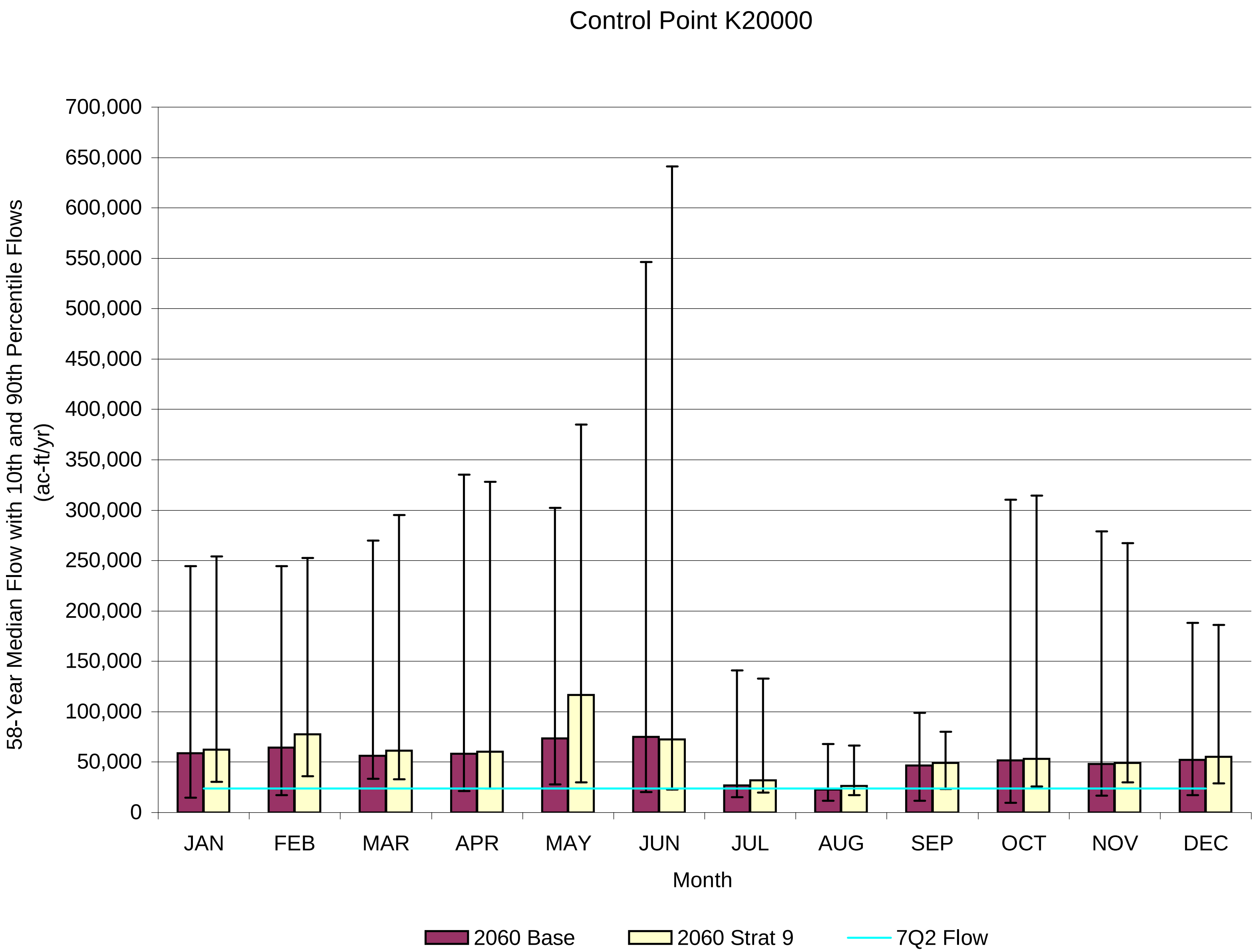
OCT
NOV
DEC
Month
2060 Base
2060 Strat 9
7Q2 Flow


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows
(ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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OCT
NOV
DEC
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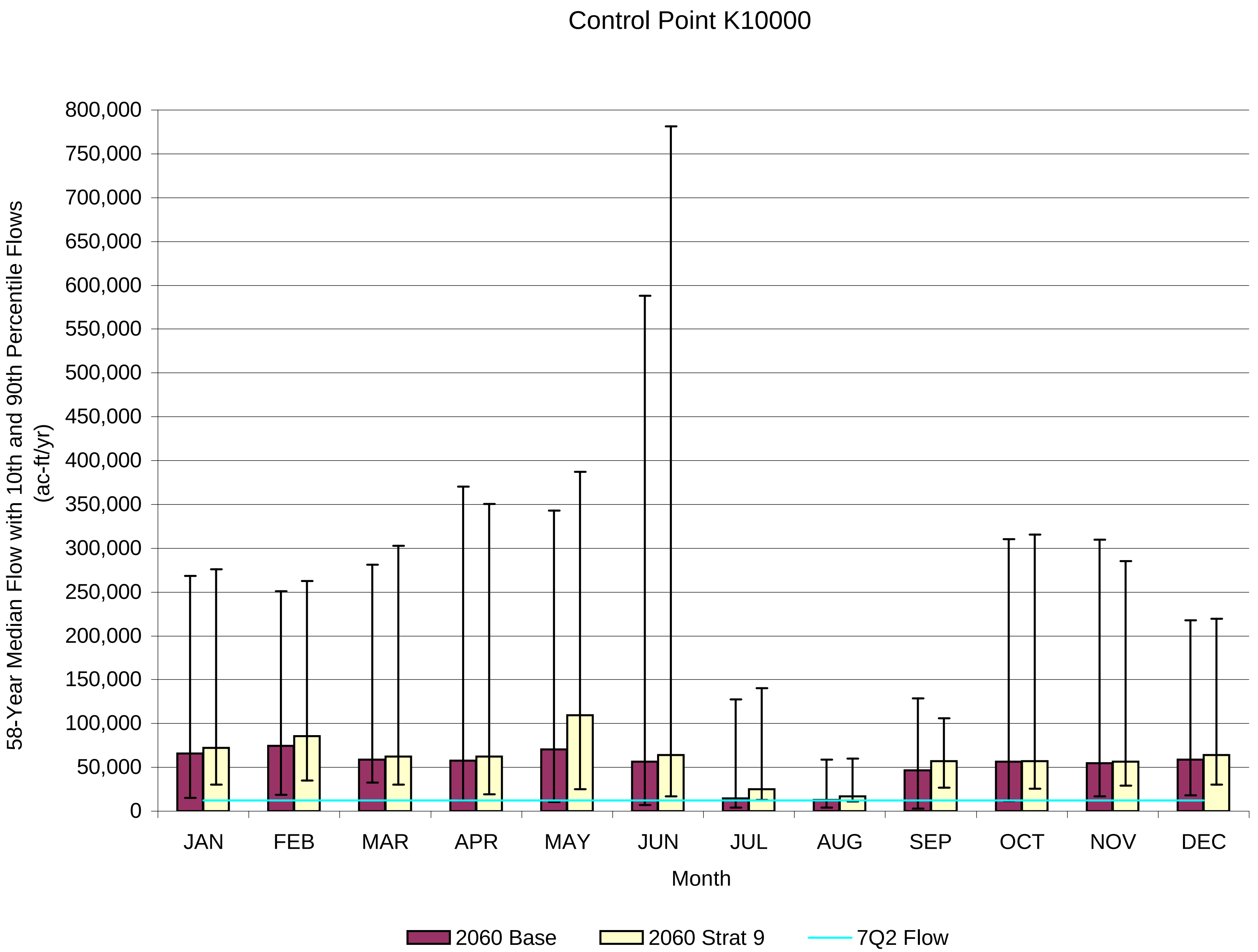
2060 Base
2060 Strat 9
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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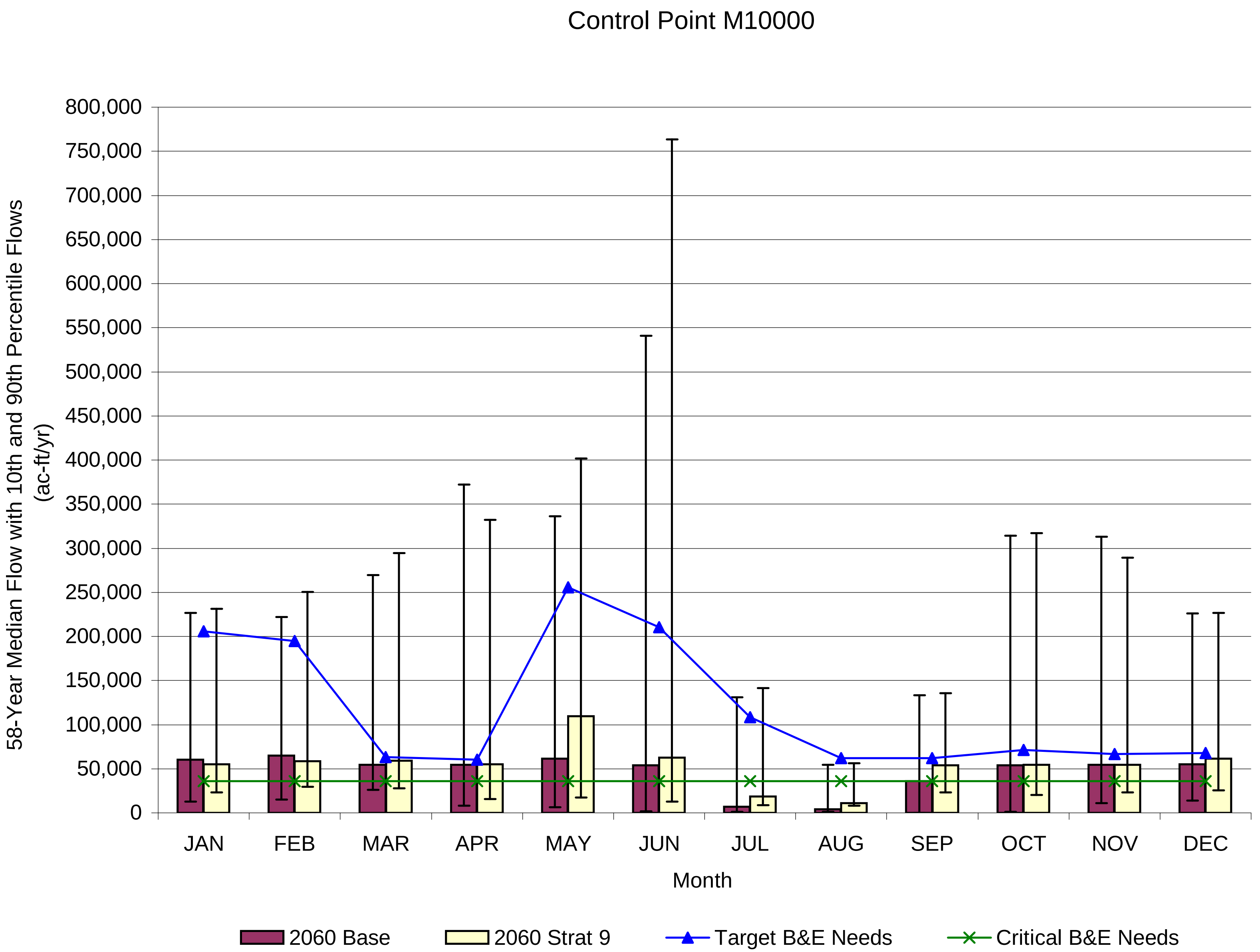
Month
2060 Base
2060 Strat 9
7Q2 Flow


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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OCT
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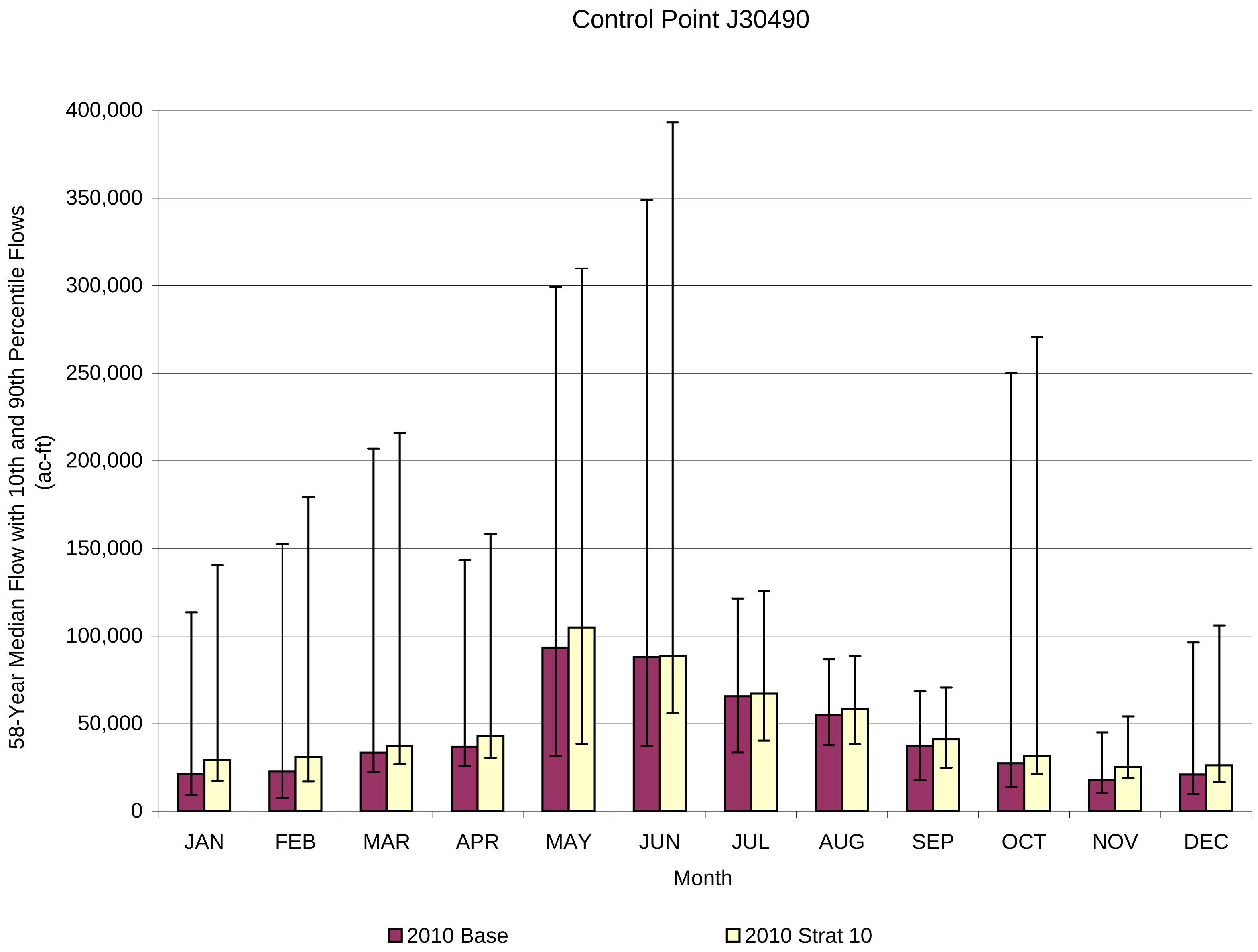
DEC
Month
2060 Base
2060 Strat 9
Target B&E Needs
Critical B&E Needs

STRATEGY 10
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2010 AND 2060


Control Point J30490
58-Year Median Flow with 10th and 90th Percentile Flows
(ac-ft)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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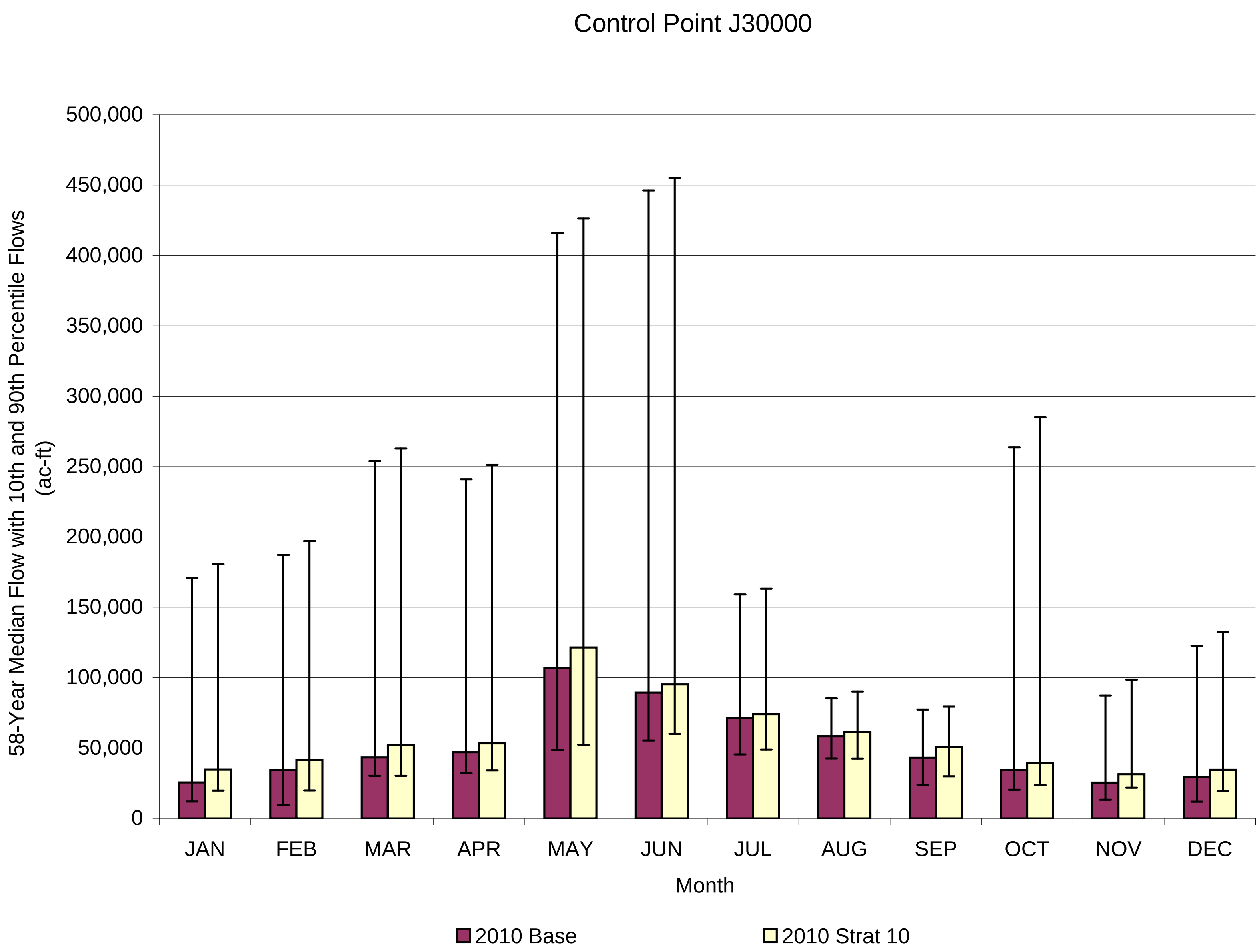
Month
2010 Base
2010 Strat 10


Control Point J30000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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JAN
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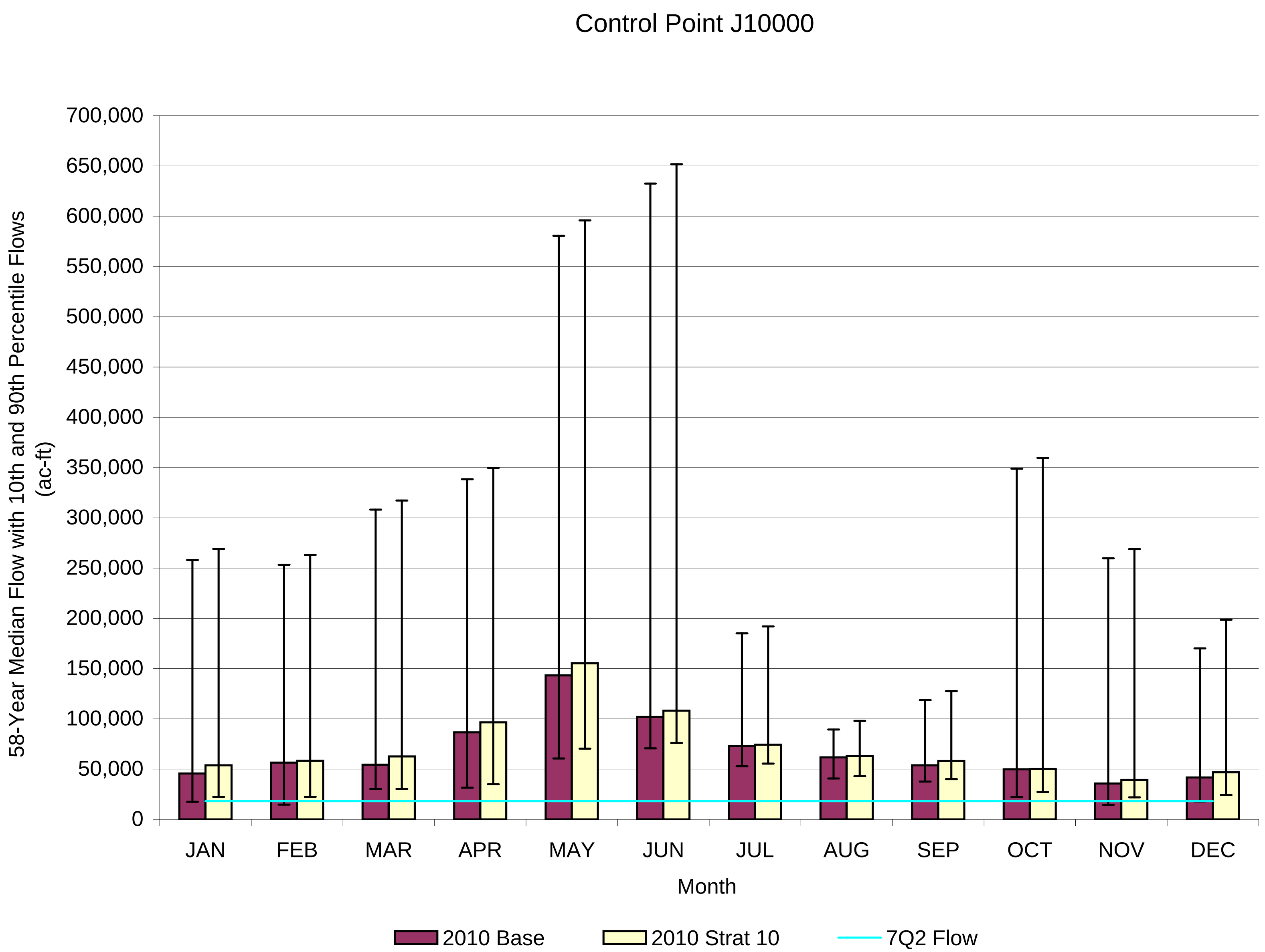
Month
2010 Base
2010 Strat 10


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
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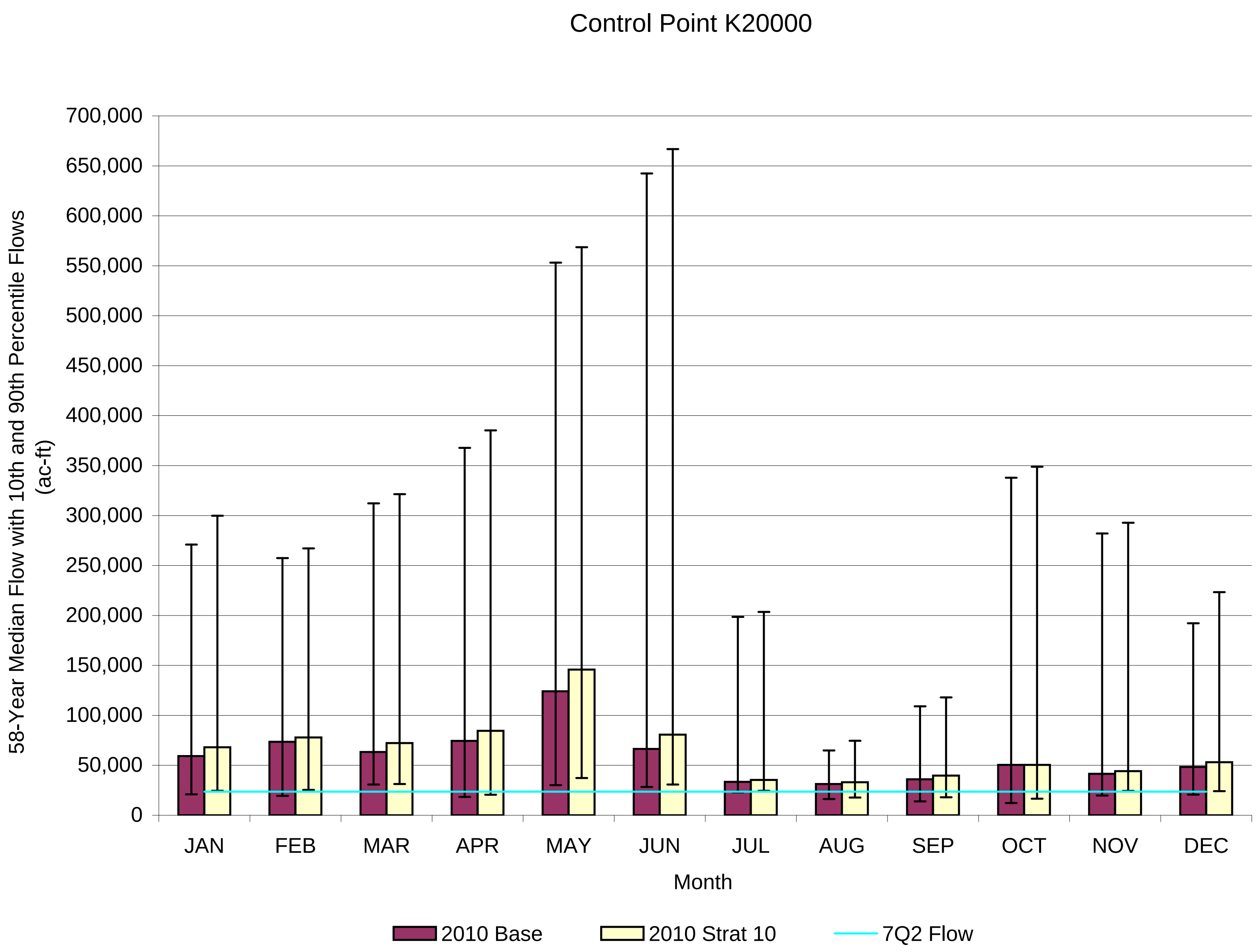
Month
2010 Base
2010 Strat 10
7Q2 Flow


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
700,000
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600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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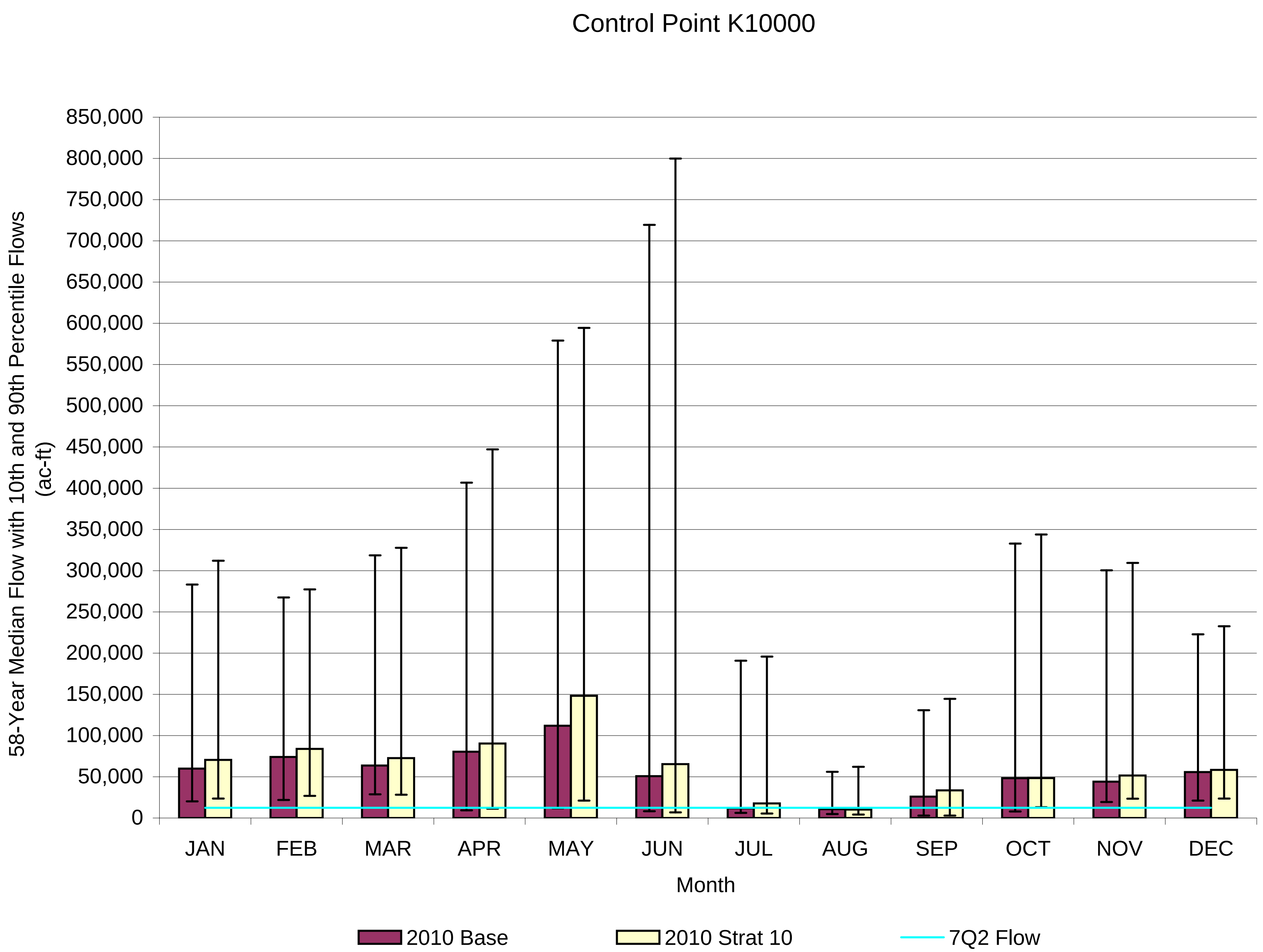
Month
2010 Base
2010 Strat 10
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
850,000
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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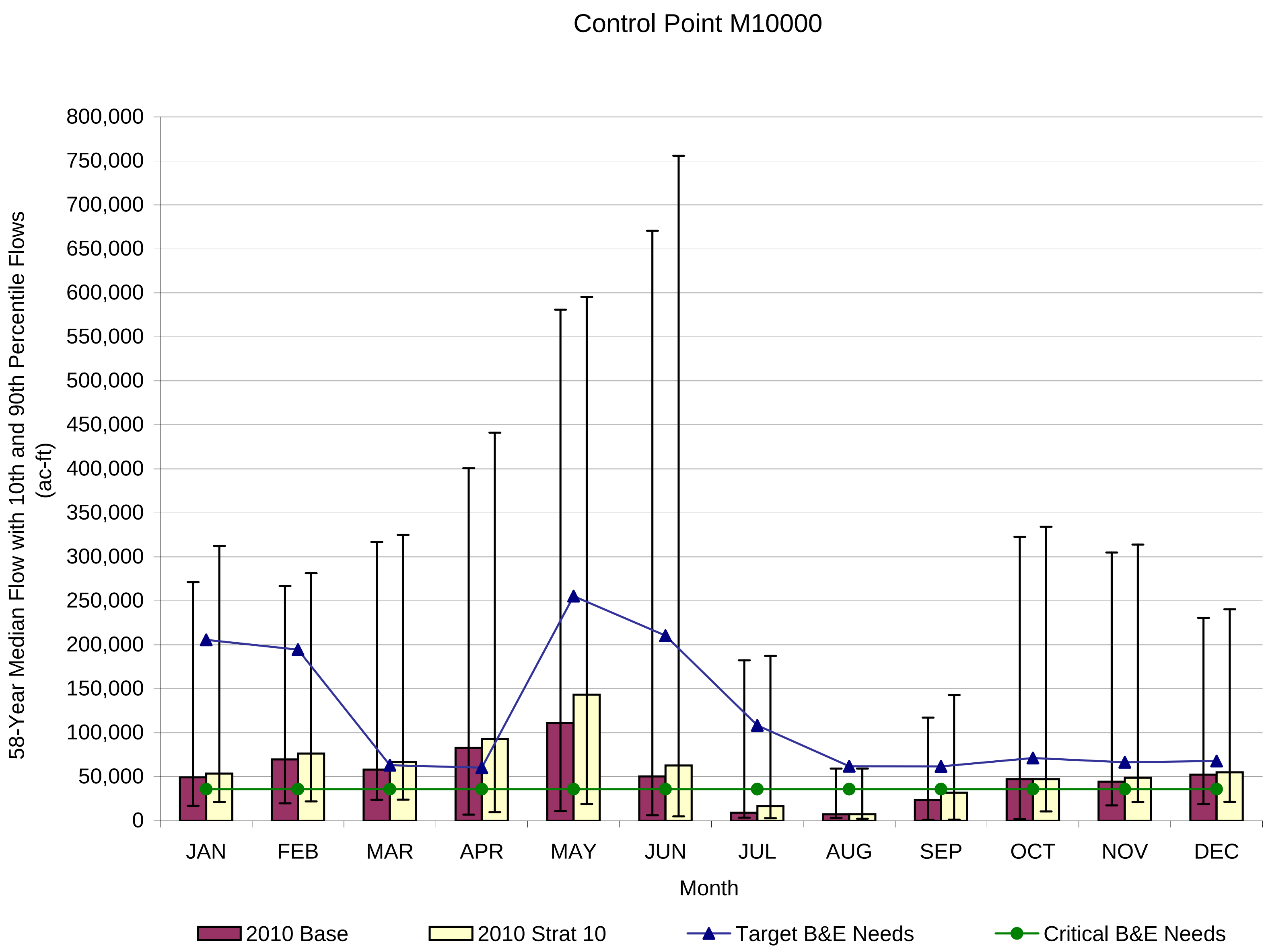
2010 Base
2010 Strat 10
7Q2 Flow


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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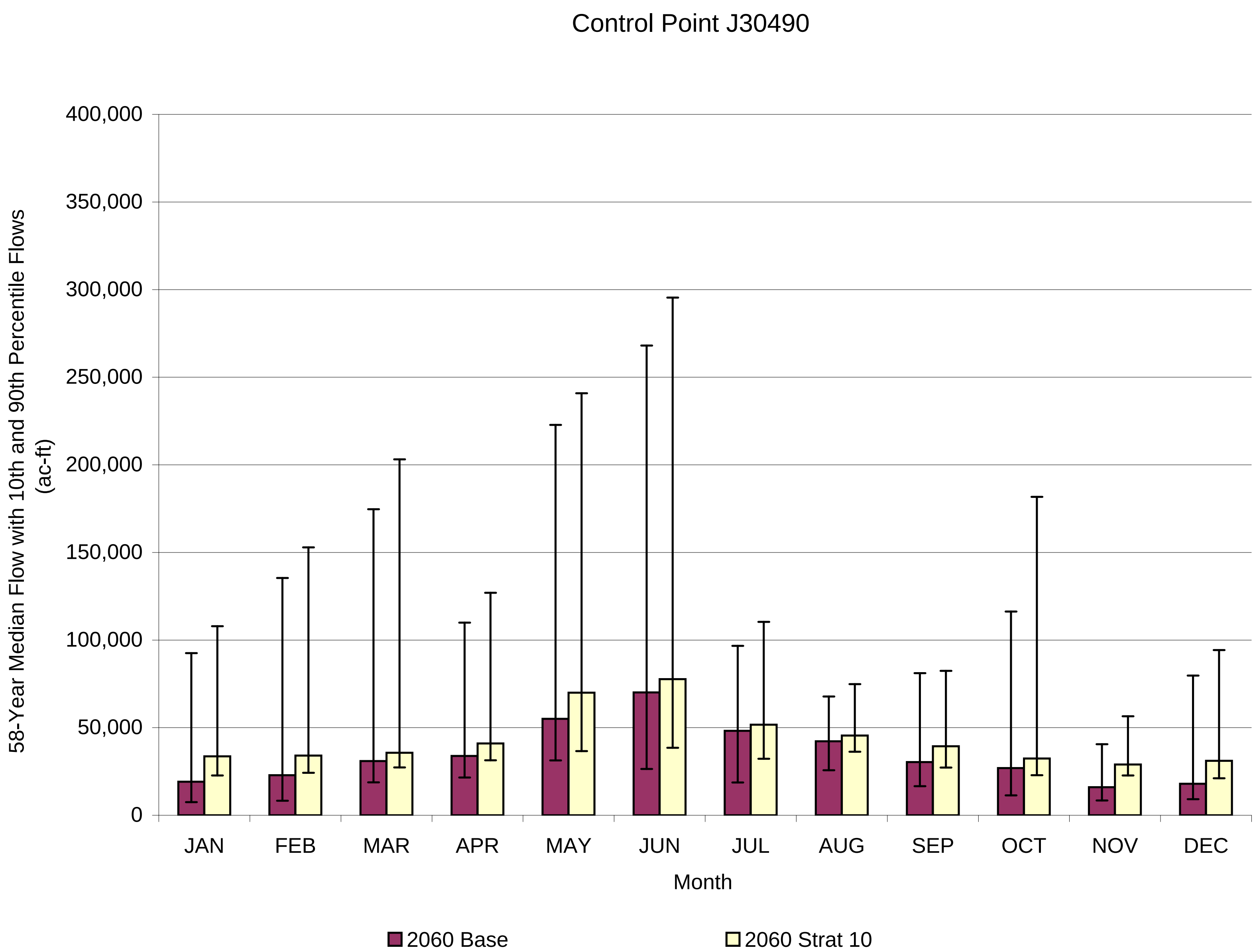
DEC
Month
2010 Base
2010 Strat 10
Target B&E Needs
Critical B&E Needs


Control Point J30490
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
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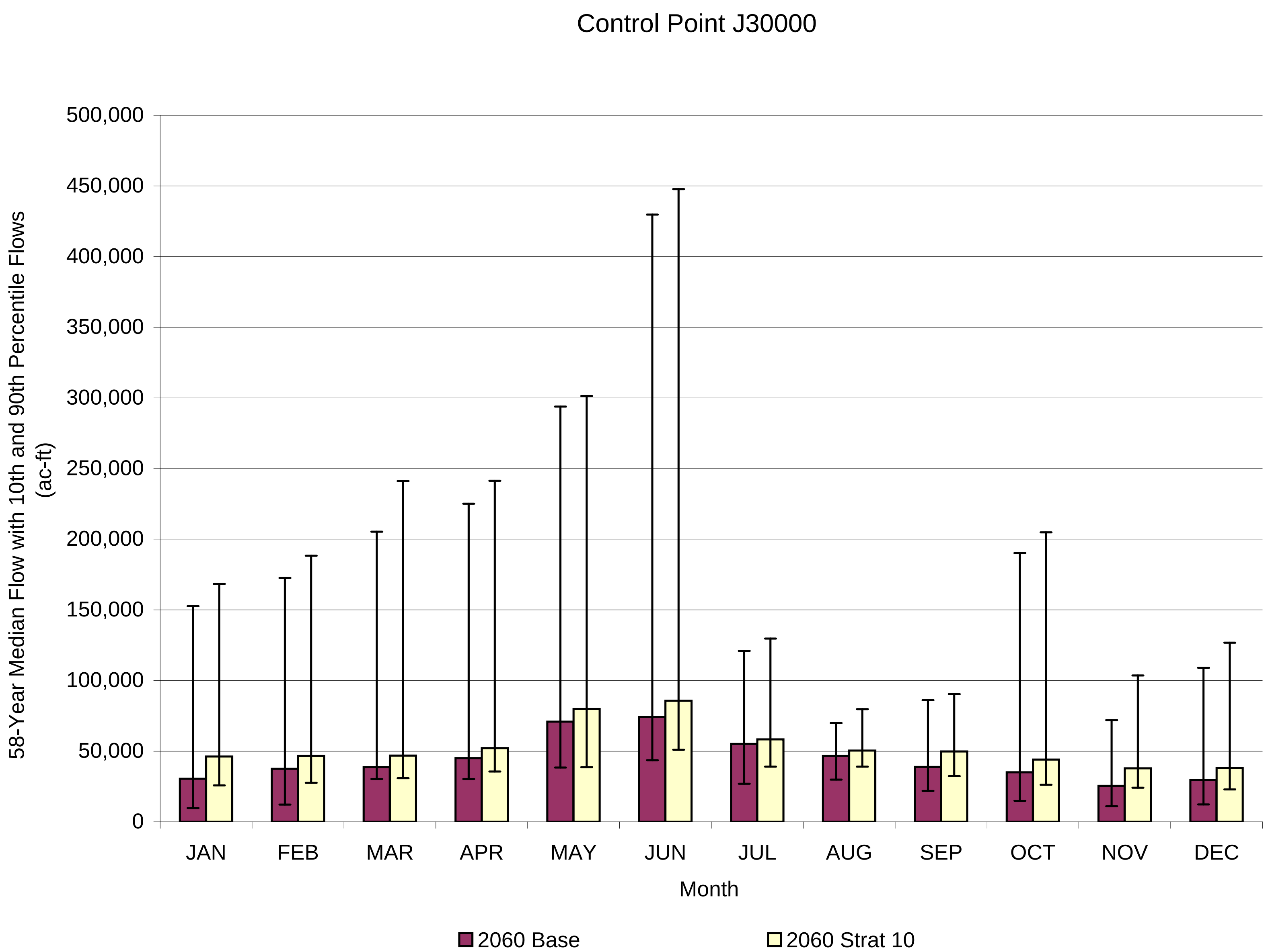
Month
2060 Base
2060 Strat 10


Control Point J30000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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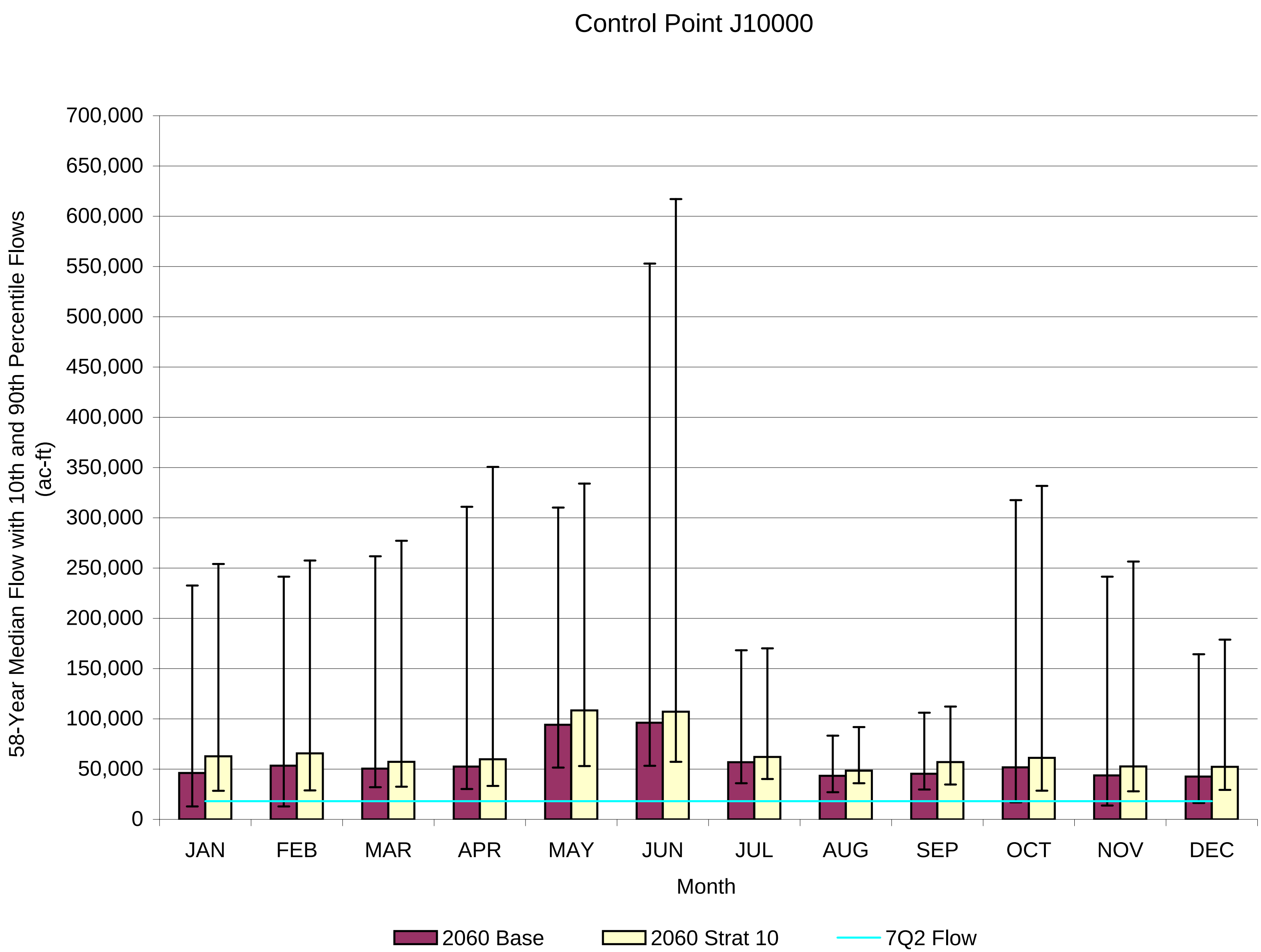
Month
2060 Base
2060 Strat 10


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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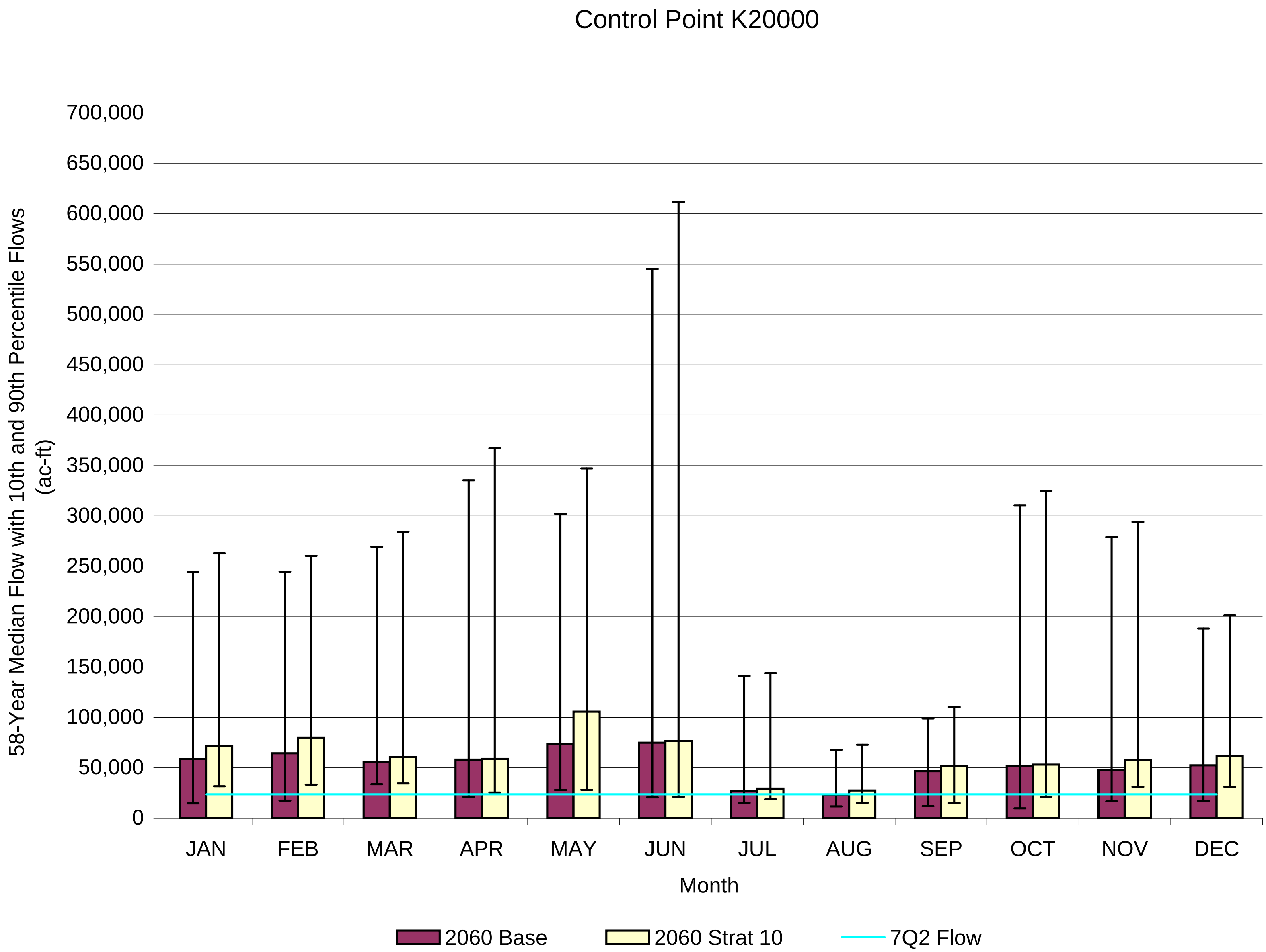
2060 Base
2060 Strat 10
7Q2 Flow


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
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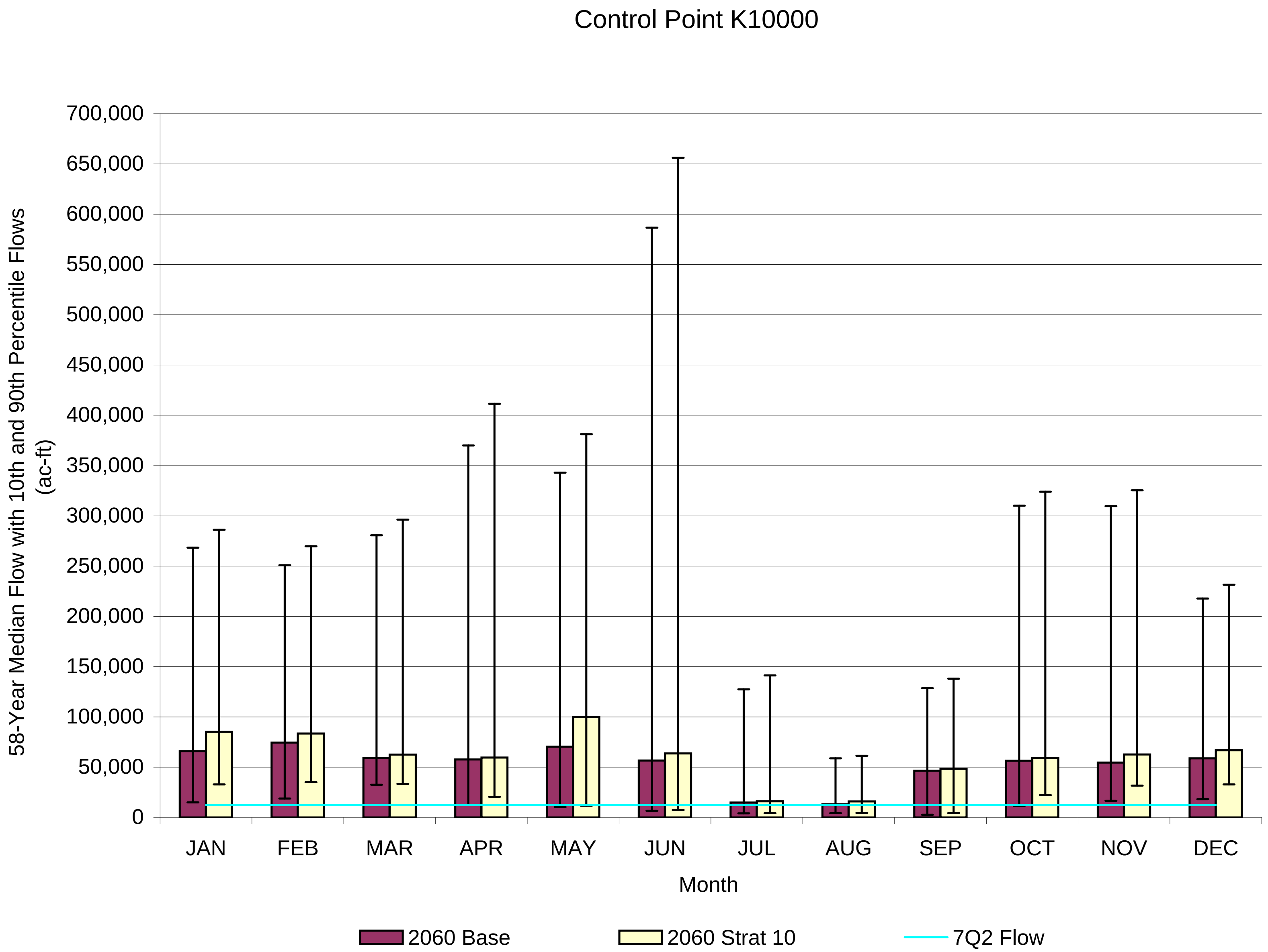
OCT
NOV
DEC
Month
2060 Base
2060 Strat 10
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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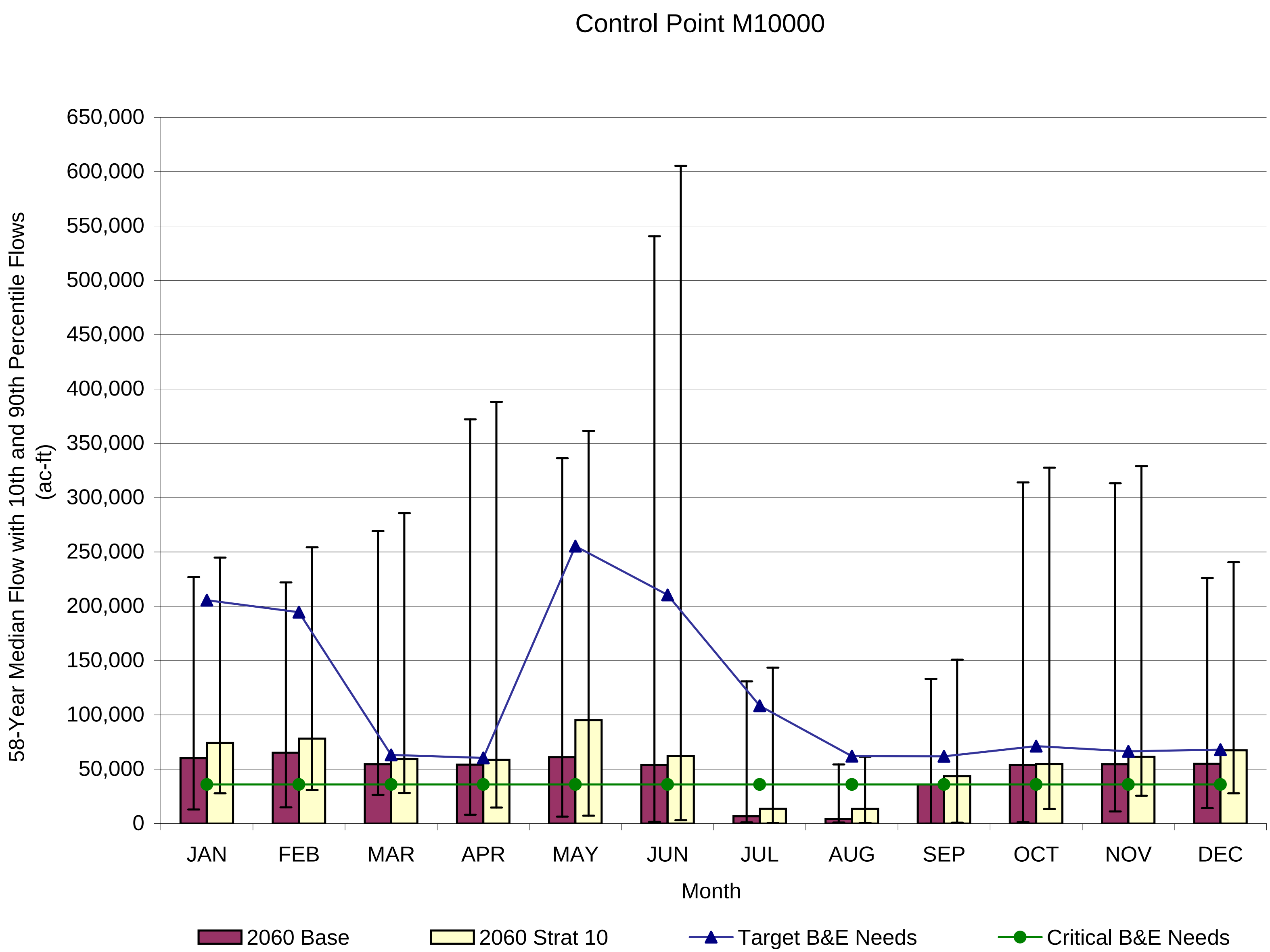
NOV
DEC
Month
2060 Base
2060 Strat 10
7Q2 Flow


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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JUN
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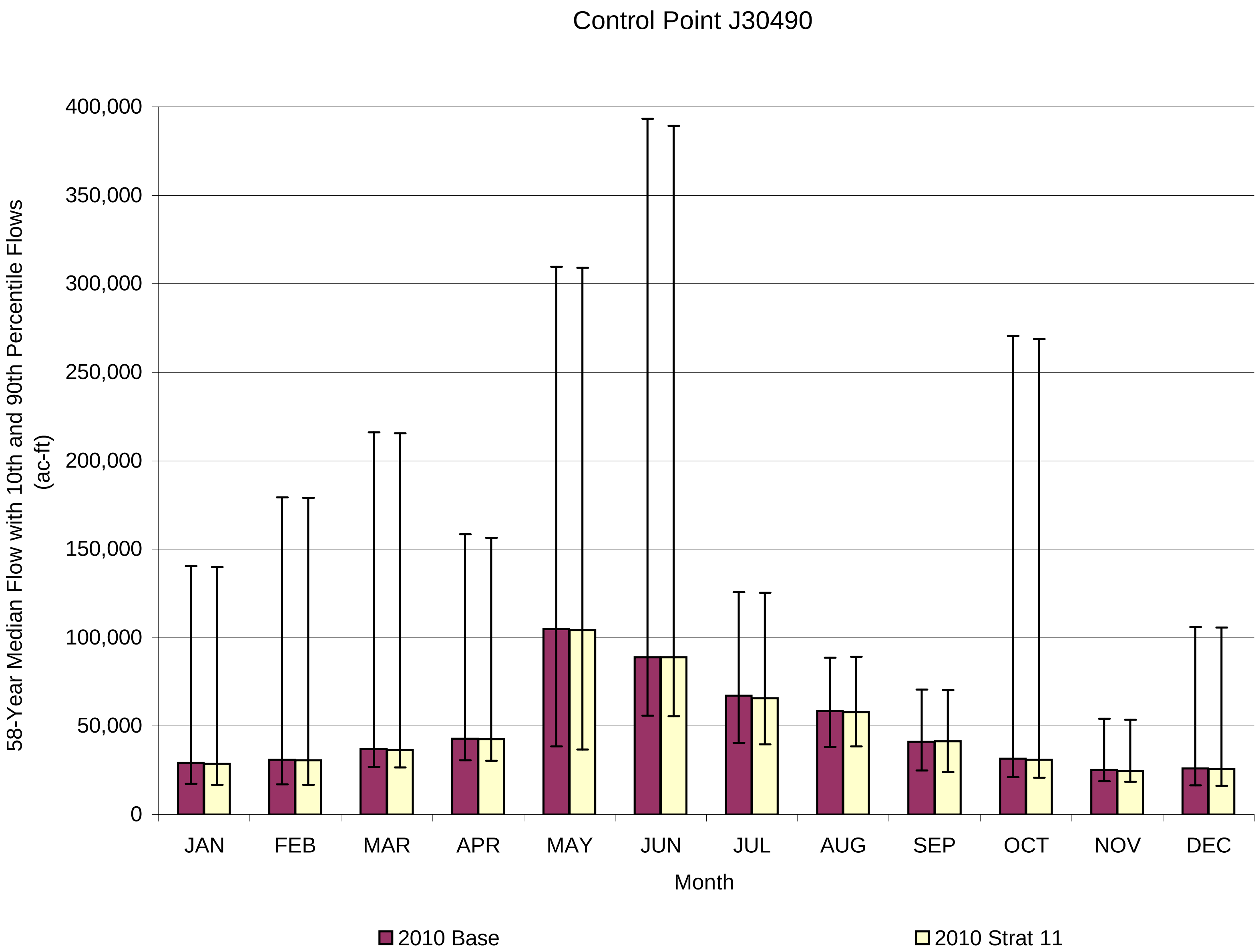
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 10
Target B&E Needs
Critical B&E Needs

STRATEGY 11
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2010 AND 2060


Control Point J30490
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
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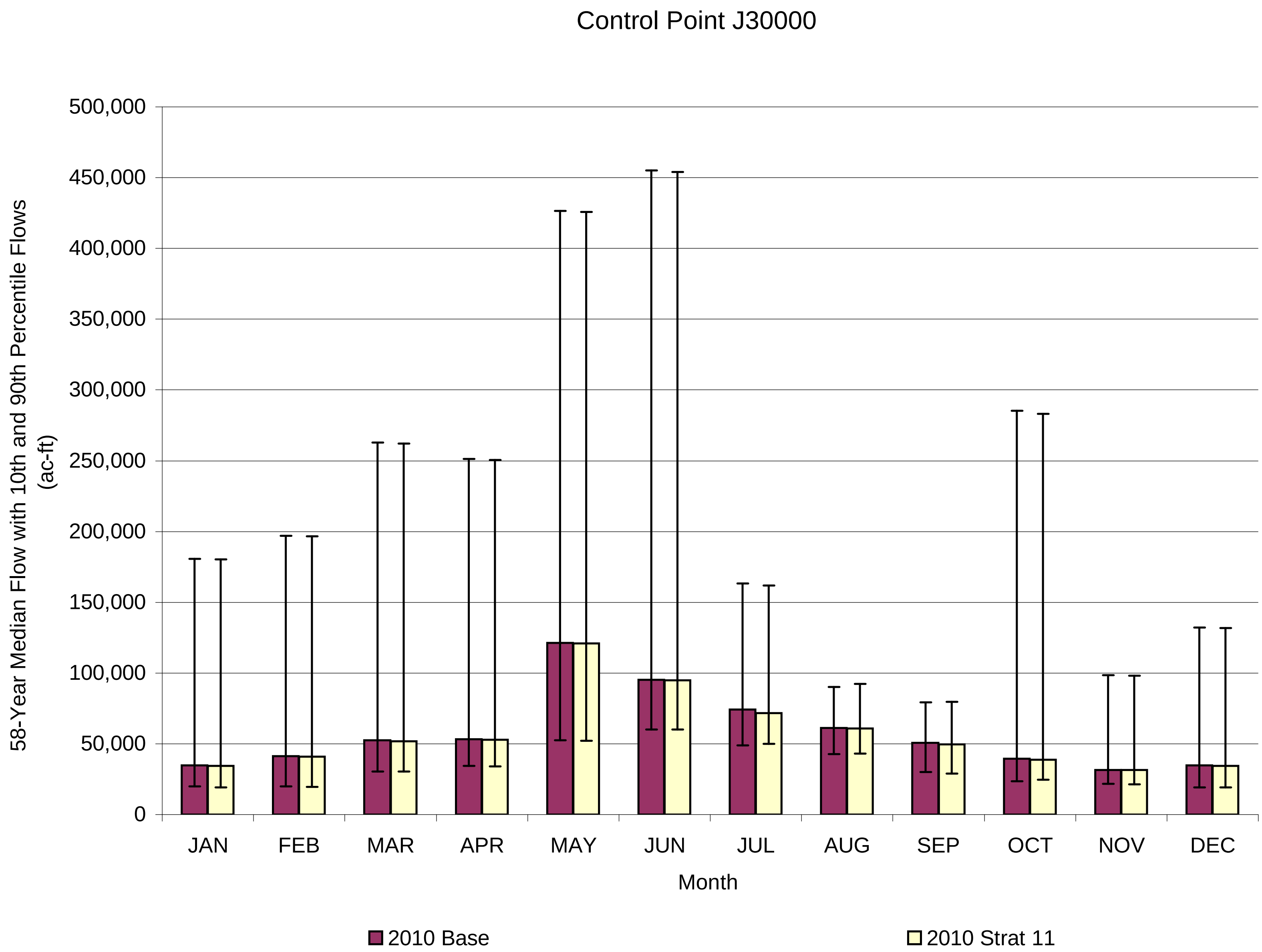
NOV
DEC
Month
2010 Base
2010 Strat 11



Control Point J30000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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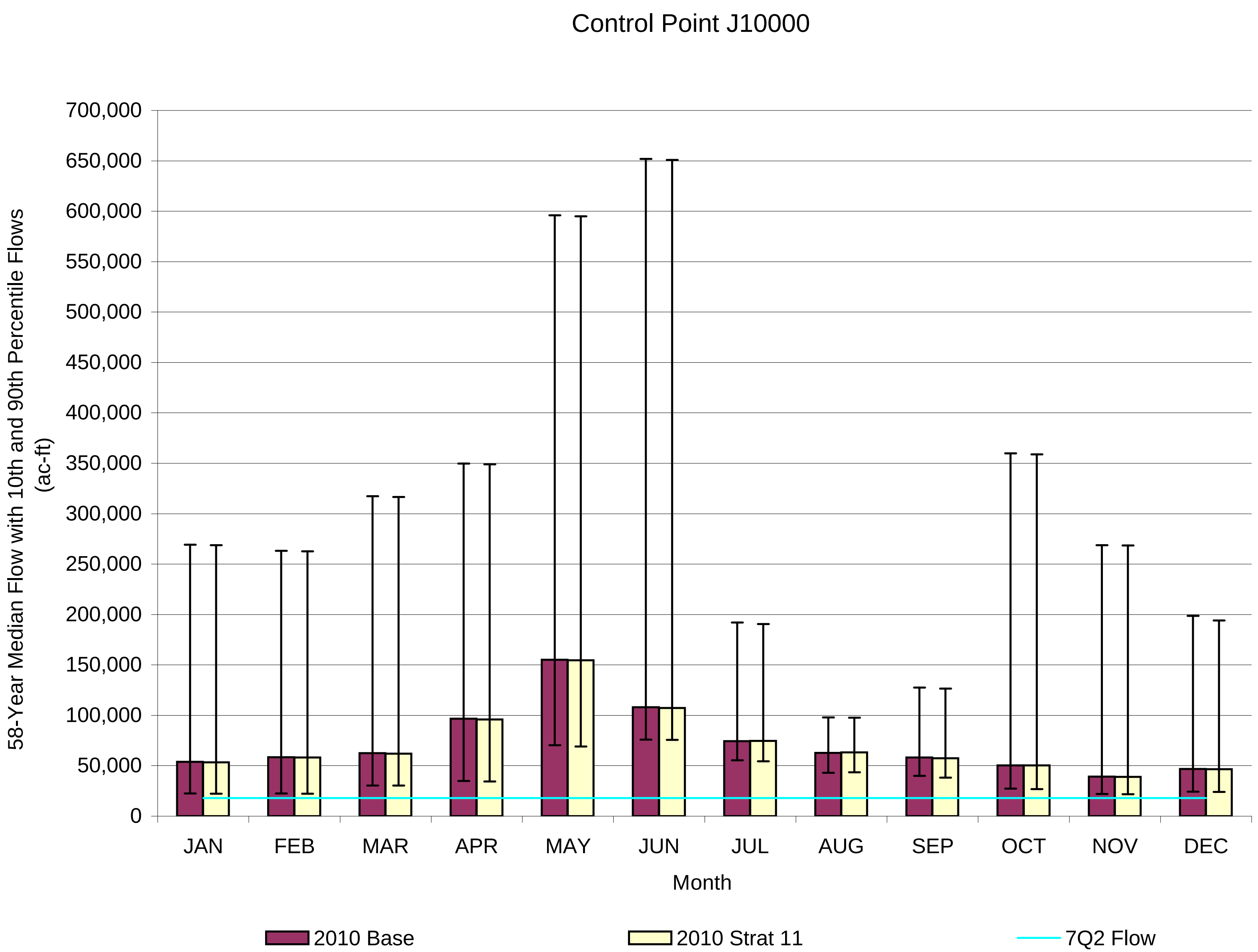
Month
2010 Base
2010 Strat 11


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
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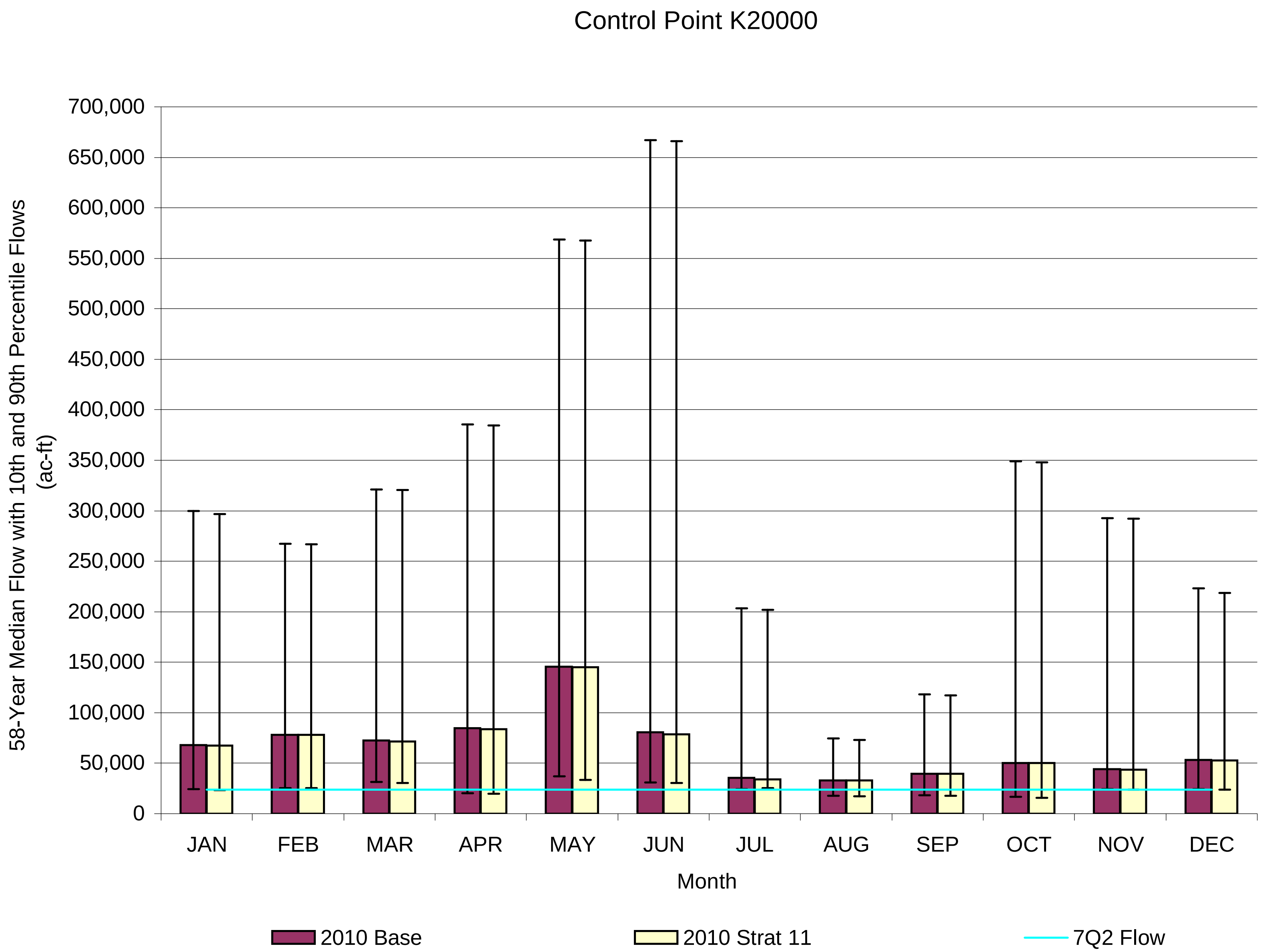
DEC
Month
2010 Base
2010 Strat 11
7Q2 Flow


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
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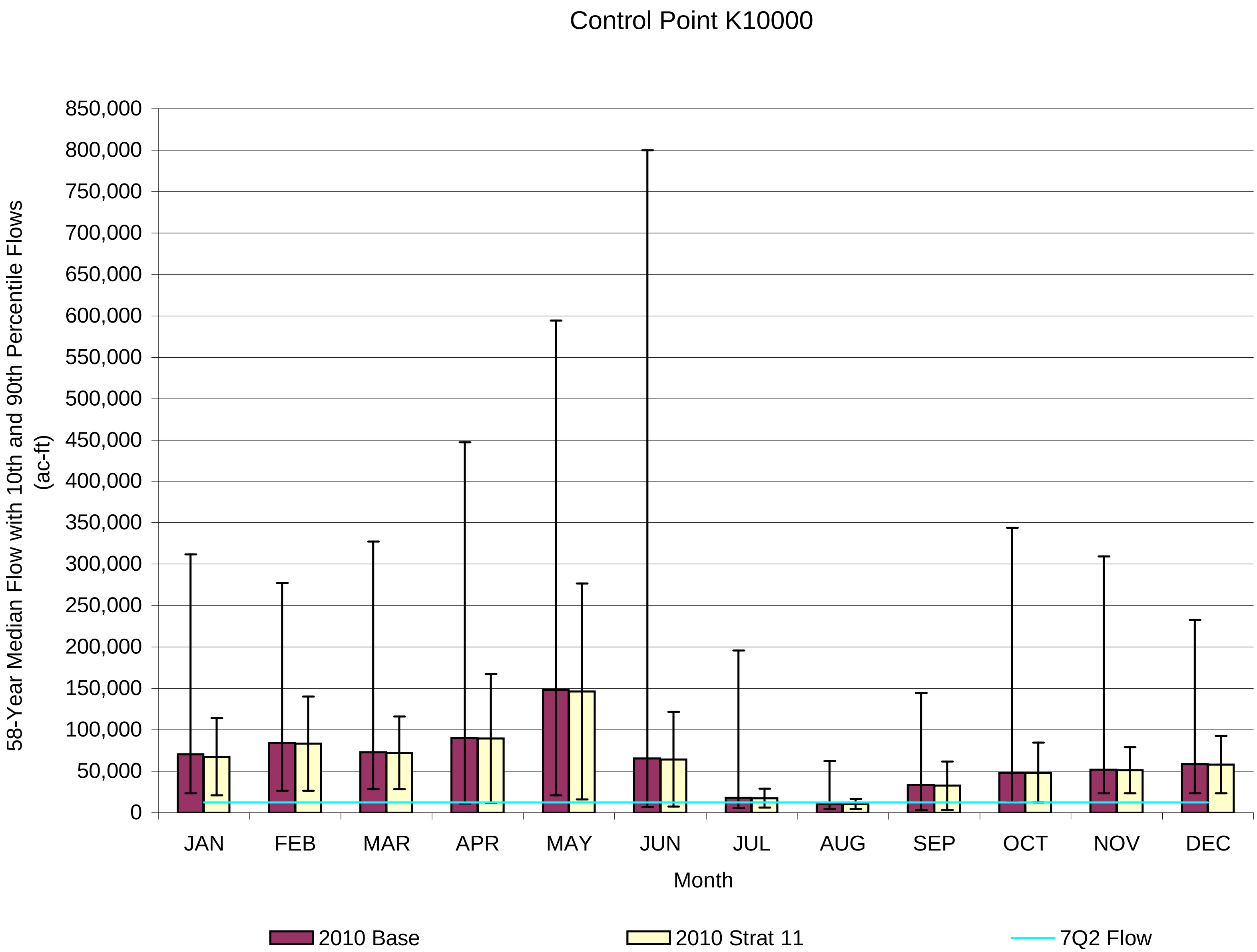
Month
2010 Base
2010 Strat 11
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
850,000
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
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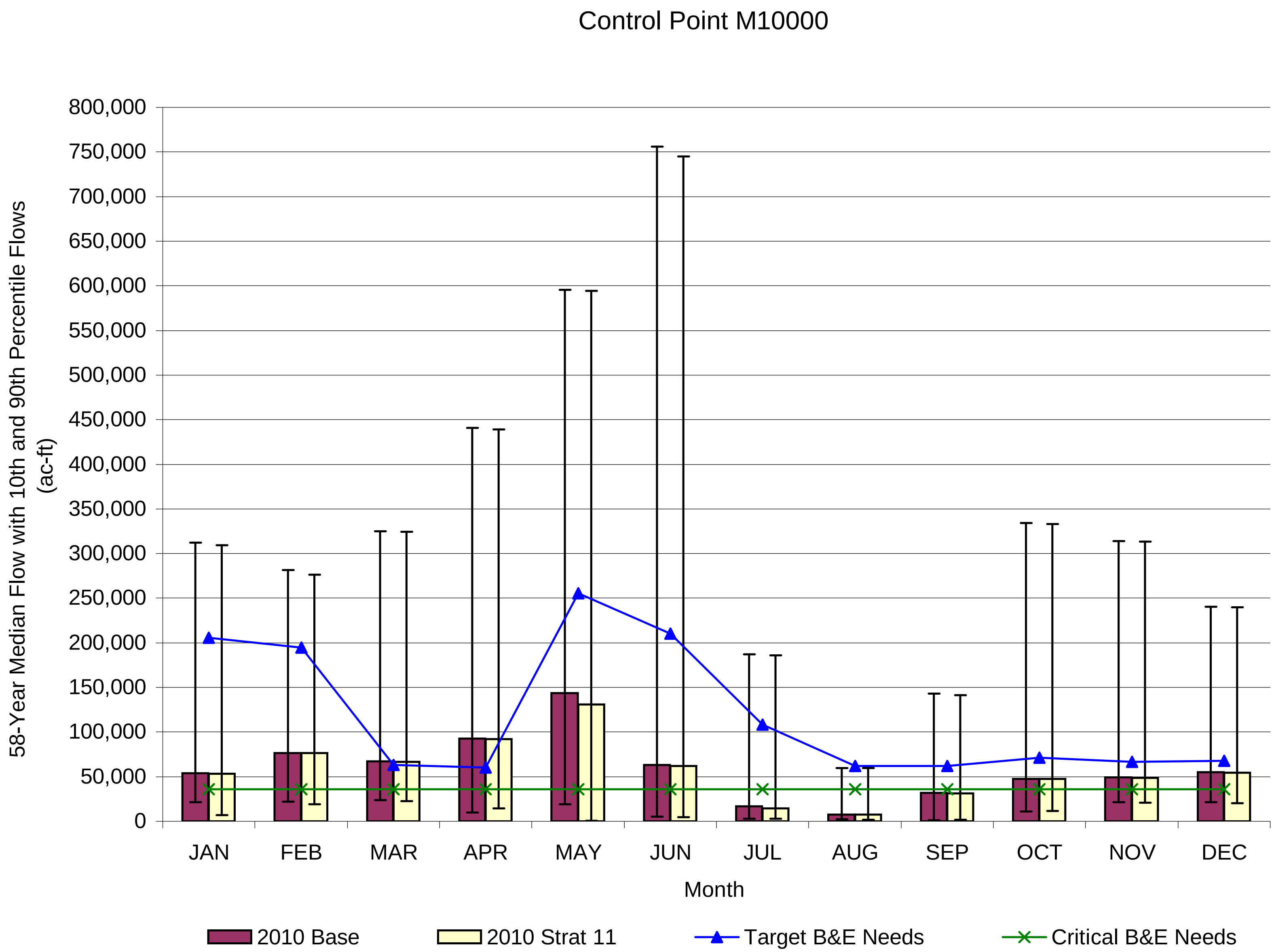
Month
2010 Base
2010 Strat 11
7Q2 Flow


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
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50,000
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JAN
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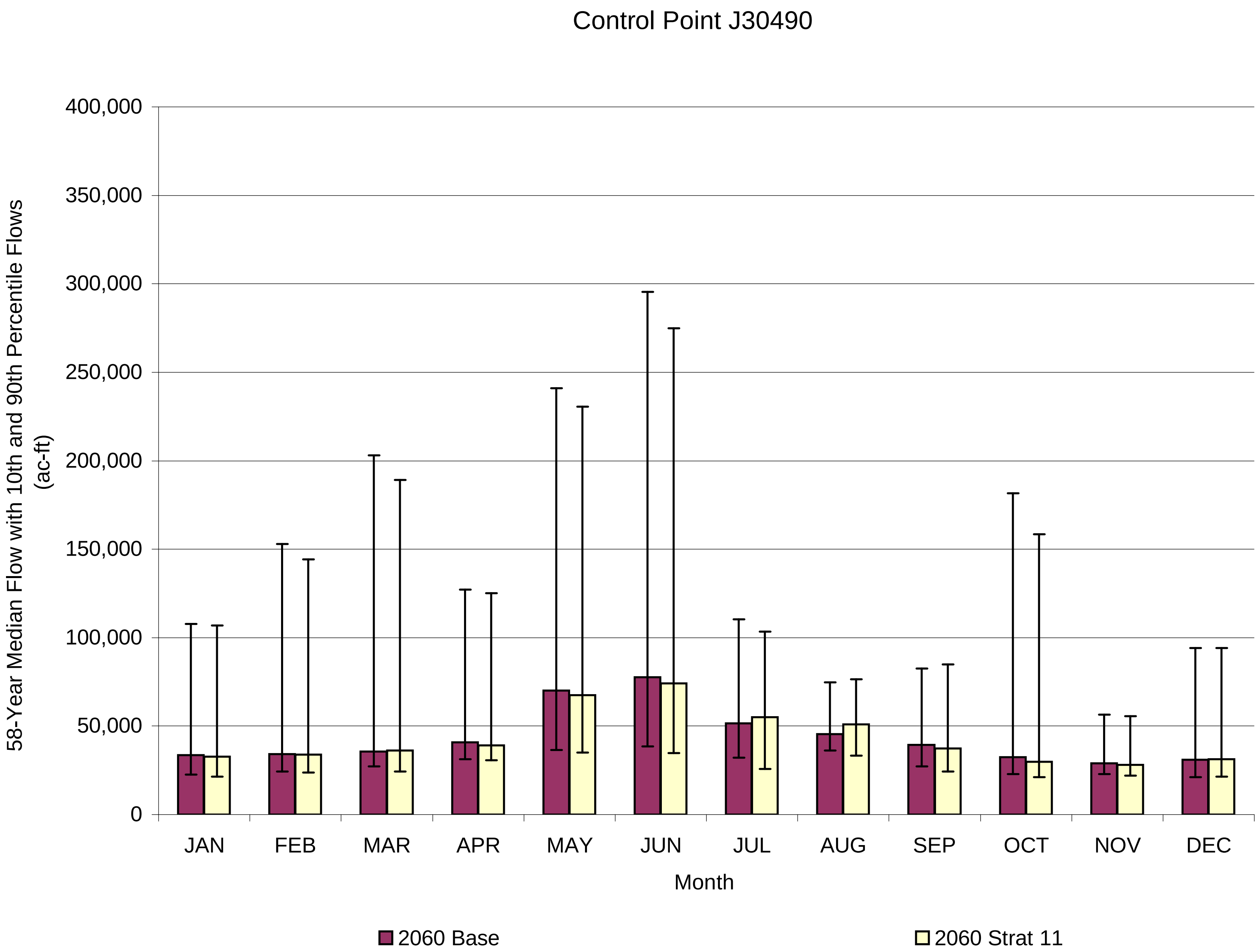
Month
2010 Base
2010 Strat 11
Target B&E Needs
Critical B&E Needs


Control Point J30490
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
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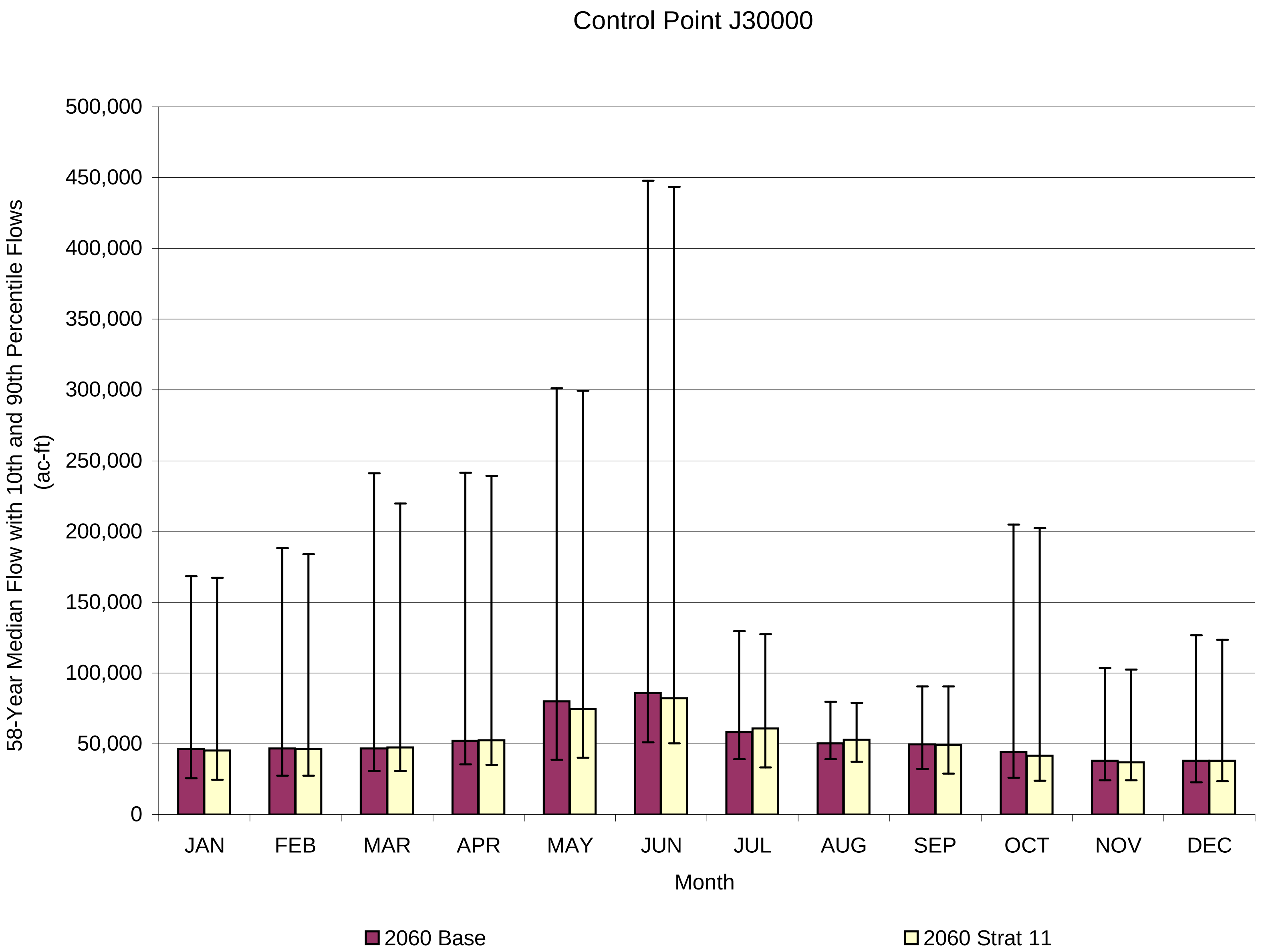
Month
2060 Base
2060 Strat 11


Control Point J30000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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300,000
250,000
200,000
150,000
100,000
50,000
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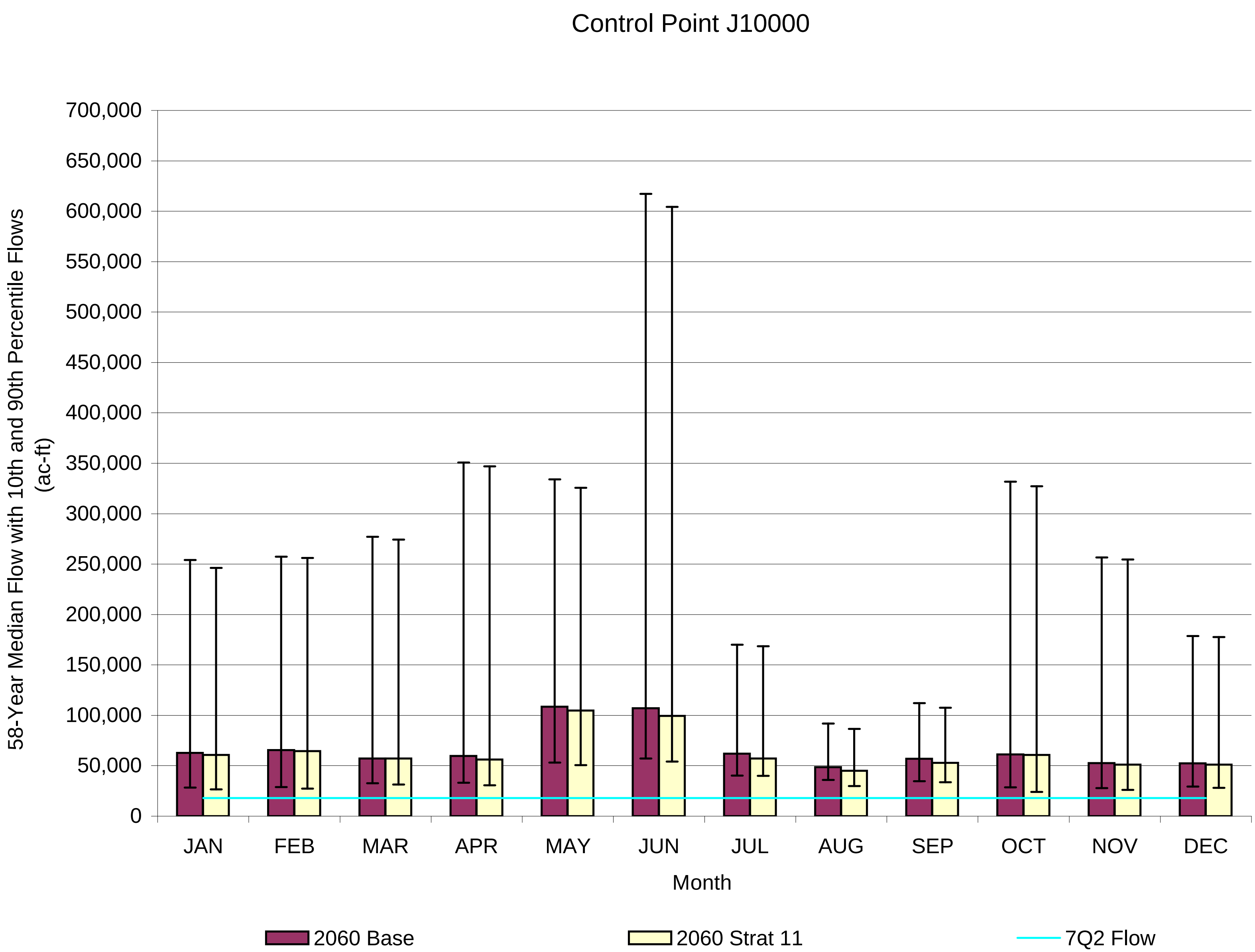
Month
2060 Base
2060 Strat 11


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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600,000
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500,000
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400,000
350,000
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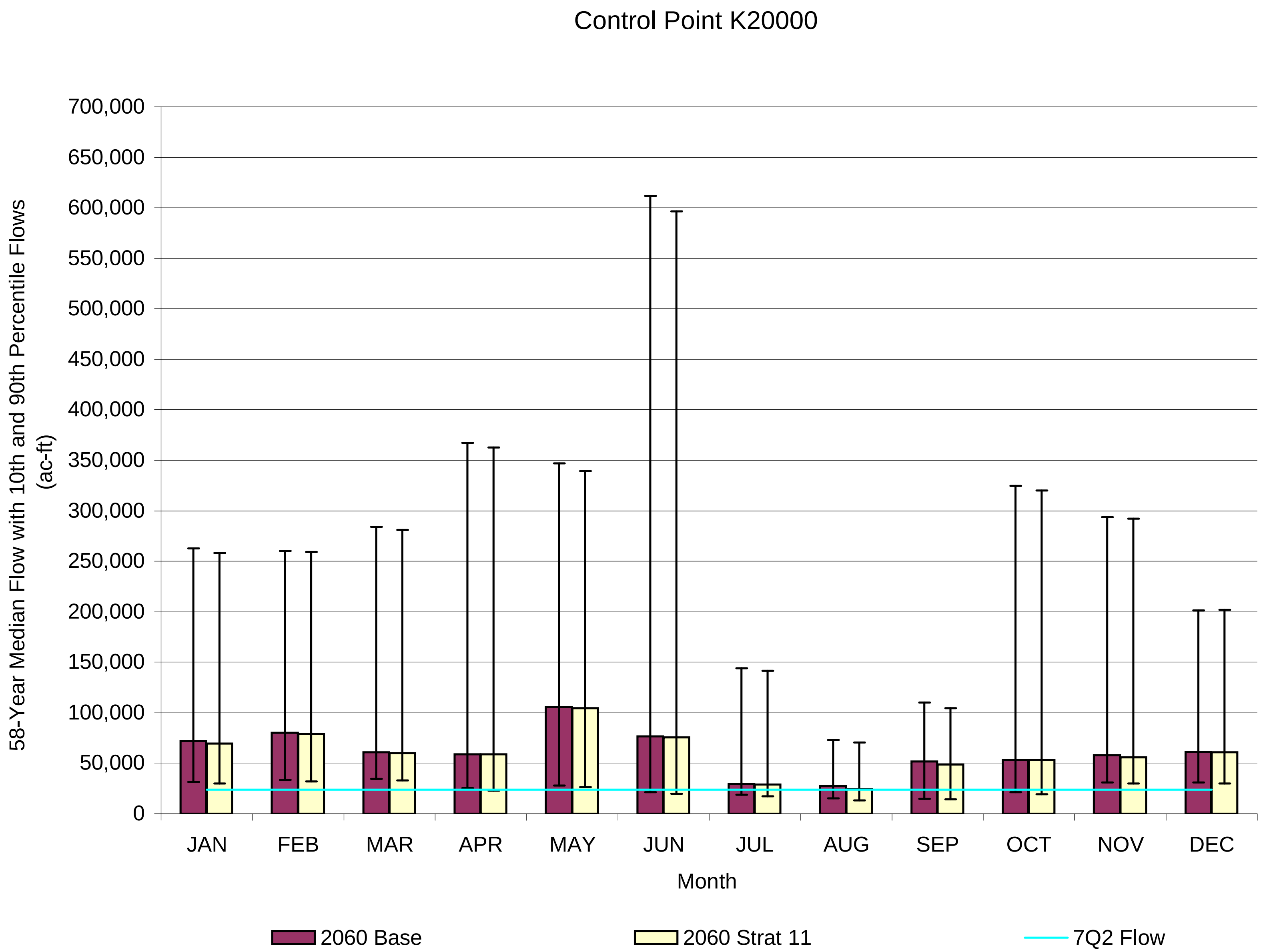
2060 Base
2060 Strat 11
7Q2 Flow


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
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650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
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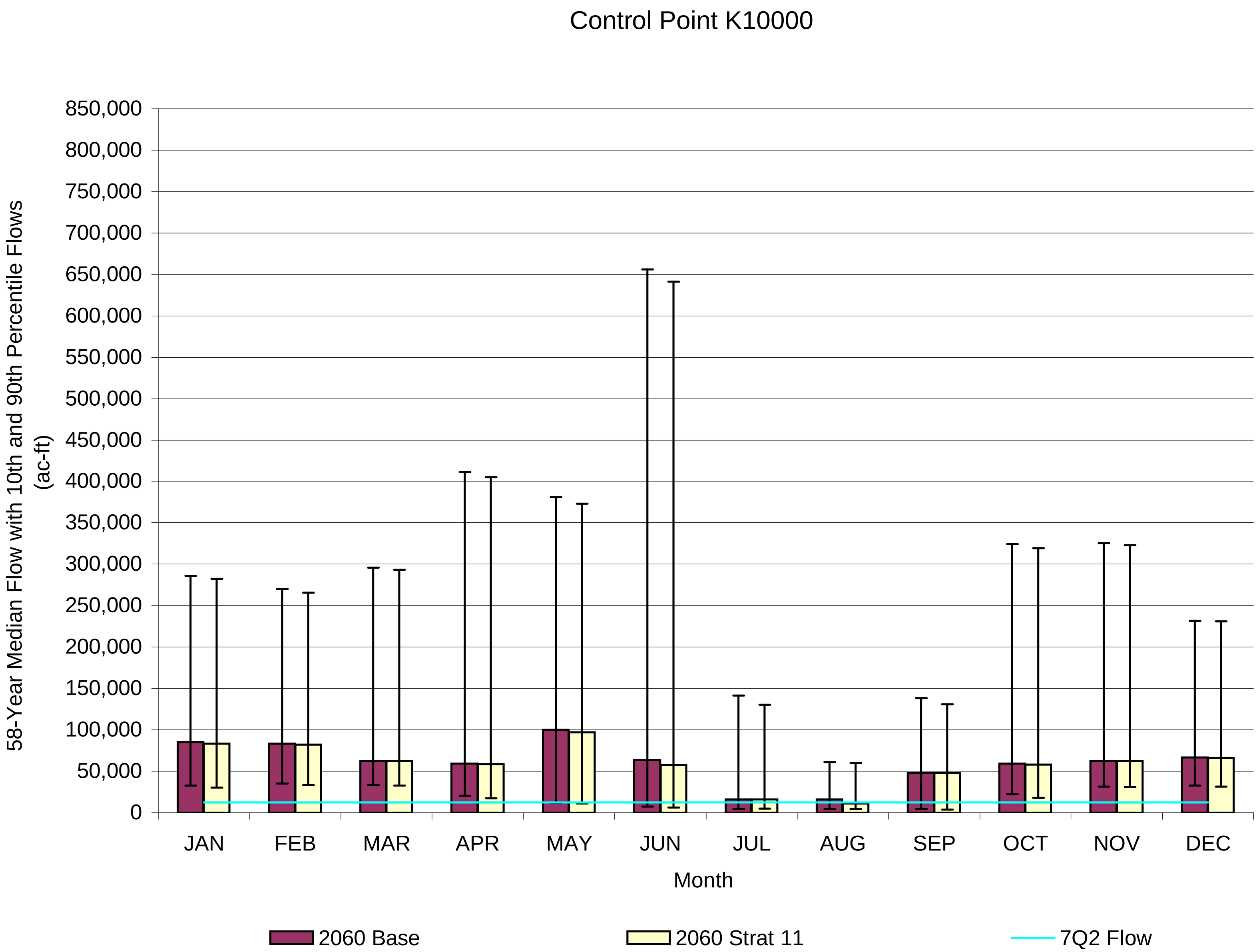
2060 Base
2060 Strat 11
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
850,000
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
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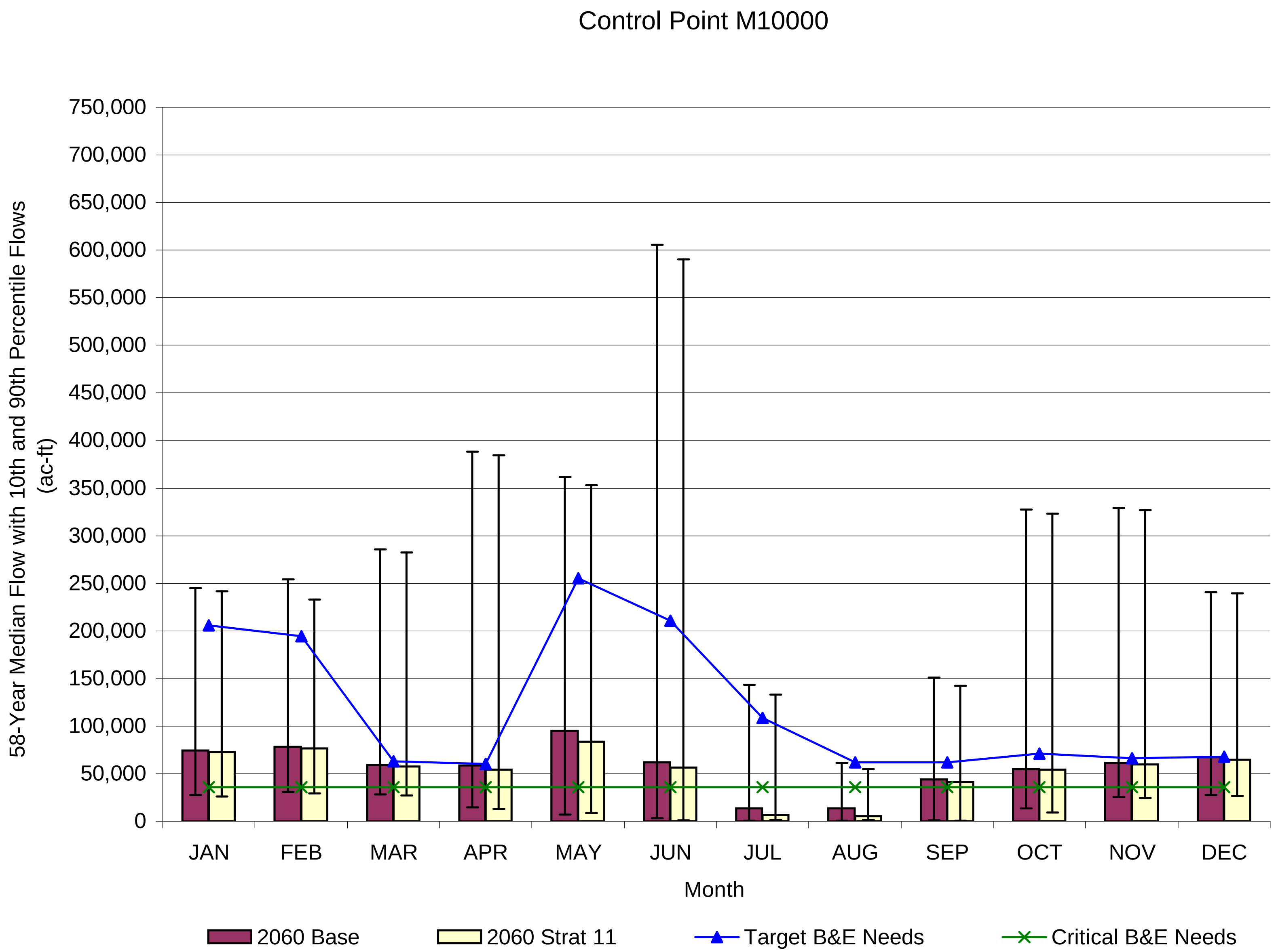
2060 Base
2060 Strat 11
7Q2 Flow


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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MAY
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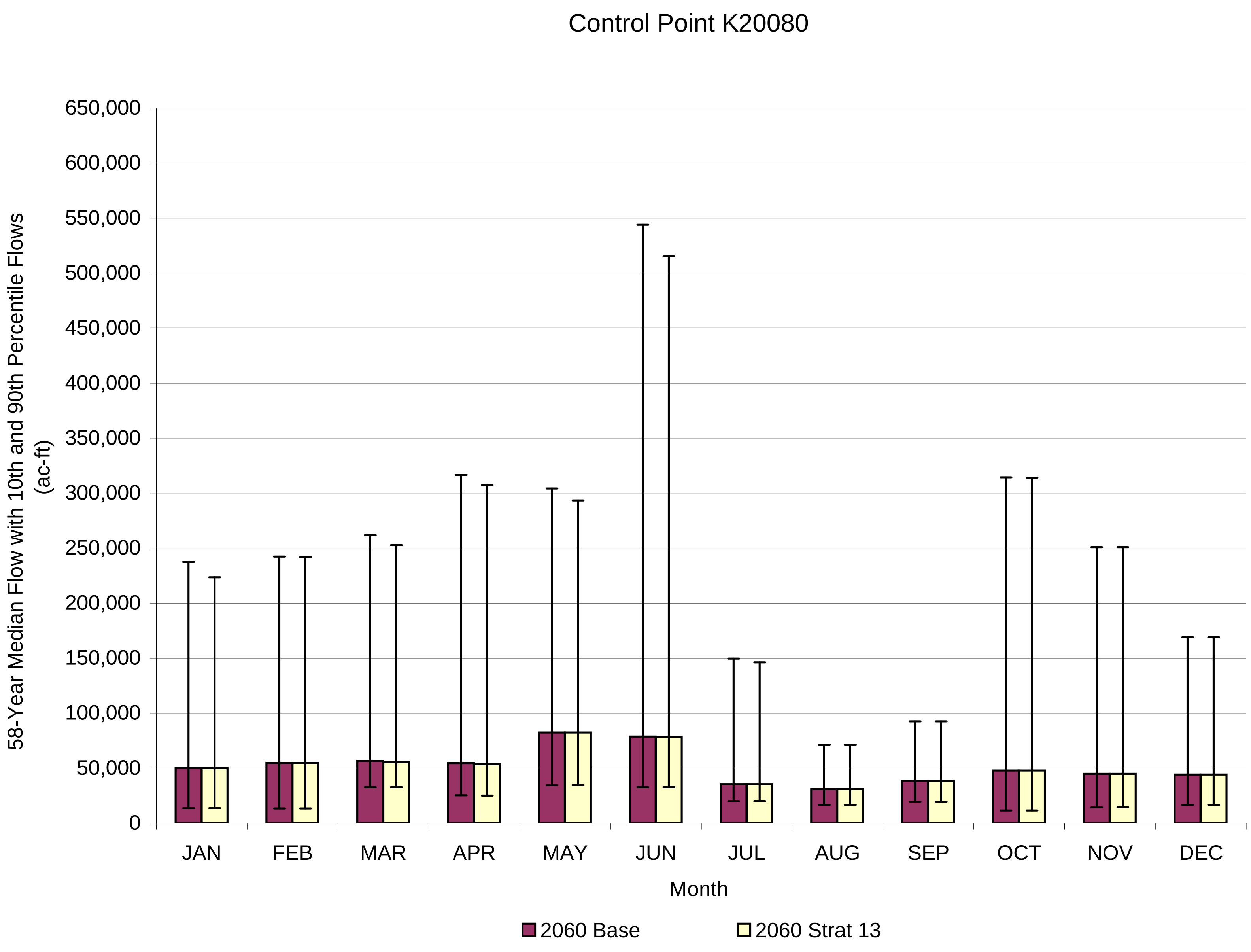
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 11
Target B&E Needs
Critical B&E Needs

STRATEGY 13
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2060


Control Point K20080
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
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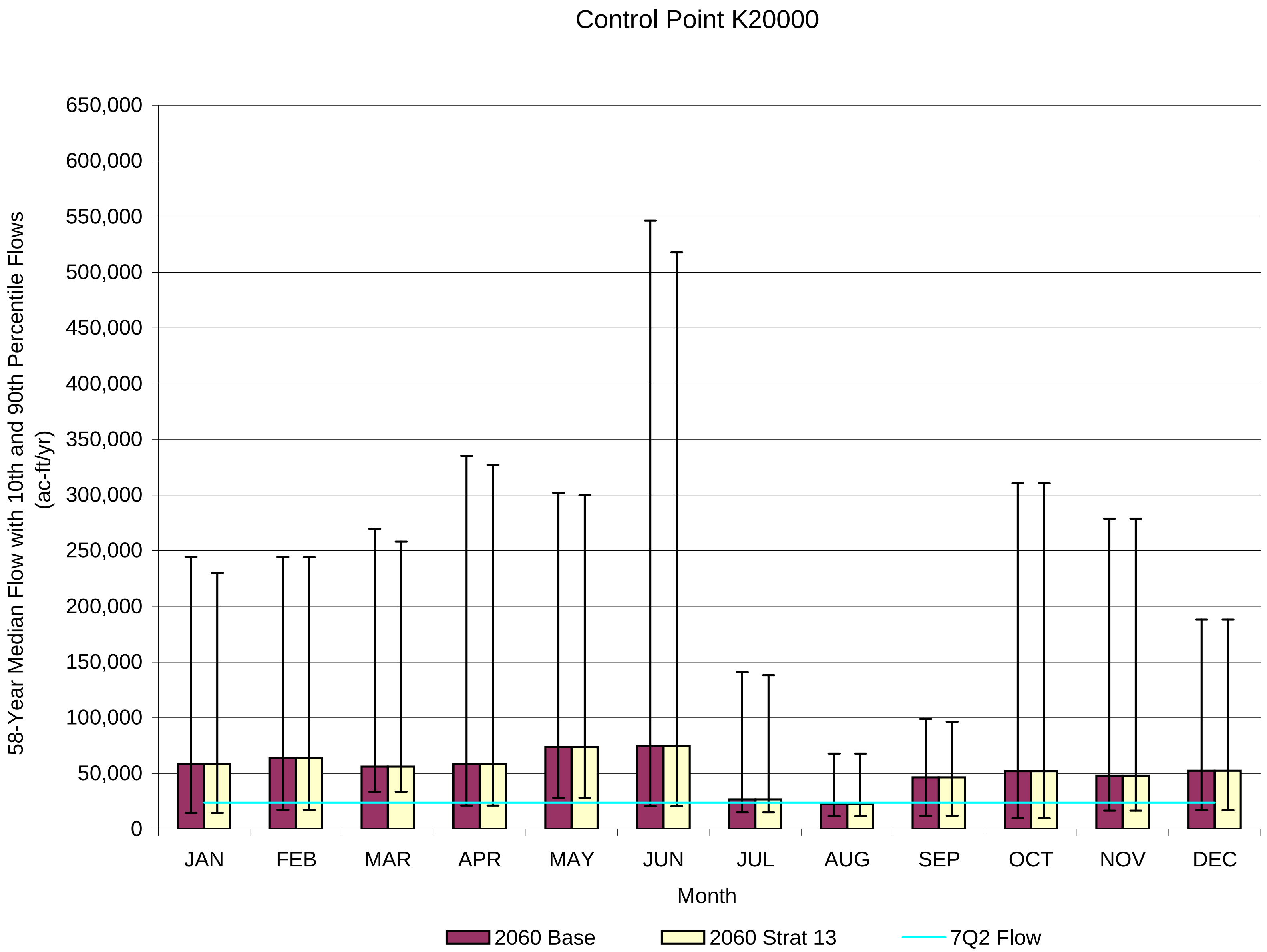
OCT
NOV
DEC
Month
2060 Base
2060 Strat 13


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
APR
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JUN
JUL
AUG
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OCT
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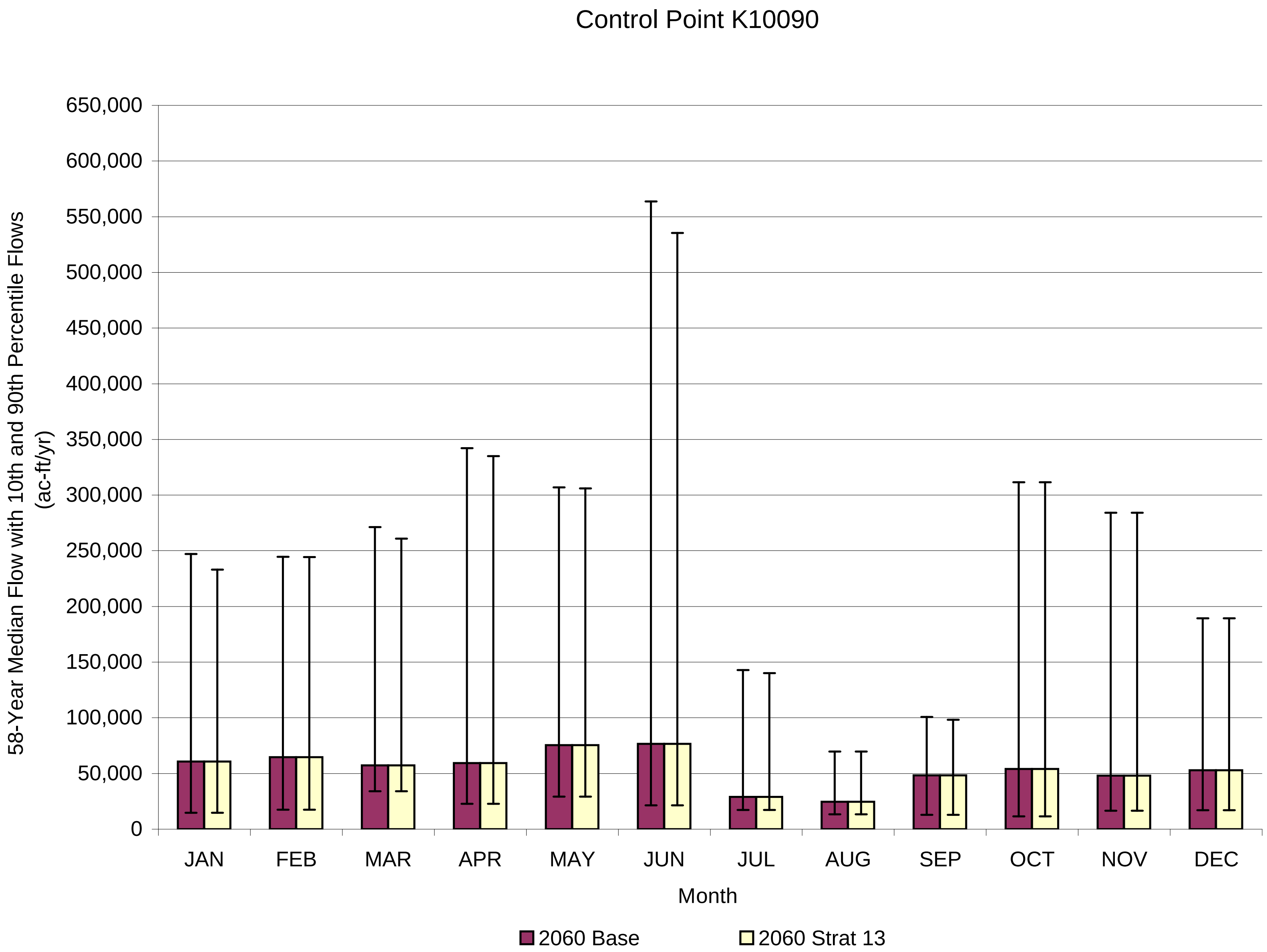
DEC
Month
2060 Base
2060 Strat 13
7Q2 Flow


Control Point K10090
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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JAN
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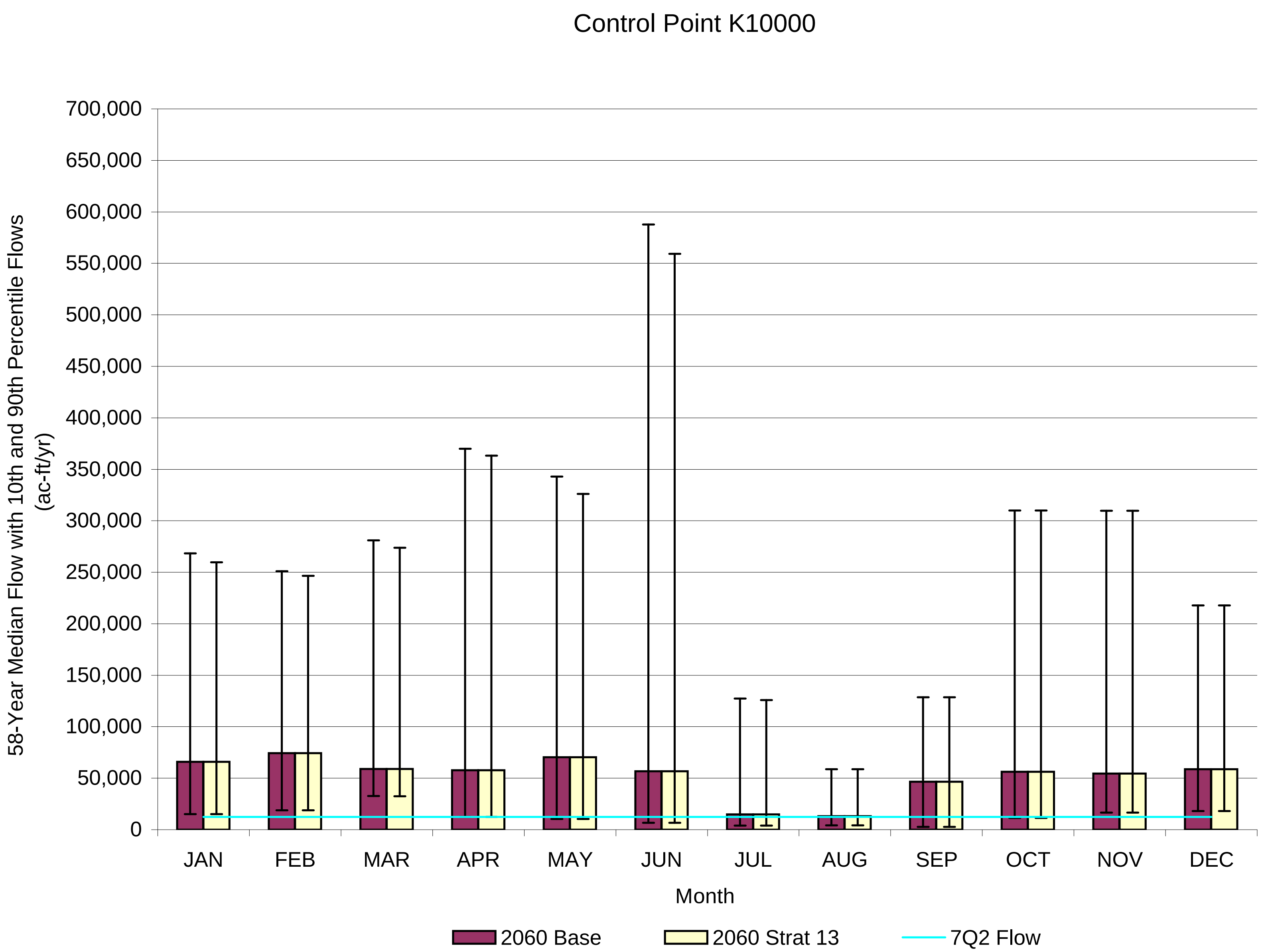
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 13


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
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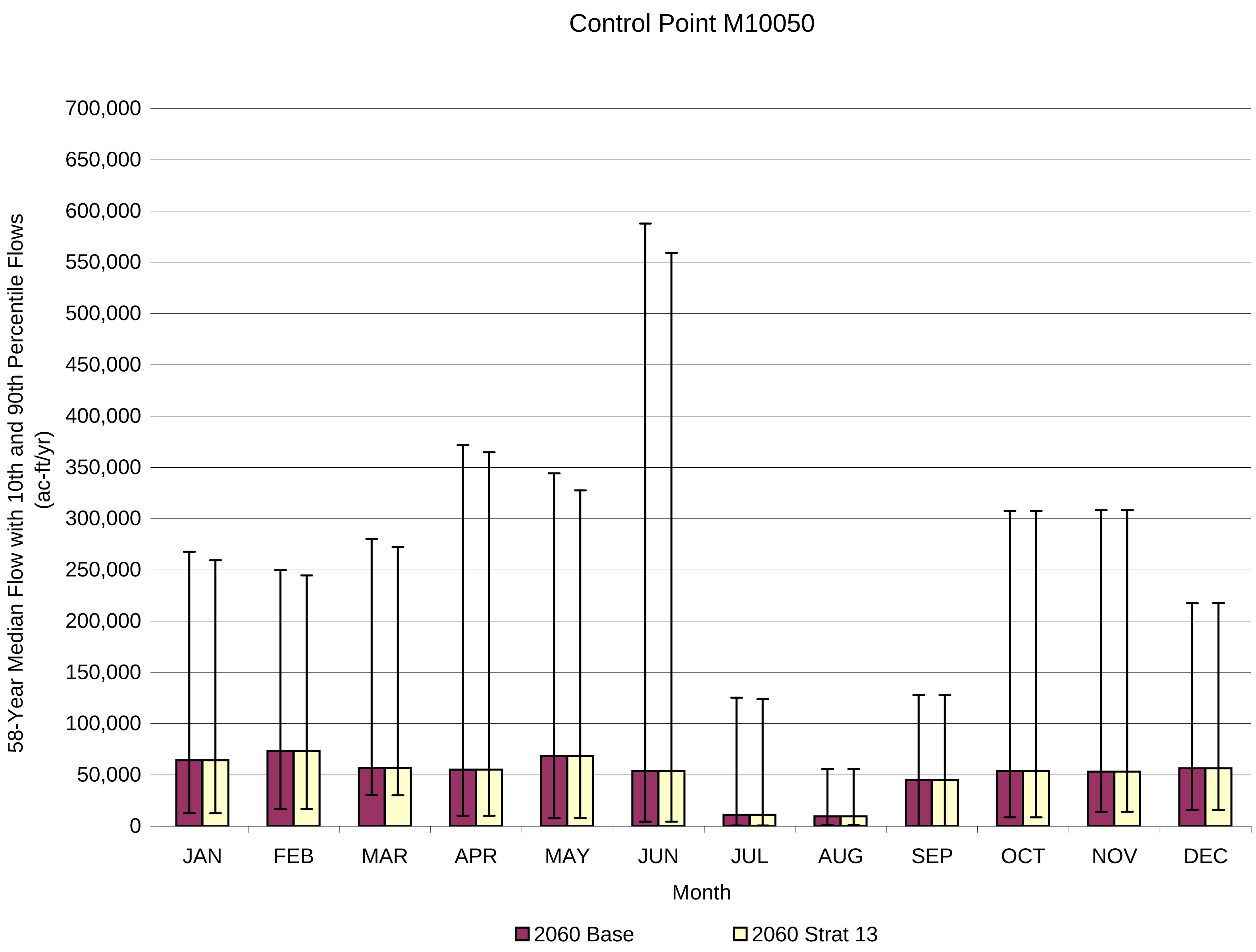
DEC
Month
2060 Base
2060 Strat 13
7Q2 Flow


Control Point M10050
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
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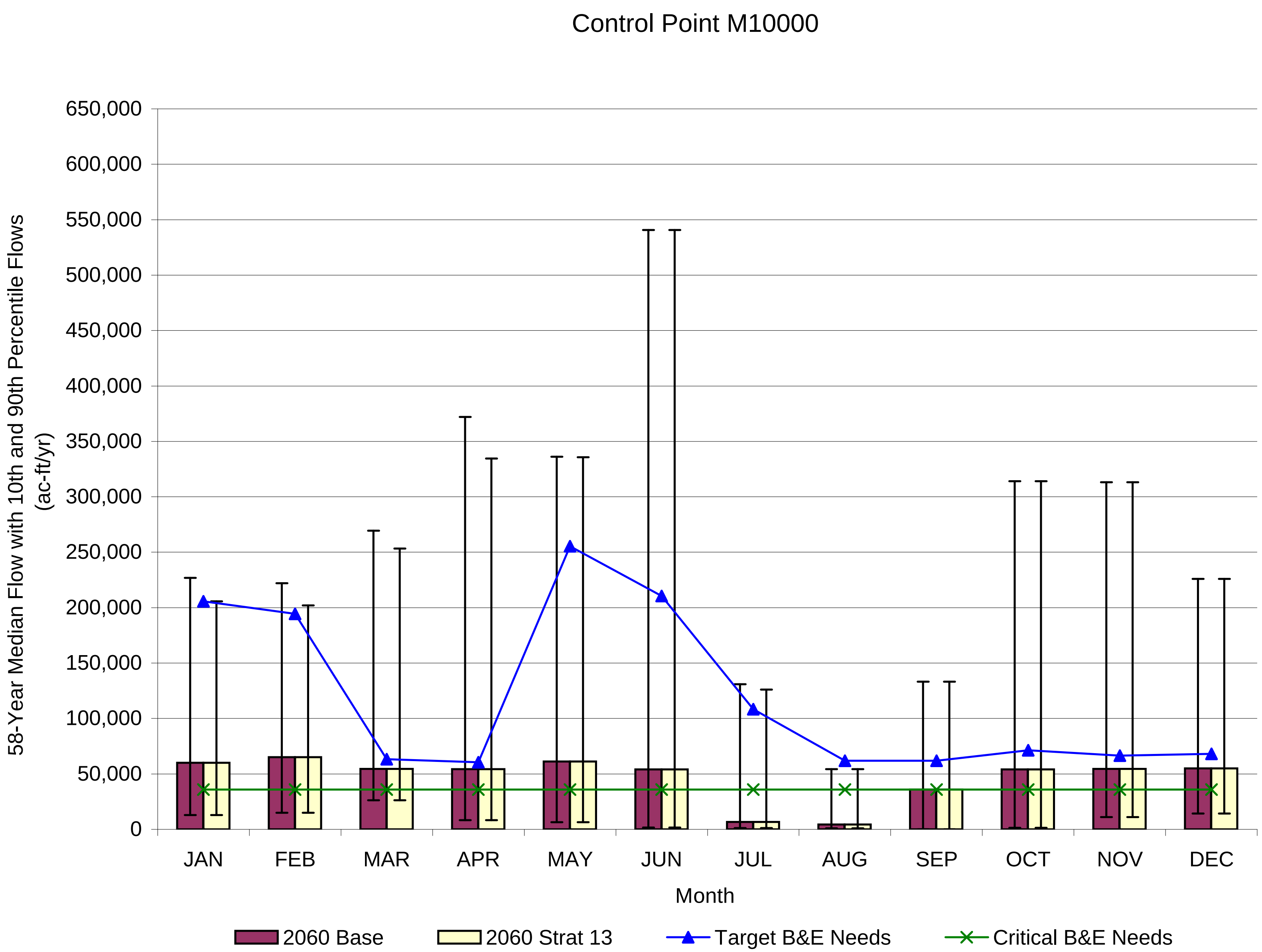
JUL
AUG
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 13


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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JAN
FEB
MAR
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JUN
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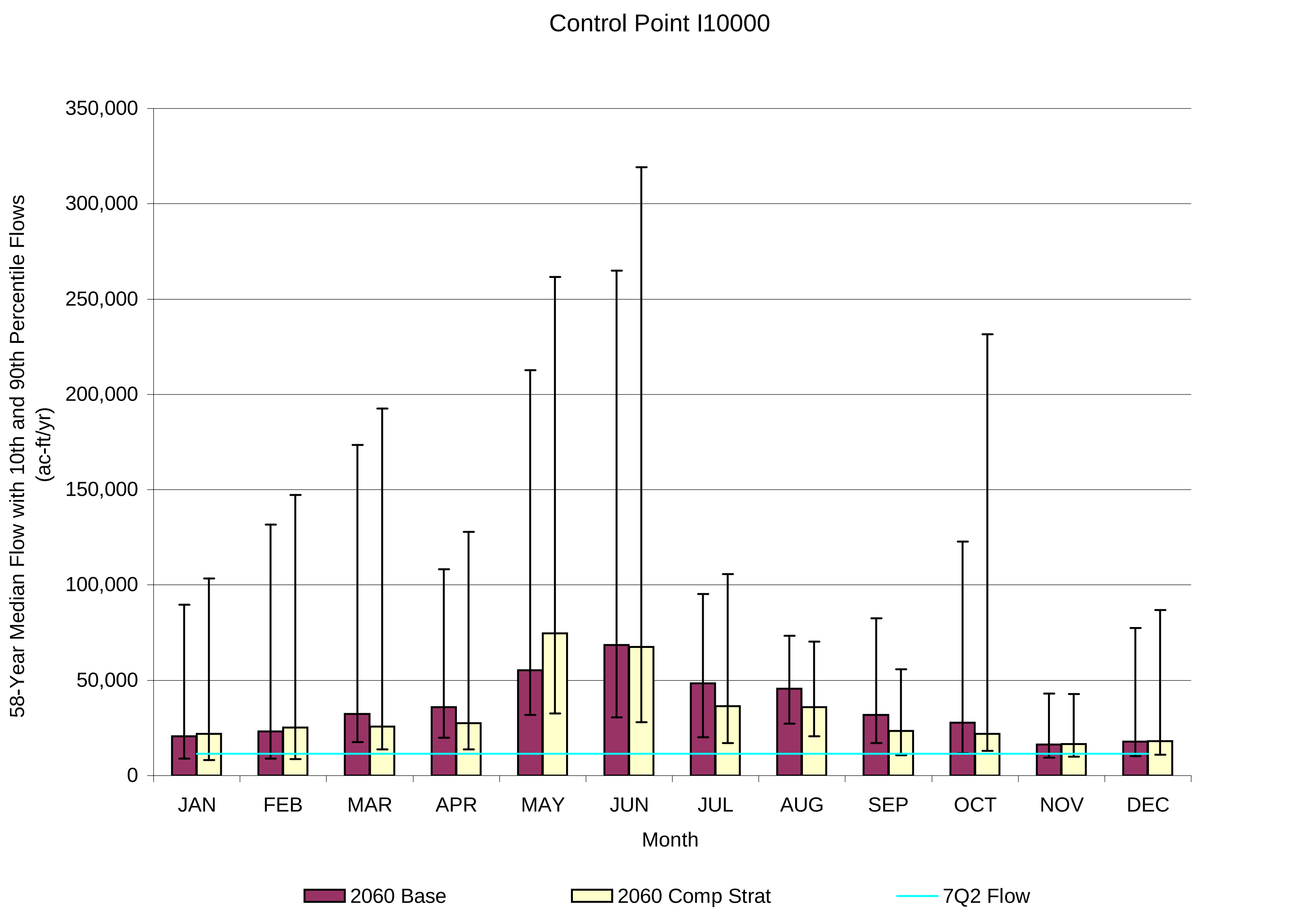
SEP
OCT
NOV
DEC
Month
2060 Base
2060 Strat 13
Target B&E Needs
Critical B&E Needs

COMPREHENSIVE STRATEGY
IMPACT RESULT GRAPHS AT SIX CONTROL POINTS
2060


Control Point I10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
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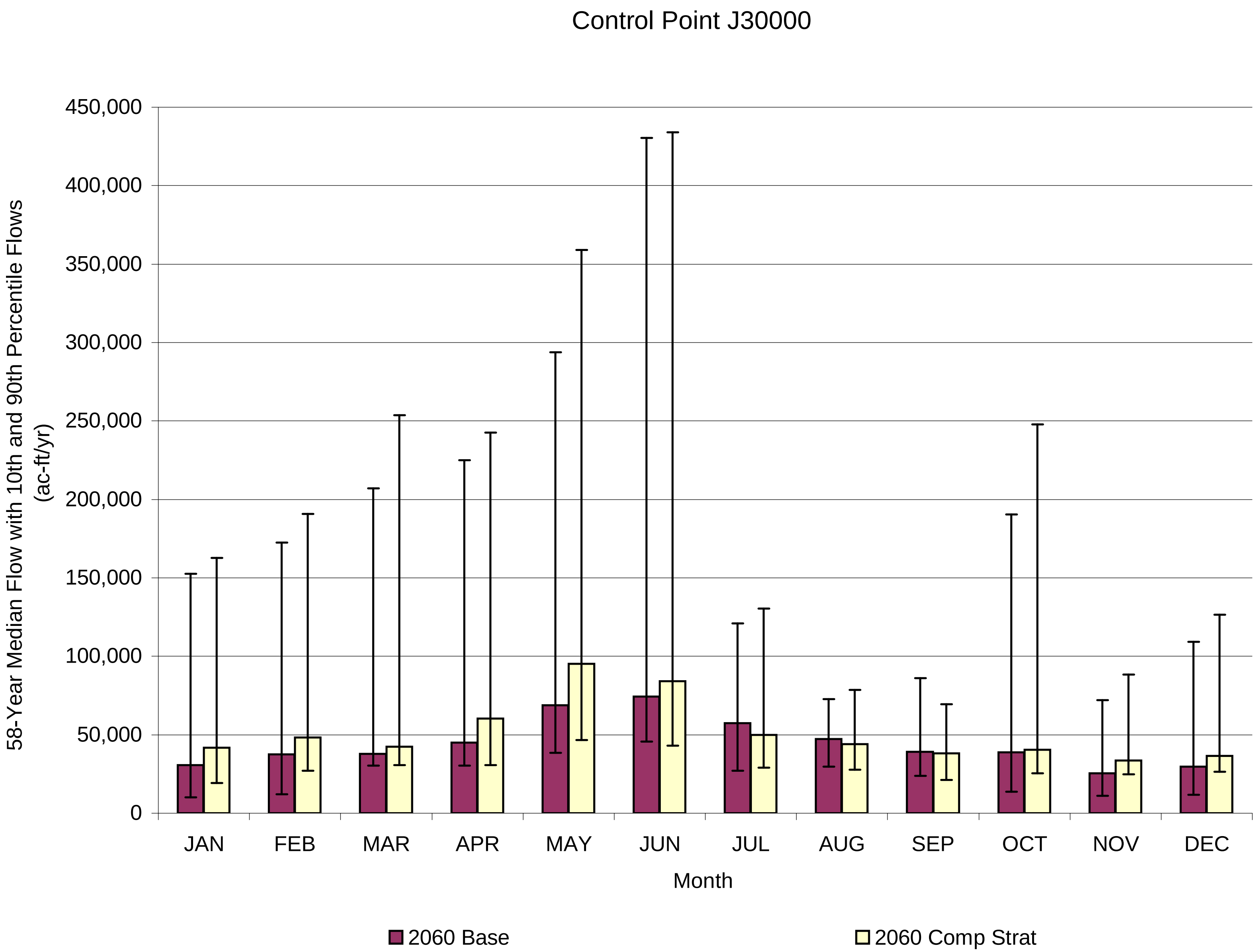
Month
2060 Base
2060 Comp Strat
7Q2 Flow


Control Point J30000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
JAN
FEB
MAR
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MAY
JUN
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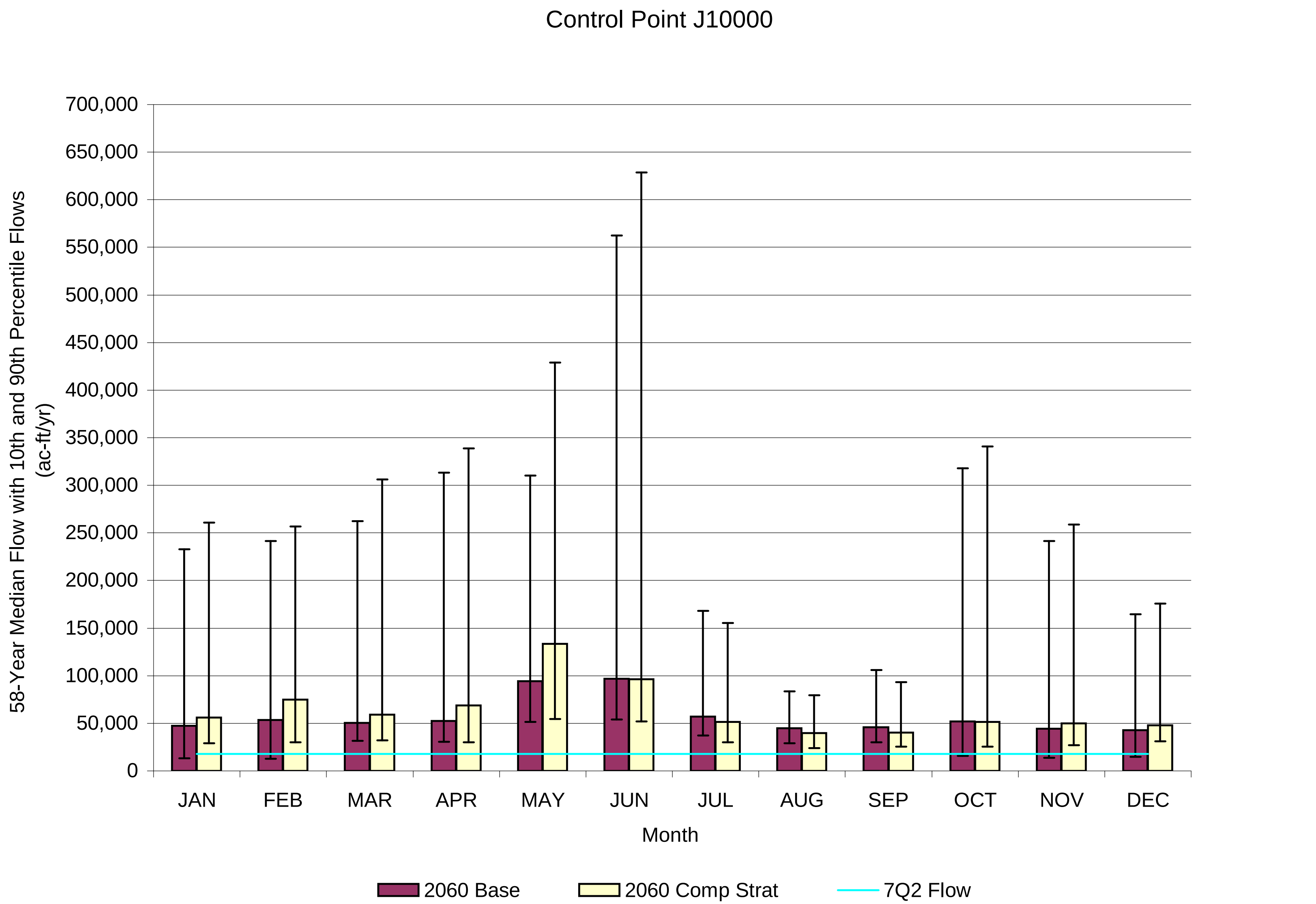
Month
2060 Base
2060 Comp Strat


Control Point J10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
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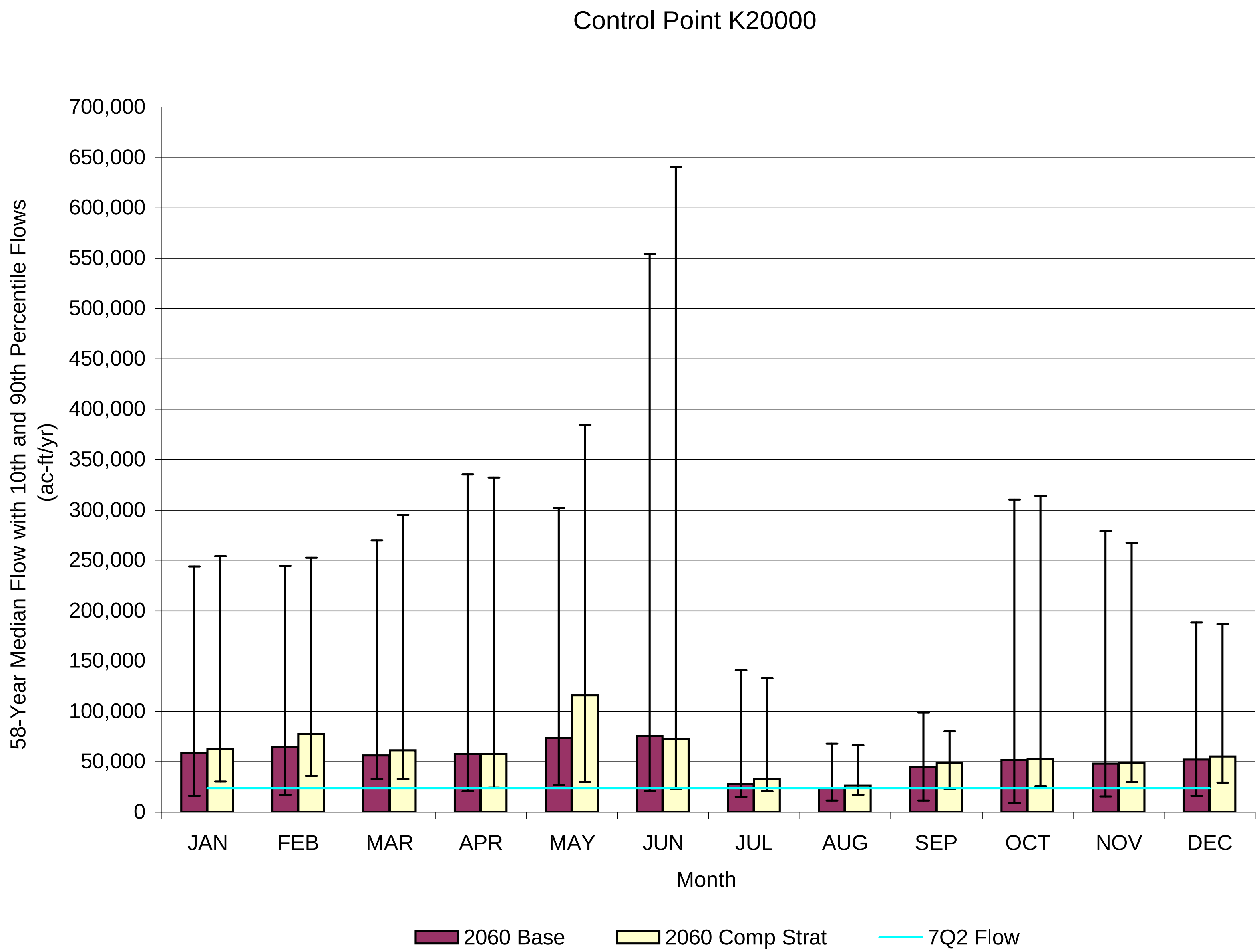
Month
2060 Base
2060 Comp Strat
7Q2 Flow


Control Point K20000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
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JAN
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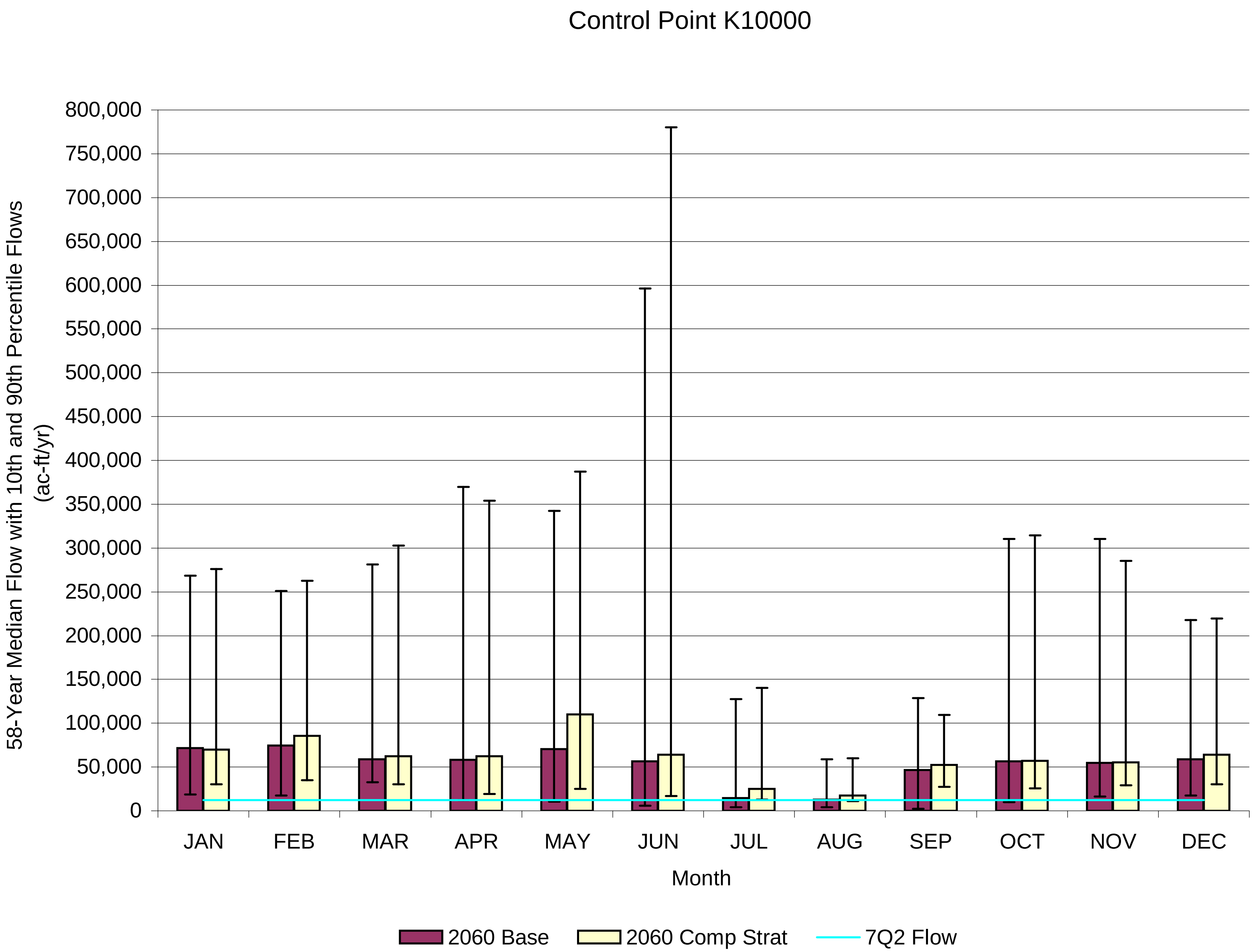
2060 Base
2060 Comp Strat
7Q2 Flow


Control Point K10000
58-Year Median Flow with 10th and 90th Percentile Flows (ac-ft/yr)
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
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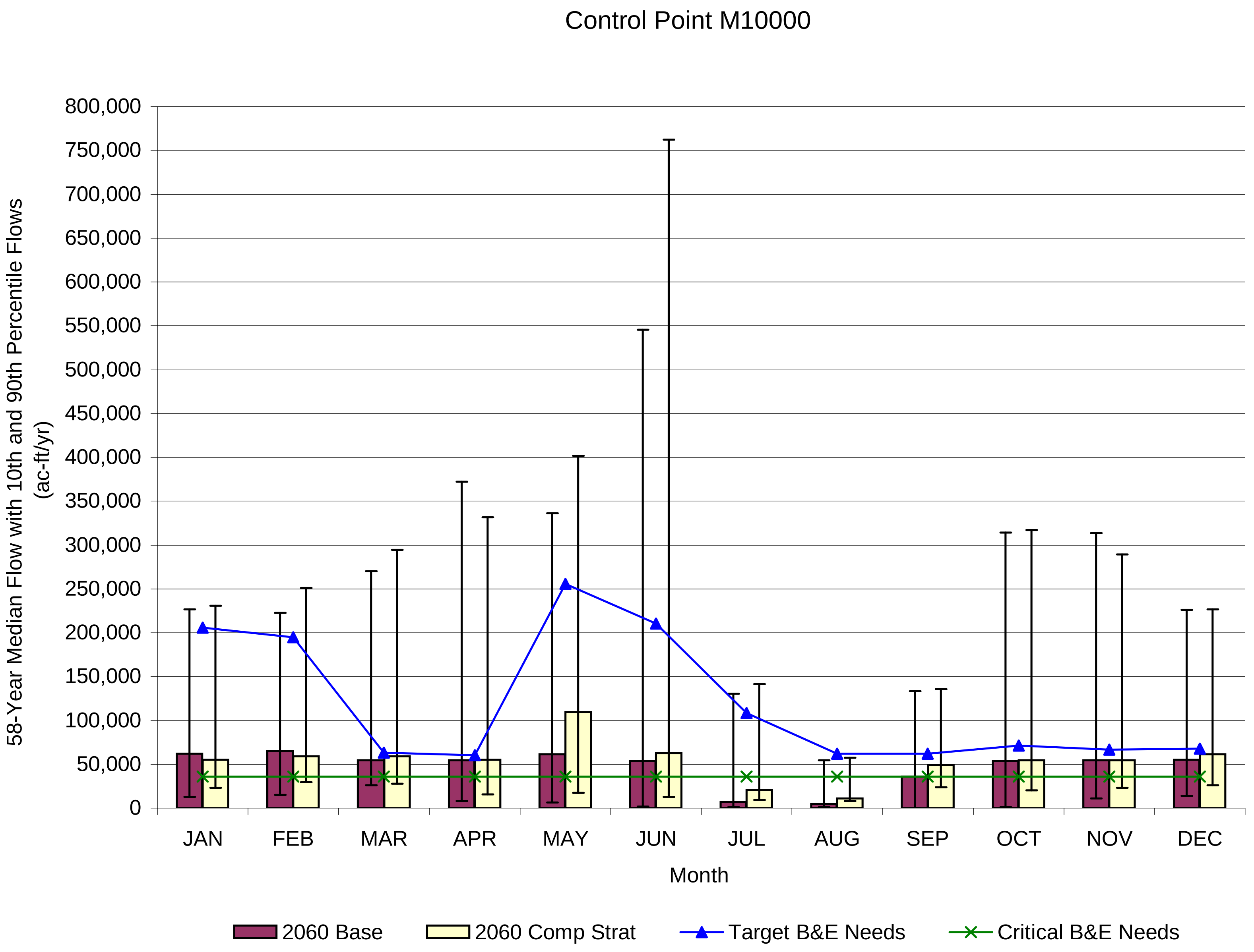
Month
2060 Base
2060 Comp Strat
7Q2 Flow


Control Point M10000
58-Year Median Flow with 10th and 90th Percentile Flows
(ac-ft/yr)
800,000
750,000
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
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JAN
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SEP
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DEC
Month
2060 Base
2060 Comp Strat
Target B&E Needs
Critical B&E Needs

APPENDIX D

COMMENTS RECEIVED

SIERRA CLUB
FOUNDED 1892

January 7, 2008

Thank you for the opportunity to comment on the Revised Draft Report *Environmental Impacts of Water Management Strategies Study.*

<u>General Comments</u>

We would like to see the number of years that critical and target environmental flows criteria are engaged both without and with each strategy (these criteria are based on lake level triggers established in the 1999 LCRA WMP).

<u>Executive Summary</u>

When referencing a control point in the text of the report, it would be useful to list the geographic location of the control point along with the numerical designation. For example, list the control point as "CP J10000 (Colorado County)" instead of just "CP J10000".

The first two sentences of the last paragraph in the Executive Summary should be deleted. They are subjective and may not necessarily be the opinion of the Region K Group. (Page ES-8&9).

The Base Model is never fully described. Please provide a full description of the Base Model and the assumptions used in it (this might be done in Appendix B, but should be referenced in the ES). If the Base Model differs for a particular strategy evaluation, then list the Base Model assumptions specific to that Base-Strategy model pairing.

<u>2.0 Methodology</u>

Page 2-4: The control points referred to for strategies 4 and 5 are not defined anywhere in the report. The control points are J40160 and F10780

Page 2-7: The second paragraph states that, "It should be noted that the LSWP model does contain several of the other strategies within it, which do contribute to the overall results." Please provide a more thorough explanation of this and how the results are different as a result of the inclusion of the additional strategies. Please list the additional strategies.

Page 2-8: The control points referred to for strategy 13 are not defined anywhere in the report. The control points listed are K20080, K10090 and M10050

3.0 Results

We are unclear on why the consultants chose the 10th percentile to compare the results of the base and base + strategy analysis to. The reason given was that the strategies were likely to be incorporated during periods of drought and 10th percentile was a good representation of that scenario. We would argue that these strategies will be implemented (if at all) during all climactic conditions and that some other quantity might yield a more useful comparison. It is our opinion that the 25% percentile may be more useful in creating robust statistical comparisons because of the simulation limitations of a monthly model in accurately quantifying extreme low (or high) flows.

This study compares the instream flow results to a 7Q2 value for that particular location. 7Q2 is a very low flow rate and could lead to a misinterpretation that the base and base + strategy scenarios that it is being compared to have minimal environmental impact if they are above that amount. It would be more useful to insert the instream flow requirements from the LCRA 1999 WMP into the data table and to use those for comparison instead of 7Q2.

The WAM's environmental flow maintenance code is not designed to protect the 7Q2 flow level. The WAM's code is, however, designed to attempt to reduce deviations below the instream flow criteria listed in the 1999 WMP. Those criteria would be a better comparative instream flow metric than the 7Q2. The 7Q2 flow is derived from data of 1-week averaged flow events. It may not be appropriate to aggregate a constant 7Q2 flow into a monthly equivalent volume.

Strategy 7, HB 1437 (page 3-29)

It does not seem possible that this strategy could have no effect on instream flows. The premise of the "no net loss" provision of HB 1437 is that on-farm conservation measures will result in at least 25,000 afy of water savings. Therefore, that amount of water will no longer have to be released down the Colorado River to the irrigation districts and will instead be held in the Highland Lakes and provided to municipalities in Williamson County. How can a strategy that will result in less water being transported down the Colorado River result in essentially no change to instream flows?

Strategy 9, LCRA-SAWS Water Sharing Project (LSWP), pages 3-34

AECOM used the LSWP model that was developed by LCRA for the analysis of this strategy. This model has several other strategies embedded in it that can affect the results that were achieved. Most importantly, the model includes the reuse strategy of the 2007 Settlement Agreement between the City of Austin and LCRA in it. This agreement dedicates the COA return flows to help meet WMP environmental flow requirements prior to reuse by Austin and prior to diversion by any LCRA water rights. Therefore, the LSWP could appear to increase environmental flows when it is really a variety of factors resulting in the increase, namely the environmental flow dedication of COA return flows.

The base model that the LSWP is compared to should include all the strategies that are in the LCRA-LSWP model except for the actual LSWP in order to get a meaningful comparison.

The first sentence of the last paragraph on Page 3-34 states that CP I10000 is the first control point downstream of where the transfer would occur. This is incorrect. The LSWP water transfer will occur in the lower basin. The nearest downstream control point should be CP K20000 (Wharton County).

Please include an explanation of how the environmental impact results for the LSWP may be inaccurate due to the model that was used.

Strategy 10, COA Return Flows for Downstream Water Needs
This strategy appears to show a positive impact to instream flows. This gain is not in addition to the benefits that we currently see from the COA return flows. Therefore, this strategy analysis gives the impression that the COA return flows are a benefit to the Colorado River above and beyond what we currently see. The base model should closely reflect current conditions and the strategies should be compared to that so that planning group members can get a realistic picture of the impact of WMS.

Strategy 11, City of Austin Reuse
Is it possible to have only a slightly negative impact with a strategy that will eventually remove 100% of the COA return flows from the Colorado River? COA return flows can make up a significant portion of the flow in the river at certain times of the year.

Strategy 13, LCRA Excess Flows Permit and Off-Channel Storage
Again, how is it possible that a strategy that uses the magnitude of water that Permit 5731 and the off-channel storage facility will use can have no impact on environmental flows? According to this analysis the strategy has a practically no impact on instream flows and freshwater inflows. Since Strategy 13 impacts peak flows. It would be better to measure deviations from flows in the range of the 75^{th} to 90^{th} percentiles. The LSWP strategy should be evaluated for impacts to high flows too because LSWP depends greatly on the "Excess Flows" permit.

Strategy 14, Comprehensive Model Containing all the Strategies
The results state that the LSWP strategy tends to dominate the "all strategies" results. As discussed previously we have concerns about the modeling results for the LSWP. These should be addressed in the report and the analysis should be redone for the 2011 Region K plan.

<u>4.0 Conclusions</u>

First bullet (contract expansion): the last sentence states that impacts to instream flows in the lower portion of the basin can be considered to be reasonable considering the lack of any feasible water strategies. This is a subjective statement and should be modified or removed.

Sixth bullet (HB 1437): The last sentence should be changed to, "There is potential for future agreements to be executed that would convey the return flows from the transferred water back to the Colorado Basin."

Eighth bullet (LSWP): The conclusions for the LSWP need to be revised. The results need to be explained as discussed above.

Ninth bullet (COA return flows and reuse): The second to the last sentence in this paragraph should be deleted. We do not have enough information to determine if the "tradeoffs" are valuable or not.

Appendix C

Please include the names of the geographic locations for the control points as well as the name of the strategies in the title of the charts in Appendix C (similar to the naming protocol used for the Tables)

Ways to Improve the Environmental Impact Analysis for the 2011 Region K Plan

A more accurate analysis needs to be performed on some of the strategies from this report that have unclear results or issues with the models such as the COA return flows and reuse strategies, HB 1437, LSWP and the Excess Flows strategy.

We anticipate providing more information on ways to improve and enhance the analysis of the environmental impacts of water management strategies in time for inclusion in the analysis performed for the 2011 Region K plan.

Please contact me if you have any questions or need clarification on any of these comments.

Sincerely,

Jennifer Walker
Water Resources Specialist
Lone Star Chapter, Sierra Club

Response to Comment Received from Jennifer Walker (Sierra Club) on the Draft Final Environmental Impacts of Water Management Strategies (Task 2) Study Report

General Comments

1. We would like to see the number of years that critical and target environmental flows criteria are engaged both without and with each strategy (these criteria are based on lake level triggers established in the 1999 LCRA WMP).

Response: This is an additional way of presenting the results that can be considered for future impact analyses.

Executive Summary

2. When referencing a control point in the text of the report, it would be useful to list the geographic location of the control point along with the numerical designation. For example, list the control point as “CP J10000 (Colorado County)” instead of just “CP J10000”.

Response: The geographic location may be added to control point names in the text of the Executive Summary, since it cannot reference other parts of the document, but the main report will reference an additional exhibit in the Appendix that will show the location of all of the control points mentioned in the report.

3. The first two sentences of the last paragraph in the Executive Summary should be deleted. They are subjective and may not necessarily be the opinion of the Region K Group. (Page ES-8&9).

Response: Part of the scope of this report is to determine whether the impacts are reasonable and consistent with the State’s goals, so the Planning Group needs to decide whether or not they agree with the statement.

4. The Base Model is never fully described. Please provide a full description of the Base Model and the assumptions used in it (this might be done in Appendix B, but should be referenced in the ES). If the Base Model differs for a particular strategy evaluation, then list the Base Model assumptions specific to that Base-Strategy model pairing.

Response: The Task 2 report refers to a separate report (Surface Water Availability Modeling Study Report) that provides the description of the supply model. The Task 2 report then goes on to discuss what changes were made to the supply model to create the “base model”. The description of the WAM Run 3 Cutoff Model (in Appendix B) from the Task 1 report will be added to Appendix A of the Task 2 report.

2.0 Methodology

5. Page 2-4: The control points referred to for strategies 4 and 5 are not defined anywhere in the report. The control points are J40160 and F10780

Response: A separate exhibit will be provided in the report that shows the location of all of the control points that are mentioned. A reference to this exhibit will be made where necessary.

6. Page 2-7: The second paragraph states that, "It should be noted that the LSWP model does contain several of the other strategies within it, which do contribute to the overall results." Please provide a more thorough explanation of this and how the results are different as a result of the inclusion of the additional strategies. Please list the additional strategies.

Response: The paragraph will be adjusted as recommended. See below.

For this study, and because of the complexity of the LSWP strategy, the time that would be required to develop the code within the model would not be possible with the state funds available under this regional water planning program. Instead, as a part of the LSWP, LCRA has created a model specifically for the project that is compatible with the Region K WAM Run 3 Cutoff Model and can be used for comparison purposes; therefore, it is more efficient to use the LCRA's already developed LSWP model. It should be noted that the LSWP model does contain several of the other strategies within it, which do contribute to the overall results. These strategies were already embedded in the model, and it was too difficult to remove them. The strategies include the 2007 Settlement Agreement between the City of Austin and the LCRA, as well as the Amendment of LCRA irrigation water rights (Strategy 12) and the LCRA excess flows permit and off-channel storage (Strategy 13). It is likely that the incorporation of the Settlement Agreement in the LSWP model will create the appearance of more positive impact results than if it was not included, as it is not for the other strategy comparisons. This should be considered when comparing the results. As the LSWP strategy will not be used in 2010, only a 2060 comparison of the impacts was performed using this existing model.

7. Page 2-8: The control points referred to for strategy 13 are not defined anywhere in the report. The control points listed are K20080, K10090 and M10050

Response: A separate exhibit will be provided in the report that shows the location of all of the control points that are mentioned. A reference to this exhibit will be made where necessary.

<u>3.0 Results</u>

8. We are unclear on why the consultants chose the 10th percentile to compare the results of the base and base + strategy analysis to. The reason given was that the strategies were likely to be incorporated during periods of drought and 10th percentile was a good representation of that scenario. We would argue that these strategies will be implemented (if at all) during all climactic conditions and that some other quantity might yield a more useful comparison. It is our opinion that the 25% percentile may be more useful in creating robust statistical comparisons because of the simulation limitations of a monthly model in accurately quantifying extreme low (or high) flows.

Response: The 25th percentile can be considered for future studies. For this report, it is too late to make this change. Median flows and 90th percentile flow results are provided in graphic form in Section 3.0 and Appendix C. The tables discussing the frequency of the flows meeting the target and critical instream flows and freshwater inflows were also added to the report to provide an additional level of results.

9. This study compares the instream flow results to a 7Q2 value for that particular location. 7Q2 is a very low flow rate and could lead to a misinterpretation that the base and base + strategy scenarios that it is being compared to have minimal environmental impact if they are above that amount. It would be more useful to insert the instream flow requirements from the LCRA 1999 WMP into the data table and to use those for comparison instead of 7Q2.
The WAM's environmental flow maintenance code is not designed to protect the 7Q2 flow level. The WAM's code is, however, designed to attempt to reduce deviations below the instream flow criteria listed in the 1999 WMP. Those criteria would be a better comparative instream flow metric than the 7Q2. The 7Q2 flow is derived from data of 1-week averaged flow events. It may not be appropriate to aggregate a constant 7Q2 flow into a monthly equivalent volume.

Response: The instream flow requirements are not available at all of the analyzed control point locations. The purpose of the study was to compare the base model to the base plus strategy model. The 7Q2 flows were included simply as information. A statement will be added to help prevent any misinterpretation of the inclusion of the 7Q2 flows. See below.

(from Page 2-1)
The purpose of the adjusted cutoff model is to quantifiably measure the impact that certain water management strategies have on the Colorado River and its major tributaries, as well as Matagorda Bay, by comparing the regulated stream flow in the model without the strategy to the regulated stream flow in the model with the strategy. Regulated flow represents physical flow at a location, some or all of which may be required to meet water rights requirements (Wurbs 2008). The instream flow results were also compared to the seven-day, two-year low-flow (7Q2 flows) obtained from the Texas Administrative Code (TAC) 307.10(2) – Appendix B – Low Flow Criteria. 7Q2 flows are defined as "-- the lowest average stream flow for seven consecutive days with a recurrence interval of two years, as statistically determined from historical data," and were determined to be a good measure of low-flow conditions. It should be noted that the 7Q2 flow information is provided simply as information and should not be used to determine whether or not a strategy is reasonable based on whether the strategy causes the instream flows to go above or below a particular value. Again, the main comparison for this study is the flow with and without the strategy implemented. The bay and estuary inflow results were also compared to the target and critical bay and estuary monthly inflows as determined in the 2006 Matagorda Bay Freshwater Inflow Needs Study. Thirteen proposed water management strategies from the 2006 Region K Plan were chosen as potentially impacting the Colorado River or its major tributaries in a way that could be quantifiably determined using the adjusted Region K WAM Run 3 Cutoff model. In general, the strategies were analyzed for the years 2010 and 2060.

10. *Strategy 7, HB 1437 (page 3-29)*
It does not seem possible that this strategy could have no effect on instream flows. The premise of the "no net loss" provision of HB 1437 is that on-farm conservation measures will result in at least 25,000 afy of water savings. Therefore, that amount of water will no longer have to be released down the Colorado River to the irrigation districts and will instead be held in the Highland Lakes and provided to municipalities in Williamson County. How can a strategy that will result in less water being transported down the Colorado River result in essentially no change to instream flows?

Response: We believe the strategy was modeled correctly. At this time, there has not been a detailed investigation into what happens to the additional firm yield in the model. Because the supplies to the irrigation operations are considered interruptible, it is not guaranteed that additional firm yield would be available to them. The model output does show slight variations in the results, but they are not large enough (0.01%) to appear in the report findings.

11. *Strategy 9, LCRA-SAWS Water Sharing Project (LSWP), pages 3-34*
AECOM used the LSWP model that was developed by LCRA for the analysis of this strategy. This model has several other strategies embedded in it that can affect the results that were achieved. Most importantly, the model includes the reuse strategy of the 2007 Settlement Agreement between the City of Austin and LCRA in it. This agreement dedicates the COA return flows to help meet WMP environmental flow requirements prior to reuse by Austin and prior to diversion by any LCRA water rights. Therefore, the LSWP could appear to increase environmental flows when it is really a variety of factors resulting in the increase, namely the environmental flow dedication of COA return flows. The base model that the LSWP is compared to should include all the strategies that are in the LCRA-LSWP model except for the actual LSWP in order to get a meaningful comparison.

Response: Because of the complexity of the LSWP model, along with the 2007 Settlement Agreement between the City of Austin and LCRA versus the City of Austin strategies in the 2006 Plan, adding the appropriate strategies to the base model and/or removing strategies from the LSWP model was too difficult to be incorporated within our time constraints. We acknowledge that the results are not accurate and will need to be updated in the future.

12. The first sentence of the last paragraph on Page 3-34 states that CP I10000 is the first control point downstream of where the transfer would occur. This is incorrect. The LSWP water transfer will occur in the lower basin. The nearest downstream control point should be CP K20000 (Wharton County).

Response: This sentence will be revised to say "The instream flow impacts at CP I10000…"

13. Please include an explanation of how the environmental impact results for the LSWP may be inaccurate due to the model that was used.

Response: Will include recommended explanation. See below. (From Page 3-38)

Table 3.7G demonstrates the various impacts that the LSWP strategy has on the number of occurrences of the flow falling below target/critical levels, and duration and volume of those occurrences, as compared to not implementing the strategy. Negative impacts occur at the Matagorda Bay control point for the number of times the flow falls below the target level (increased from 85 to 90), and the maximum duration below the target level (increased from 51 months to 83 months). The other negative impacts occur at the Colorado County control point for the number of times the flow falls below the critical level and the total duration below the critical level (both increased from 6 to 7).

As was mentioned in Section 2.0 Methodology, the model used for the LSWP strategy also contained other strategies within it that could not be removed. It is likely that having the incorporation of the 2007 Settlement Agreement between City of Austin and the LCRA in the LSWP model created impact results that were more positive than if it was not included, as it is not for other strategy comparisons. The results are not as accurate as they could be if a more separate and detailed analysis were done, and these strategies and analyses should be updated in the future to provide a better idea of the true impact of the LSWP strategy.

14. *Strategy 10, COA Return Flows for Downstream Water Needs*
This strategy appears to show a positive impact to instream flows. This gain is not in addition to the benefits that we currently see from the COA return flows. Therefore, this strategy analysis gives the impression that the COA return flows are a benefit to the Colorado River above and beyond what we currently see. The base model should closely reflect current conditions and the strategies should be compared to that so that planning group members can get a realistic picture of the impact of WMS.

Response: Because the supply model contains no return flows, for purposes of the Plan, all return flows are considered a strategy. One might look at the 2010 model results to see what “current conditions” might be similar to. A sentence will be added to Section 3.0 Results to clarify that the base model for this strategy has no return flows.

15. *Strategy 11, City of Austin Reuse*
Is it possible to have only a slightly negative impact with a strategy that will eventually remove 100% of the COA return flows from the Colorado River? COA return flows can make up a significant portion of the flow in the river at certain times of the year.

Response: This study only analyzes results through 2060. The results shown in the tables for 2060 show the amount of flow that the effluent reuse reduces the return flows by for that decade. Future versions of the Plan will analyze the impacts for future decades.

16. *Strategy 13, LCRA Excess Flows Permit and Off-Channel Storage*
Again, how is it possible that a strategy that uses the magnitude of water that Permit 5731 and the off-channel storage facility will use can have no impact on environmental flows? According to this analysis the strategy has a practically no impact on instream flows and freshwater inflows. Since Strategy 13 impacts peak flows. It would be better to measure deviations from flows in the range of the 75th to 90th percentiles. The LSWP strategy should be evaluated for impacts to high flows too because LSWP depends greatly on the “Excess Flows” permit.

Response: 90th percentile impacts can be seen in the graphic results provided both in Section 3.0 of the report and in Appendix C. “10th percentile” will be added to the first sentence on page 3-49 for clarification. A sentence will be added stating that the graphs shown in Appendix C (C-107 through C-112) display the 90th percentile flow impacts at each control point, and show decreases of as much as 10 percent for the months of January through May.

17. *Strategy 14, Comprehensive Model Containing all the Strategies*
The results state that the LSWP strategy tends to dominate the "all strategies" results. As discussed previously we have concerns about the modeling results for the LSWP. These should be addressed in the report and the analysis should be redone for the 2011 Region K plan.

Response: The text will be revised to more accurately reflect the effect of the LSWP strategy. Please see below:

Page 3-52: Because the LSWP strategy (Strategy 9) has such a large impact, the results for the comprehensive strategy model are very similar to the results for the LSWP strategy.

Change to:

Because the LSWP model (used in the LSWP strategy analysis - Strategy 9) contains several strategies that have large impacts, the results for the comprehensive strategy model are very similar to the results shown for the LSWP strategy, in this report.

Page 3-54: The impacts to the freshwater inflows at CP M10000 are also similar to the LSWP strategy impacts. The annual 10th percentile flows more than double, although they are still much less than the critical bay and estuary inflows. ~~It is apparent that the impacts of the LSWP strategy overshadow the impacts of the rest of the strategies.~~

Page 4-3: Overall, based upon the modeling assumptions developed as a part of this study, the individual water management strategies evaluated appear reasonable and consistent with the long-term protection of the state's water resources, natural resources, and agricultural resources. Likewise, the cumulative impact of all of these strategies is generally within expected ranges and is ~~dominated by the LSWP~~ similar to the results generated by the LSWP model, which contains the LSWP strategy along with other strategies, which have larger positive impacts on the basin than the rest of the strategies. The LCRWPG will continue to consider all of these strategies in further detail during future regional water planning updates, as well as examine potential alternative strategies for selected areas and for changed conditions.

<u>4.0 Conclusions</u>

18. *First bullet (contract expansion)*: the last sentence states that impacts to instream flows in the lower portion of the basin can be considered to be reasonable considering the lack of any feasible water strategies. This is a subjective statement and should be modified or removed.

Response: The sentence reads: *These strategies also have negative impacts on the instream flows in the lower portion of the basin, although the impacts are very small and can be considered reasonable, especially when considering the lack of any feasible alternatives.* Again, the scope of the study requires some subjective interpretation of results by the Planning Group. If after viewing the data results, the Planning Group does not think the results are reasonable, the sentence should be revised to say so.

19. *Sixth bullet (HB 1437)*: The last sentence should be changed to, "There is potential for future agreements to be executed that would convey the return flows from the transferred water back to the Colorado Basin."

Response: Text will be revised as suggested.

20. *Eighth bullet (LSWP)*: The conclusions for the LSWP need to be revised. The results need to be explained as discussed above.

Response: Text will be revised as suggested. Please see below (from Page 4-2):

- The LCRA-SAWS Water Project (LSWP) is subject to a number of special legislative environmental conditions as well as statutory requirements. A part of the project includes the conservation of irrigation water (through on-farm water conservation measures, irrigation district conveyance improvements, and new high yielding/water efficient rice varieties), pumping limited amounts of groundwater during drought conditions, and primarily capturing the remaining permitted portion of Colorado River flows. This study is not able to show the impact of only the LSWP strategy, as the LSWP model used contains other strategies, as well as the 2007 Settlement Agreement between the City of Austin and the LCRA. The effect of these additions is that the results shown are likely more positive than they would be if only the LSWP strategy was included. A future update of the analysis is recommended to provide more definitive results. The strategy does have some negative impacts on the frequency that target and critical instream flows and freshwater inflows are met, specifically in the months of April and November. Conservation measures are an important part of maintaining agricultural resources in the basin. This strategy will allow farmers to implement these conservation measures when otherwise they might not be able to afford to.

21. *Ninth bullet (COA return flows and reuse)*: The second to the last sentence in this paragraph should be deleted. We do not have enough information to determine if the "tradeoffs" are valuable or not.

Response: Text will be revised as suggested.

<u>Appendix C</u>

22. Please include the names of the geographic locations for the control points as well as the name of the strategies in the title of the charts in Appendix C (similar to the naming protocol used for the Tables)

Response: Graph titles may be revised for inclusion in the 2011 Plan, as appropriate.

<u>Ways to Improve the Environmental Impact Analysis for the 2011 Region K Plan</u>

23. A more accurate analysis needs to be performed on some of the strategies from this report that have unclear results or issues with the models such as the COA return flows and reuse strategies, HB 1437, LSWP and the Excess Flows strategy.

Response: Noted.

24. We anticipate providing more information on ways to improve and enhance the analysis of the environmental impacts of water management strategies in time for inclusion in the analysis performed for the 2011 Region K plan.

Response: Noted.

January 12, 2009

Jaime Burke, P.E.
Project Manager, Natural Resources Planning, Southwest and Mountain Region
AECOM
400 W. 15th Street, Suite 500
Austin, TX 78701

Dear Ms. Burke,

The Texas Parks and Wildlife Department (TPWD) appreciates the opportunity to provide comments on the Final Draft Task 3 Report *Draft LCRWPG 2011 Water Plan First Biennium Studies Environmental Impacts of Water Management Strategies Study* (November 2008). The revised draft is markedly improved over the initial draft, most notably with the addition of tables and the deletion of many seemingly subjective observations. However, the revised document still presents some of the same limitations as the initial draft. TPWD staff believes that the main deficiencies of the document are the lack of a full and detailed explanation as to the modeling assumptions used, especially regarding return flows or lack thereof in the various modeling scenarios, and the attempt to compare strategies using two different models (No-Call Colorado WAM and LSWP WAM). In large part, it seems that the results of the study are being driven by return flows. The report would greatly benefit by a table that explicitly describes all return flow assumptions for each base flow model and each strategy model.

The use of different models and different modeling assumptions sets up an "apples to oranges" comparison and makes it hard to understand the potential effect of the selected strategies on environmental flows. In addition, it is difficult to ascertain if the results of the WAM-based analyses are simply a matter of modeling assumptions and inputs, or if they accurately represent the impact to stream flow from implementation of the various strategies. For example, the analysis of the LCRA-SAWS Water Project (LSWP) strategy (Strategy 9) indicates that less water will be released from the Highland Lakes, less water will be diverted by the lower basin irrigators, and large increases to instream flows and freshwater inflows will result. The document notes that City of Austin return flow and reuse strategies are part of the LSWP strategy model and contribute to the positive impact of the strategy. However, TPWD staff opines that without the City of Austin return flows, the LSWP on its own will not increase freshwater inflows.

TPWD staff also notes that the use of a 7Q2 flow value as a threshold for determining environmental impact may not be very instructive, especially in a river system with existing target and subsistence flows as described in the 1999 LCRA Water Management Plan (WMP). For locations downstream of the Highland Lakes, deviations from target and subsistence flows identified in the 1999 WMP for each strategy and at each control point should be used as a basis for comparison. In addition, the number of years and months that subsistence and target instream flows and target and critical freshwater inflows are engaged, both with and without each strategy, should be identified. Regarding 7Q2 flows, the 7Q2 is generally defined as a rate while the tables show 7Q2 as an amount. A 7Q2 value converted to a monthly amount should not be the same for each month due to the difference of number of days in each month.

Additionally, the use of a low flow analysis is not appropriate for evaluating every strategy. Strategy 13 (LCRA Excess Flows Permit and Off-Channel Storage) is predicated on diverting water during periods of high flows; therefore an investigation of impacts during low flow periods does not seem applicable or reasonable. However, given that the draft permit for Strategy 13 includes a maximum diversion rate of 40,000 cfs that could potentially alter high flows and high flow pulses, an analysis of the strategy during higher flow periods is appropriate. Since the LSWP is partially dependent on Strategy 13, it should be evaluated for potential environmental flow impacts during high flow periods as well.

Finally, the report could benefit from more analysis, detail, and interpretation. With such a complex subject, it would be helpful if the authors provided some explanation for many of the seemingly non-intuitive results. For example, in Table ES.1C the annual frequencies of meeting the Critical freshwater inflows (FINs) are identical for both with and without the strategy for CP M10000 even though the "with strategy" column has 6 of 12 months with lower achievement. Also, Table 3.1A shows that Strategy 1 has a fairly large negative impact on 10th percentile flows in June, but zero impact on May and July. No explanation is given as to why this occurs. Table 3.7B shows that the LSWP will greatly increase the 10th percentile flows at J10000 in the winter months again without explanation. In addition, the results in Table 3.7E are not at all intuitive and, given the importance of Strategy 9 to the Lower Colorado Regional Water Plan, the results require thorough explanation.

TPWD staff appreciates the opportunity to comment on the report as drafted. While our comments may be too substantial to affect the outcome of the report given the timeline for finalization of the report, we look forward to working with AECOM and the LCRWPG in the future to develop and evaluate water supply strategies that provide for human needs while protecting essential environmental flows. Should have any questions about these comments, please contact me at (512)-389-8048 or at david.bradsby@tpwd.state.tx.us.

Sincerely,

David Bradsby, Leader
Water Quantity Program

ENVIRONMENTAL IMPACTS OF THE WATER MANAGEMENT STRATEGIES – TASK 2 COMMENTS

It seems that the principal evaluation criteria is, does the strategy result in a negative impact on flow when compared to a model flow value. This comparison generally shows that the strategy either has no or minimal impact or provides higher flows suggesting that the strategies have no detrimental impact on the environment. However, there is still the question of whether or not the strategies meet an environmental goal?

The initial report offered only a 7Q2 Flow with which to compare strategy river flow. I assumed that 7Q2 Flow could be considered the critical environmental flow, otherwise why was it offered. If it is used as an environmental yardstick, there are a number of months that strategy flows are less than the 7Q2 Flow which suggests that those strategies fail.

For example: Strategy 9: of the 5 control points referenced, only at J10k does the strategy flow exceed 7Q2 Flow every month of the year. At the other 4 points, the strategy flow is less for > 50% of the months. If you take the position that by definition the critical number must be met 100% of the time then, the strategy fails the environmental test. If current river studies result in a higher critical environmental flow rate (in acre-feet), then a re-evaluation of the strategy must be done. Also, it would be better if 7Q2 Flow showed monthly data rather than be an even 12 month distribution of an annual flow.

The post 12/3/08 meeting revision resulted in two new charts that offer 2060 comparisons with Target and Critical environmental flows taken from 1999 WMP for CP J10k at Columbus, Colorado County and from 2006 FINS report for CP M10k in Matagorda Bay. The first chart, "Frequency of Meeting Target and Critical Needs for 2060" is a bit confusing. How can an annual value be higher if there are months that show lesser values? There must be something in the math that I don't understand.

In the second chart, "Flow Duration Below Target and Critical Needs for 2060", the number of times the flow at CP M10k is below the critical flow ranges from 80 to93 and total number of months below critical flow ranges from 213 to 261. The differences do not seem to be significant but the fact that a strategy can result in flows being 80 to 90 times below a critical value in one year questions its viability. Also, how do you get 200+ months in a year? Or even a 10 year period? I must be missing something.

The revision also added in the Appendix some definitions and a table of Target and Critical monthly environmental flow values for River Control Points J10k and Target for K20k at Wharton, Wharton Co. Comparing these monthly Critical environmental flows to strategy flows:

1) Strategies 9 and 14 flows at CP J10k are > than Critical for all months in 2010 and 2060 - probably because CP J10k is above Strategy 9 impacts.

2) In 2010, March flows are less than Critical flow in 8 of 11 Strategies (1, 3, 4, 5, 6, 7, 10, and 11). Is this an unusually high frequency of occurrence for one month? Error?

3) Strategy 13 is compared to Target flows at CP K20k with results that the strategy flow is less than Target for 5 months (January, April, May, June, September). Does this mean that the Strategy fails to meet environmental requirements at Cp K20k?

CP M10k in the Matagorda Bay has “Target” and “Critical” environmental yardsticks from the FINS, 2006, study for comparison as well as five “achievement guidelines” from MBHE 10/10/08 report. (Not included).   Significantly, all Strategy flows fall below the “Critical” flow value in all 12 months in 2010 and 2060 at CP M10k. When the Strategy flows are compared to the 15k a-f per month for the absolute minimum “Threshold” flow in the MBHE 10/10/08 report, 8 Strategy Flows exceed Critical flows for the same 5 months in 2010 and in 2060, only exceeded Critical flow between 1 and 2 months (always March and occasionally February) for Strategies 1 through 9 and 13. Strategies 10,11and 14 exceeded Critical between 5 and 9 months – close, but no points! All Strategies fail to meet the 100%of the time concept of Threshold flow; therefore do not meet environmental requirements.

How significant are the differences? Are they within the error of the estimating process? (I asked this question at the joint committee meeting 12/3/08 and got no response.) Some of the lower differences appear to be within margin of error or statistical variance but there is no definition of “significant difference”.

W.R Pickens
01/11/09

January 21, 2009

John Burke, Chairman
Lower Colorado Region Water Planning Group
415 Old Austin Highway
Bastrop, TX 78602

Re: DRAFT LCRWPG 2011 WATER PLAN FIRST BIENNIUM STUDIES
ENVIRONMENTAL IMPACTS OF WATER MANAGEMENT STRATEGIES STUDY

Dear Planning Group Members,

This study provides a mixed view on how we are doing in providing the water necessary for environmental flows as we provide for the human water needs of the region. While the strategies proposed seem to do a good job of meeting critical instream flows for the Colorado River, they fall woefully short of meeting the freshwater inflow needs of Matagorda Bay. Balancing the human and environmental needs for water in the lower Colorado River and bay system will require visionary strategies beyond those currently under consideration. In developing these new strategies, the Lower Colorado Region Water Planning Group (LCRWPG) should consider both the threats to the system and the opportunities to go beyond traditional water supply paradigms.

The stated purpose of this study was to “conduct a quantitative evaluation of the potential environmental impacts of the proposed water management strategies for the 2006 Lower Colorado Regional Water Plan as related to instream flows [for the Colorado River] and freshwater inflows to Matagorda Bay”. To accomplish this it seems that the analysis should more clearly indicate where we started, where we stand, and where we seem to be going. Based on communications with AECOM Tables 1-4 were prepared to compare environmental flow needs to the “base model” and “comprehensive strategies” for 2010 and 2060. In addition, the more comprehensive 2008 LSWP Study: Lower Colorado Instream Flow Guidelines completed March 31, 2008 was used to characterize the environmental flow needs of the river. We consider this study to be more representative since it provides an ecological link between the flow relationships of the river and the aquatic habitat of the state threatened species, the blue sucker, which spawns in the lower reaches of the Colorado River.

Table 1 compares the base model to environmental flow needs for 2010. It appears from this information that the historic/current flow regime (base model) for the Colorado River provides adequate water to meet critical flows but falls short of target flow needs. The historic/current flows however fall woefully short of meeting both critical and target freshwater inflow needs of the bay.

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Table 1
2010 Comparison of environmental flow needs to base model at Wharton & Matagorda

	Colorado River Instream Flow			Matagorda Bay Freshwater Inflow		
	Base Model	2008 LSWP Study		Base Model	2006 FIN Study	
Month	**Wharton**	**Target***	**Critical****	**Matagorda**	**Target**	**Critical**
January	20,996	51,021	20,951	16,939	205,600	36,000
February	19,465	49,813	20,871	19,941	194,500	36,000
March	30,746	62,852	23,107	23,842	63,200	36,000
April	18,450	58,260	17,830	6,947	60,400	36,000
May	30,092	81,091	26,188	10,971	255,400	36,000
June	28,298	85,870	31,843	6,223	210,500	36,000
July	22,939	55,150	21,074	3,476	108,400	36,000
August	16,170	31,796	11,708	3,259	62,000	36,000
September	13,945	36,375	16,637	1,048	61,900	36,000
October	12,302	45,660	11,708	2,210	71,300	36,000
November	19,736	45,022	12,046	17,501	66,500	36,000
December	20,704	45,414	18,548	18,829	68,000	36,000
Total	**253,843**	**648,324**	**232,511**	**131,186**	**1,427,700**	**432,000**

Base Model data for river from Table 3.4D of report; Per AECOM
Base Model data for bay from Table 3.4F of report; Per AECOM
* Target = Base Average from 2008 LSWP Study
** Critical = Subsistence from 2008 LSWP Study

Table 2 compares the comprehensive strategy to environmental flow needs for 2010. Again it appears from this information that the historic/current flow regime for the Colorado River provides adequate water to meet critical flows and only marginally improves in providing target flows. Likewise the strategy provides only marginal improvement and still falls woefully short of meeting both critical and target freshwater inflow needs of the bay.

Table 2
2010 Comparison of environmental flow needs to comprehensive strategy

	Colorado River Instream Flow			Matagorda Bay Freshwater Inflow		
	Strategy	2008 LSWP Study		Strategy	2006 FIN Study	
Month	**Wharton**	**Target***	**Critical****	**Matagorda**	**Target**	**Critical**
January	23,418	51,021	20,951	21,388	205,600	36,000
February	25,297	49,813	20,871	21,388	194,500	36,000
March	30,383	62,852	23,107	23,956	63,200	36,000
April	19,889	58,260	17,830	9,167	60,400	36,000
May	33,397	81,091	26,188	13,652	255,400	36,000
June	30,572	85,870	31,843	5,301	210,500	36,000
July	25,386	55,150	21,074	3,284	108,400	36,000
August	17,002	31,796	11,708	2,772	62,000	36,000
September	17,857	36,375	16,637	1,392	61,900	36,000
October	15,809	45,660	11,708	10,002	71,300	36,000
November	23,968	45,022	12,046	21,350	66,500	36,000
December	24,091	45,414	18,548	21,524	68,000	36,000
Total	**287,069**	**648,324**	**232,511**	**155,176**	**1,427,700**	**432,000**

Strategy data for river from Table 3.9B of report: Per AECOM
Strategy data for bay from Table 3.9D of report: Per AECOM
* Target = Base Average from 2008 LSWP Study
** Critical = Subsistence from 2008 LSWP Study

Table 3 compares the base model to environmental flow needs for 2060. It appears from this information that the flows provided by the base model decline significantly, presumably due to water allocation to human needs, and no longer provides adequate water to meet critical and target flow requirements for the river. Likewise the base model declines significantly and is even more woefully short of meeting both critical and target freshwater inflow needs of the bay. Comparing these results with Table 1 it appears clear that increased demand without the implementation of the key strategies would leave the river and bay in peril.

Table 3
2060 Comparison of environmental flow needs to base model at Wharton & Matagorda

	Colorado River Instream Flow			Matagorda Bay Freshwater Inflow		
	Base Model	2008 LSWP Study		Base Model	2006 FIN Study	
Month	Wharton	Target*	Critical**	Matagorda	Target	Critical
January	16,140	51,021	20,951	12,939	205,600	36,000
February	17,188	49,813	20,871	14,988	194,500	36,000
March	33,101	62,852	23,107	26,324	63,200	36,000
April	20,782	58,260	17,830	8,131	60,400	36,000
May	27,546	81,091	26,188	6,375	255,400	36,000
June	20,624	85,870	31,843	1,595	210,500	36,000
July	15,157	55,150	21,074	1,292	108,400	36,000
August	11,617	31,796	11,708	1,154	62,000	36,000
September	11,702	36,375	16,637	15	61,900	36,000
October	8,952	45,660	11,708	1,334	71,300	36,000
November	15,596	45,022	12,046	11,010	66,500	36,000
December	16,400	45,414	18,548	13,749	68,000	36,000
Total	**214,805**	**648,324**	**232,511**	**98,906**	**1,427,700**	**432,000**

Base Model data for river from Table 3.11C of report; Does not include City of Austin return flows
Base Model data for bay from Table 3.11E of report; Does not include City of Austin return flows
* Target = Base Average from 2008 LSWP Study
** Critical = Subsistence from 2008 LSWP Study

Table 4 compares the base model to environmental flow needs for 2060. This table indicates that implementation of the key strategies is necessary to meet the critical needs of the river and make gains on meeting target needs. Likewise, implementation of the key strategies narrows the gap on critical freshwater inflow needs of the bay but still fall woefully short of meeting target needs.

Table 4
2060 Comparison of environmental flow needs to comprehensive strategy

	Colorado River Instream Flow			Matagorda Bay Freshwater Inflow		
	Strategy	2008 LSWP Study		Strategy	2006 FIN Study	
Month	Wharton	Target*	Critical**	Matagorda	Target	Critical
January	30,337	51,021	20,951	23,091	205,600	36,000
February	35,866	49,813	20,871	29,513	194,500	36,000
March	32,939	62,852	23,107	27,947	63,200	36,000
April	24,129	58,260	17,830	15,892	60,400	36,000
May	29,816	81,091	26,188	17,352	255,400	36,000
June	22,637	85,870	31,843	12,986	210,500	36,000
July	20,648	55,150	21,074	9,025	108,400	36,000
August	17,285	31,796	11,708	7,899	62,000	36,000
September	23,193	36,375	16,637	23,490	61,900	36,000
October	25,737	45,660	11,708	20,220	71,300	36,000
November	29,852	45,022	12,046	23,173	66,500	36,000
December	29,183	45,414	18,548	25,903	68,000	36,000
Total	**321,622**	**648,324**	**232,511**	**236,491**	**1,427,700**	**432,000**

Strategy data for river from Table 3.11C of report; Includes City of Austin Return Flows
Strategy data for bay from Table 3.11E of report; Includes City of Austin Return Flows
* Target = Base Average from 2008 LSWP Study
** Critical = Subsistence from 2008 LSWP Study

With this information in mind, we are confused by Tables 3.11F and 3.11G which indicate that the comprehensive model meets target and critical instream flows 100% on an annual basis with and without the strategy; and does this even though the model falls short of 100% on a monthly basis Likewise, it seems contradictory that the model indicates small to significant shortfalls in the average volume of flow while indicating that flows are met 100% on an annual basis. These results seem counter intuitive and no data are provided in the study documents that support/refute the claims in these two tables. This discrepancy points to the danger of viewing such matters on an annualized basis without consideration of the ecological consequences. When considered in regard to the protection of the spawning season of the blue sucker, it is imperative that the flow regime be met monthly throughout the annual and decadal cycles in order to protect this threatened species.

We are concerned that the study may lead some to a sense of false complacency. The study implies that most of the strategies have marginal environmental impacts and that only a few strategies have potential significant impacts. In reality, the sum total of these strategies do not provide adequate environmental flows for the river and bay systems we are attempting to manage and protect.

LCRWPG planning should provide environmental flows that meet the target needs of the river and bay to keep them healthy in normal times and provide adequate water during critical periods of low flow (drought) to sustain them through these dry periods. This environmental impact study would be improved if it clearly indicated whether the overall objectives of the planning process are being met and identified strategies that help (hinder) achieving the objectives. Certainly we realize that the instream and freshwater inflow standards must be integrated together to provide a single flow regime before final decisions can be made on strategies to meet these objectives. Clearly however, the overall planning strategy will be flawed if it fails to provide for the environmental and human water needs of the region.

We further believe that planning should consider the known threats, evaluate the threats qualitatively if not quantitatively, and provide monitoring or mitigation of the treats where possible. For example, over pumping of the Carrizo-Wilcox aquifer, a threat recognized in the 2006 plan, could dramatically alter the volume of water and quality of habitat at and below the segment of river where these major water features intersect. Due to the high probability of this threat and the importance of the threat to the blue sucker and water supplies throughout the region, this portion of the river should be considered for designation as an "ecologically unique stream segment" in order to protect the river and the blue sucker. Certainly monitoring measures should be employed to provide an early indication should the threat start to materialize.

We greatly appreciate the work of the LCRWPG members and consultants. We also appreciate that you face monumental challenges as you attempt to plan for the human and environmental needs of our region. We realize that the environmental flow needs have only recently been quantified to a level of confidence that the studies are useful in informing the process. However, we believe it to be critically important that the shortage of water to meet the planning objectives of the group be clearly evident during this planning cycle so that new strategies can be developed in a timely manner.

Thank you for this opportunity to comment.

Respectfully submitted,
Environmental Stewardship

Steve Box
Executive Director

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January 23, 2009

John Burke, Chairman
Lower Colorado Regional Water Planning Group
Aqua Water Supply Corporation
P.O. Drawer
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Dear Region K Planning Group Members,

I appreciate this opportunity to submit comments regarding the Environmental Impacts of Water Management Strategies Study included in the LCRWPG 2011 Water Plan First Biennium Studies. Specifically, I would like to provide a couple of points for consideration when comparing model stream flow results against environmental flow criteria.

1. Modeled stream flows are best compared to the environmental flow criteria included in the model's coding. The model has no mechanisms to meet or protect other levels of environmental flow. In the case of this study, the model is coded with the 1999 LCRA Water Management Plan (WMP) instream flow criteria and the 2006 Freshwater Inflow Needs Study (FINS) criteria for bay & estuary needs.

2. Modeled stream flows should be compared to the environmental flow criteria engaged during that specific time of the simulation. For example, the simulations for this study cover a period of record of 59 years and will contain a portion of years in which the WMP critical instream flow criteria are engaged. All 59 years of monthly flows should not be averaged and compared to the WMP target criteria. Only those years of monthly flows in which the target instream flow criteria are engaged should be included in the statistical computation. The same separation of results based on criteria engagement should be applied when assessing compliance with the bay & estuary inflow criteria.

Sincerely,

Richard Hoffpauir

ATTACHMENT 1

TWDB Contract No. 0704830696

Region K, Region-Specific Contract Study

1) **Surface Water Availability Modeling Study**
2) **Environmental Impacts of Water Management Strategies**
3) **Evaluation of High Growth Areas**

<u>TWDB Comments on Draft Final Region-Specific Study Reports</u>

Surface Water Availability Modeling Study

1. Page ES-1, the last paragraph states "overall, total availability increased slightly as compared to the 2006 Region K plan." However, the first paragraph on the next page indicates that availability in three sectors was unchanged, while the availability for municipal, irrigation, and steam-electric demands was "smaller" than in the 2006 plan. Please reconcile these two statements in the final report.

2. Page 3-2, the second paragraph refers to FNI, but does not define the term. Please define it in the final report.

3. It is difficult to find information in appendices A and B, then to relate the information to the main body of the report. Please consider adding an index to both appendices in the final report.

Environmental Impacts of Water Management Strategies

1. Interpretation of the study results is somewhat difficult because two different base models were used for "with" and "without" strategy comparisons (i.e. WAM Run 3 Cutoff Model and LSWP Model). Also, one or more strategies may have been incorporated in the "without" strategy (base) model used to evaluate other strategies. The report documents the necessity of conducting the analysis in this fashion but could be improved by making it explicitly clear which model was used and which strategies were incorporated in the base model for the analysis of each strategy. Please consider adding a clarifying sentence to the description of each strategy analysis in Chapter 3.0 Results (pp 3-1 to 3-50). For example, on page 3-2, the first paragraph could read (additions in *italics*): "This strategy involves the expansion of LCRA contracts to meet shortages. The increase in contract amounts should decrease interruptible supplies, and therefore, regulated streamflows downstream of the strategy." *For the analysis, the* (WAM Run 3 Cutoff Model or LSWP Model) *with the inclusion of strategies* (xxx) *was used for the base condition.*

2. Figure 3.1 on page 3-2 is titled "location of control points" but it seems to list only the major control points used in the study, as there are several other control

points referred to in the text that are not included in this or a similar figure. Please consider re-titling Figure 3.1 “location of major control points” and referencing the map in Exhibit B of all control points.

3. Strategies number 4 (pp. 3-13 through 3-15), 10 (pp. 3-38 through 3-40), and 11 (pp. 3-43 through 3-45) use four control points, but the contract scope of work states that five designated control points on the Colorado River and major tributaries will be used for a quantitative impact analysis. Likewise, strategy number 13 (pp. 3-48 through 3-49) only uses three control points. Please justify the deviation from the contract scope of work in the final report.

4. In the Executive Summary, an example of the detailed results of a single strategy is given. Please include a summary of the significant results of all the strategies in the final report.

5. Figures 3.2 – 3.19 beginning on page 3-6 show 58-year median flows with 10th and 90th percentile flows. The legend is shown on the x axis, which actually shows flow volumes in increments of 50,000 acre-feet per year. Please consider moving this legend to the y axis which shows median flows for each month of the year.

Evaluation of High Growth Areas

1. Please note that TWDB’s acceptance of a final report for this study does not constitute approval of any revised population or water demand projections contained therein. The formal procedure for requesting revised projections is stated in TAC 357.5 (d) (2):
   “Before requesting a revision to the population and water demand projections, the regional water planning group shall discuss the issue at a public meeting for which notice has been posted pursuant to the Open Meetings Act in addition to being published on the internet and mailed at least 14 days before the meeting to every person or entity that has requested notice of regional water planning group activities. The public will be able to submit oral or written comment at the meeting and written comments for 14 days following the meeting. The regional water planning group will summarize the public comments received in its request for projection revisions. Within 45 days of receipt of a request from a regional water planning group for revision of population or water demand projections, the executive administrator shall consult with the requesting regional water planning group and respond to their request."

   All requested revisions which receive the consensus recommendation of the Texas Water Development Board, Texas Department of Agriculture, Texas Commission on Environmental Quality, and Texas Parks and Wildlife Department, will then be presented for consideration of Board approval at the next scheduled meeting.

2. Page 3-6, the first paragraph states that a population density of 150 persons per square mile was assumed but no explanation is provided. Please provide the rationale for this assumption in the final report.

3. Page 3-6, Table 3-6 includes the numerical difference between the State Data Center's estimated 1/1/07 population in the study area and the interpolated TWDB estimates for the same time period. In addition to the numerical difference between the projections, please consider including the percentage difference as well.

4. Page 3-7, Table 3.7 lists the "CAMPO" growth estimates for 2035 compared with the 2006 Region K plan estimates. For areas where they don't agree (Manor and Mustang Ridge), suggested increases were made to the projections by subtracting from county-other, but no explanation or methodology for the selected projections is provided. Please provide the rationale for these assumptions in the final report.

Response to TWDB Comments on Draft Final Region-Specific Study Reports (4/07/09)

Environmental Impacts of Water Management Strategies

1. Interpretation of the study results is somewhat difficult because two different base models were used for "with" and "without" strategy comparisons (i.e. WAM Run 3 Cutoff Model and LSWP Model). Also, one or more strategies may have been incorporated in the "without" strategy (base) model used to evaluate other strategies. The report documents the necessity of conducting the analysis in this fashion but could be improved by making it explicitly clear which model was used and which strategies were incorporated in the base model for the analysis of each strategy. Please consider adding a clarifying sentence to the description of each strategy analysis in Chapter 3.0 Results (pp 3-1 to 3-50). For example, on page 3-2, the first paragraph could read (additions in *italics*): "This strategy involves the expansion of LCRA contracts to meet shortages. The increase in contract amounts should decrease interruptible supplies, and therefore, regulated streamflows downstream of the strategy." *For the analysis, the* (WAM Run 3 Cutoff Model or LSWP Model) *with the inclusion of strategies* (xxx) *was used for the base condition.*

   Response: Agreed. A clarifying sentence will be added to the description of each strategy analysis in Chapter 3.

2. Figure 3.1 on page 3-2 is titled "location of control points" but it seems to list only the major control points used in the study, as there are several other control points referred to in the text that are not included in this or a similar figure. Please consider re-titling Figure 3.1 "location of major control points" and referencing the map in Exhibit B of all control points.

   Response: Figure 3.1 only shows the location of control points discussed in Section 3, as is stated in the sentence on page 3-1 that describes the graphic. The title of Figure 3.1 will be changed to include the word "Selected". On page 2-2, a reference is made to the Appendix B exhibit showing the location of all control points discussed in the study. A sentence referring the reader to the Appendix B exhibit will be provided in the description of each strategy that references control points other than those shown on Figure 3.1.

3. Strategies number 4 (pp. 3-13 through 3-15), 10 (pp. 3-38 through 3-40), and 11 (pp. 3-43 through 3-45) use four control points, but the contract scope of work states that five designated control points on the Colorado River and major tributaries will be used for a quantitative impact analysis. Likewise, strategy number 13 (pp. 3-48 through 3-49) only uses three control points. Please justify the deviation from the contract scope of work in the final report.

   Response: For the strategies mentioned, the appropriate number of control points were analyzed, as required by the contract scope of work, but the results were not chosen for discussion in Section 3.0. Instead, page 3-1 refers the reader to Appendix C for the graphic impact analysis of all control points. The control

points chosen for discussion in Section 3.0 were ones where additional stream gauge data was available for comparison. For each of the strategies mentioned, a sentence will be added to refer the reader to Appendix C for additional control point analysis results.

4. In the Executive Summary, an example of the detailed results of a single strategy is given. Please include a summary of the significant results of all the strategies in the final report.

   Response: A table showing a summary of the results of all of the strategies will be included.

5. Figures 3.2 – 3.19 beginning on page 3-6 show 58-year median flows with 10^{th} and 90^{th} percentile flows. The legend is shown on the x axis, which actually shows flow volumes in increments of 50,000 acre-feet per year. Please consider moving this legend to the y axis which shows median flows for each month of the year.

   Response: The request to move the legend was considered, but it was determined that making this costly change would not substantially benefit the report.