ATTACHMENT M

Sensitivity Analysis of Modeled Lake Mead Water Level Protection Assumptions

This attachment illustrates the water surface elevations of Lake Mead and Lake Powell when modeled using a shortage assumption other than was used in the FEIS. In the modeling for the FEIS analysis, it was assumed that the Lake Mead water surface elevation of 1083 feet msl would be protected by determining the existence of a shortage declaration when the operation threatened to draw the water level below 1083. For the sensitivity analysis, the Lake Mead water surface elevation of 1050 feet msl was used as the alternate assumed water level to be protected. The results of the sensitivity analysis are shown by plots of reservoir water levels for Lake Mead and Lake Powell. These plots are to be compared with the plots on the corresponding figures in Section 3.3.

The plots for elevation 1050 protection were produced by the CRSS model configured in the same manner as for the analysis using the Lake Mead water level of 1083 feet msl as a protection level. In both cases an 80 percent probability of protecting the Lake Mead water level was programmed into the model.

Sensitivity Analysis of Shortage Protection Assumptions

Overview

This attachment to the Colorado River Interim Surplus Criteria FEIS presents the results of a sensitivity analysis conducted to assess the effects of using different Lake Mead shortage protection lines in the modeling of the baseline conditions and surplus alternatives. As discussed in Section 3.3.3.4, it was assumed that the Lake Mead water surface elevation of 1083 feet msl would be protected with a certain degree of confidence (approximately 80% of the time). Also, as discussed in Section 3.3.4.1, separate modeling studies were used to determine a "protection line" or trigger such that if Mead's elevation falls below that line, a Level 1 shortage is declared. The actual assurance achieved with respect to the protection of this level (water surface elevation 1083-foot msl) was about 73% through year 2040.

For the sensitivity analysis, the modeling assumptions included a lower protection line (one that would protect Lake Mead water surface elevation of 1050 feet msl approximately 80% of the time). The shortage protection triggers that were used for this purpose are presented graphically in Figure M-1. A graphical comparison of the probability of Lake Mead water surface elevations dropping below 1050 feet msl is presented in Figure M-2. This figure compares the water surface elevations observed under the baseline conditions to those observed under the surplus. As seen in Figure M-2, the level of protection achieved under the baseline conditions was approximately 75% through the year 2040 and then further decreased to 73 percent by 2050.

The sensitivity analysis evaluates the effect that a change to the shortage protection assumptions for the baseline conditions, the Basin States alternative, and the Shortage Protection Alternative would have on the water surface elevations of Lakes Powell and Mead. The relative differences in Lake Powell and Lake Mead water levels between the surplus alternatives and the baseline conditions using the 1050 feet msl Lake Mead water level protection criteria were determined to be similar to those observed under the 1083 feet msl Lake Mead water level protection criteria. There is also little to no difference in the observed Lake Powell water levels under the modeled conditions using the 1083 and 1050 feet msl shortage criteria. However, in general, the 1050 feet msl Lake Mead water level protection criteria provided lower Lake Mead water levels under the baseline conditions and the surplus alternatives.

Lake Mead Water Surface Elevations

Figure M-3 compares the $90^{th,}$ 50^{th} and 10^{th} Percentile Values of Lake Mead water surface elevations observed under the baseline conditions to that of the surplus alternatives, using the 1050 shortage protection triggers. This figure can be compared to Figure 3.3-13 in Volume I of the FEIS that reflects the same information using the 1083

feet protection criteria. In Figure M-4, a direct comparison of the 90th, 50th, and 10th percentile values of the observed Lake Mead elevations for each shortage assumption is shown for baseline conditions. Figures M-5 and M-6 show the same comparison for the Shortage Protection and Basin States Alternatives, respectively. As noted in these three figures, the 90th percentile values for the three modeled conditions are similar. There are some differences between the 50th percentile values and the 10th percentile values of the three modeled conditions. Generally, the 50th and 10th percentile values are similar during the initial years and then depart. Departures are observed much earlier in time for the Shortage Protection Alternative (Figure M-6), then the Basin States Alternative (Figure M-5) and finally the baseline conditions (Figure M-4). Lower lake water levels are observed for the modeled conditions that use the 1050 feet msl shortage protection criteria. This is attributable to the more liberal modeled criteria that allows the lake to be drawn down to lower levels before the shortage triggers kick-in and water delivery reductions begin.

Summaries of the observed differences in Lake Mead water levels are presented in Tables M-1, M-2 and M-3.

Table M-1
Lake Mead Water Surface Elevations
90th, 50th and 10th Percentile Values for Baseline Conditions
Comparison of Lake Mead Shortage Protection Criteria (1083 to 1050)

	Departures (49-year Period)		
	90th Percentile Values	**50th Percentile Values**	**10th Percentile Values**
Maximum Departure	1.65	14.73	12.80
Minimum Departure	-0.62	0.00	0.00
Average Departure	0.06	5.45	4.60

Table M-2
Lake Mead Water Surface Elevations
90th, 50th and 10th Percentile Values for Basin States Alternative
Comparison of Lake Mead Shortage Protection Criteria (1083 to 1050)

	Departures (49-year Period)		
	90th Percentile Values	**50th Percentile Values**	**10th Percentile Values**
Maximum Departure	1.62	14.84	12.96
Minimum Departure	-0.64	0.00	0.00
Average Departure	0.10	5.92	5.15

Table M-3 Lake Mead Water Surface Elevations 90th, 50th and 10th Percentile Values for Shortage Protection Alternative Comparison of Lake Mead Shortage Protection Criteria (1083 to 1050)			
	Departures (49-year Period)		
	90th Percentile Values	50th Percentile Values	10th Percentile Values
Maximum Departure	3.36	23.56	26.22
Minimum Departure	-1.84	0.00	0.00
Average Departure	0.23	9.21	9.72

Lake Powell Water Surface Elevations

Figure M-7 compares the 90th, 50th and 10th percentile Lake Powell water surface elevations observed under the baseline conditions and all of the surplus alternatives, using the 1050 shortage protection triggers. This figure can be compared to Figure 3.3-6 in Volume I of the FEIS that reflects the same information using the 1083 feet protection criteria. In Figure M-8, a direct comparison of the 90th, 50th, and 10th percentile Lake Powell elevations for each shortage protection assumption is shown for baseline conditions. Figures M-9 and M-10 show the same comparison for the Shortage Protection and Basin States Alternatives respectively. As shown in Figures M-8, M-9 and M-10, differences observed under the baseline, Basin States Alternative and Shortage Protection Alternative are minimum and considered to be insignificant. This indicates that the use of different Lake Mead shortage protection criteria has very little to no impact on Lake Powell water surface elevations.

Summaries of the observed differences in Lake Powell water levels are presented in Tables M-4, M-5 and M-6.

Table M-4 Lake Powell Water Surface Elevations 90th, 50th and 10th Percentile Values for Baseline Conditions Comparison of Lake Mead Shortage Protection Criteria (1083 to 1050)			
	Departures (49-year Period)		
	90th Percentile Values	50th Percentile Values	10th Percentile Values
Maximum Departure	0.48	0.00	0.00
Minimum Departure	-0.13	0.00	0.00
Average Departure	0.02	0.00	0.00

Table M-5 Lake Powell Water Surface Elevations 90th, 50th and 10th Percentile Values for Basin States Alternative Comparison of Lake Mead Shortage Protection Criteria (1083 to 1050)			
	Departures (49-year Period)		
	90th Percentile Values	50th Percentile Values	10th Percentile Values
Maximum Departure	0.20	0.00	0.00
Minimum Departure	-0.13	0.00	0.00
Average Departure	0.01	0.00	0.00

Table M-6 Lake Powell Water Surface Elevations 90th, 50th and 10th Percentile Values for Shortage Protection Alternative Comparison of Lake Mead Shortage Protection Criteria (1083 to 1050)			
	Departures (49-year Period)		
	90th Percentile Values	50th Percentile Values	10th Percentile Values
Maximum Departure	0.25	2.78	5.37
Minimum Departure	-0.02	0.00	0.00
Average Departure	0.03	0.33	1.68

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Figure M-1
Lake Mead Level 1 Shortage Triggers Assumed for Modeling

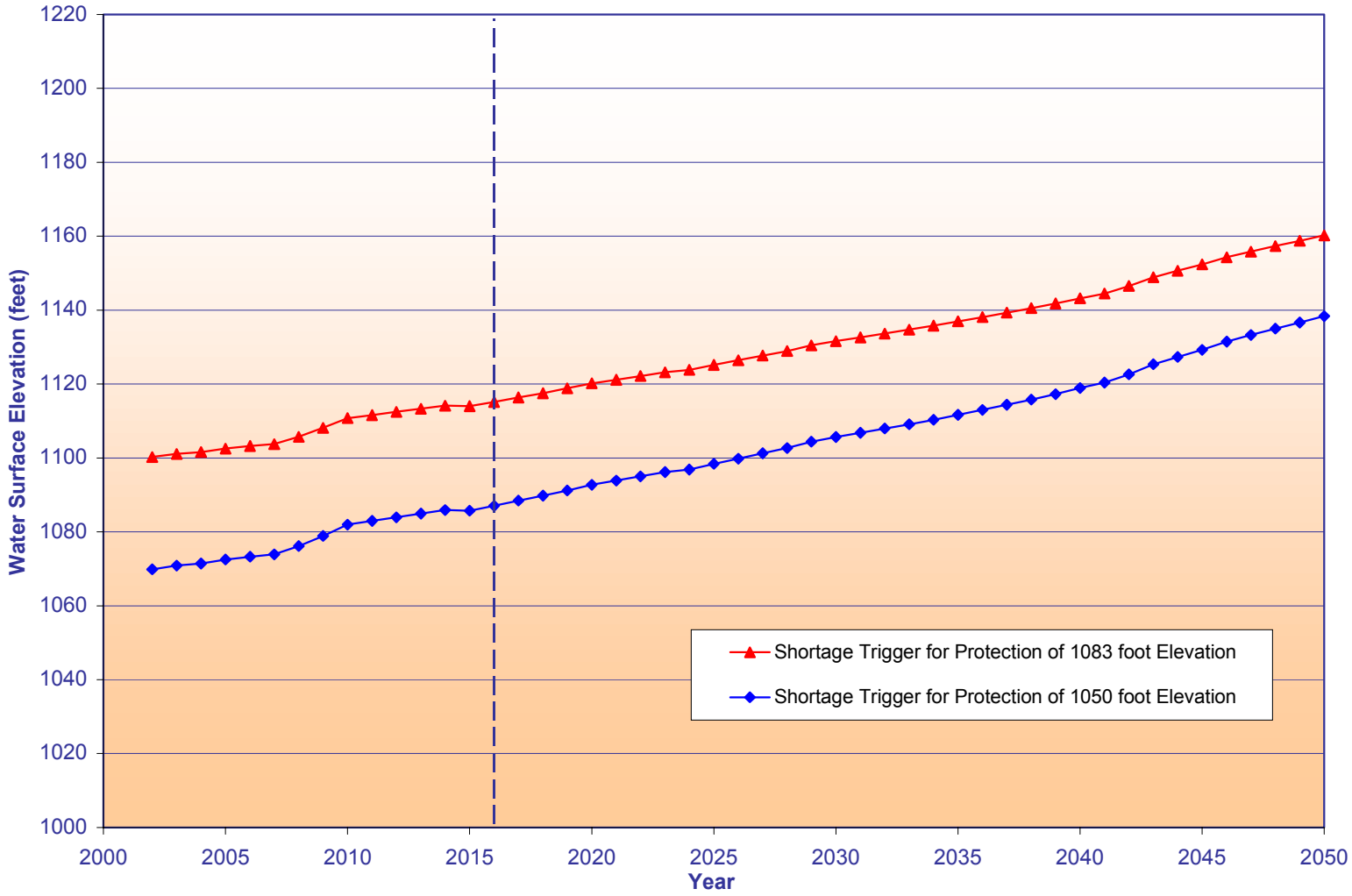

Figure M-2
Lake Mead Water Surface Elevations
Comparison of Surplus Alternatives to Baseline
Percent of Values Greater than or Equal to 1050 (80P-1050)

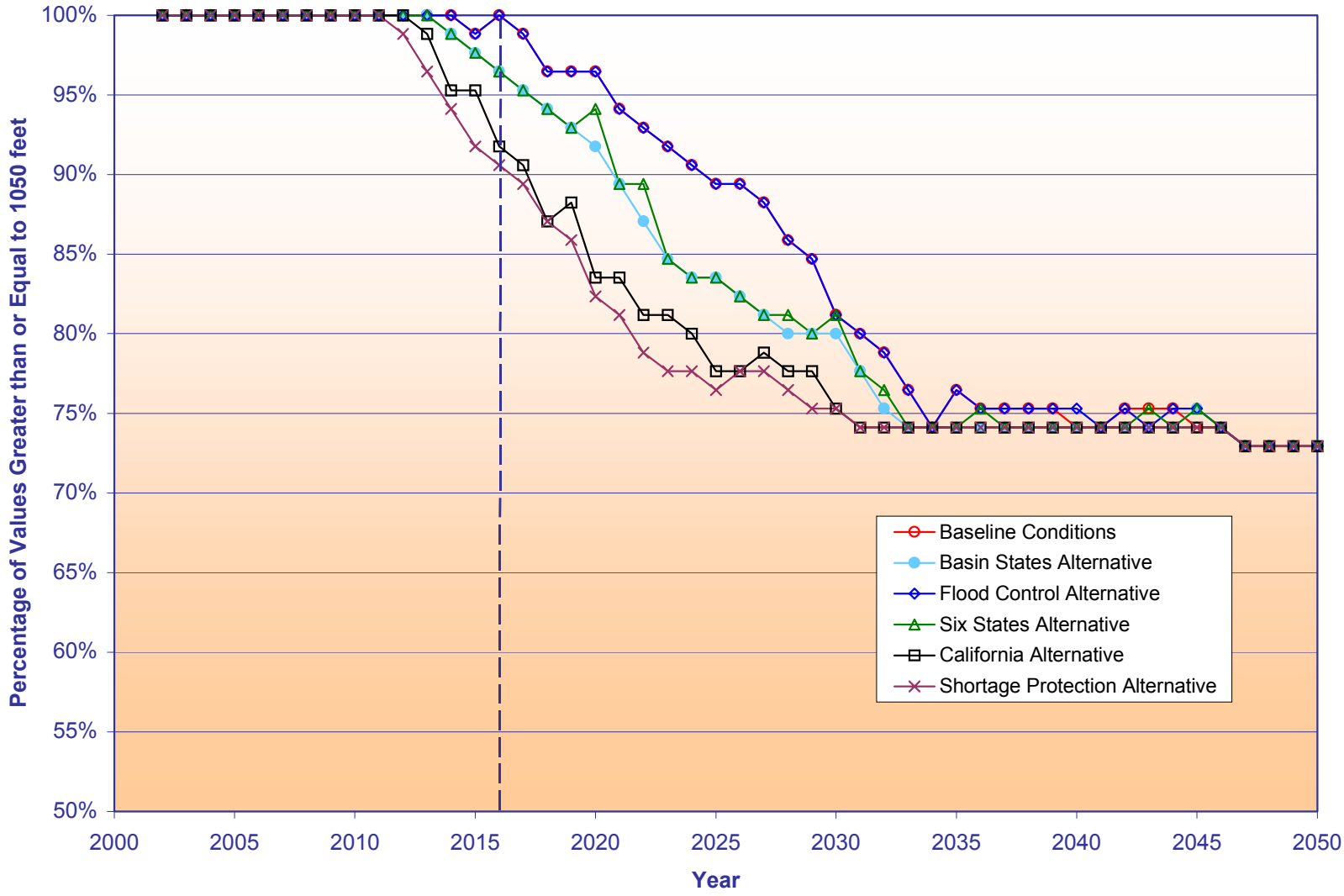

Figure M-3
Lake Mead End-of-December Water Elevations
Comparison of Surplus Alternatives to Baseline for 1050 Shortage Protection
90th, 50th, and 10th Percentile Values

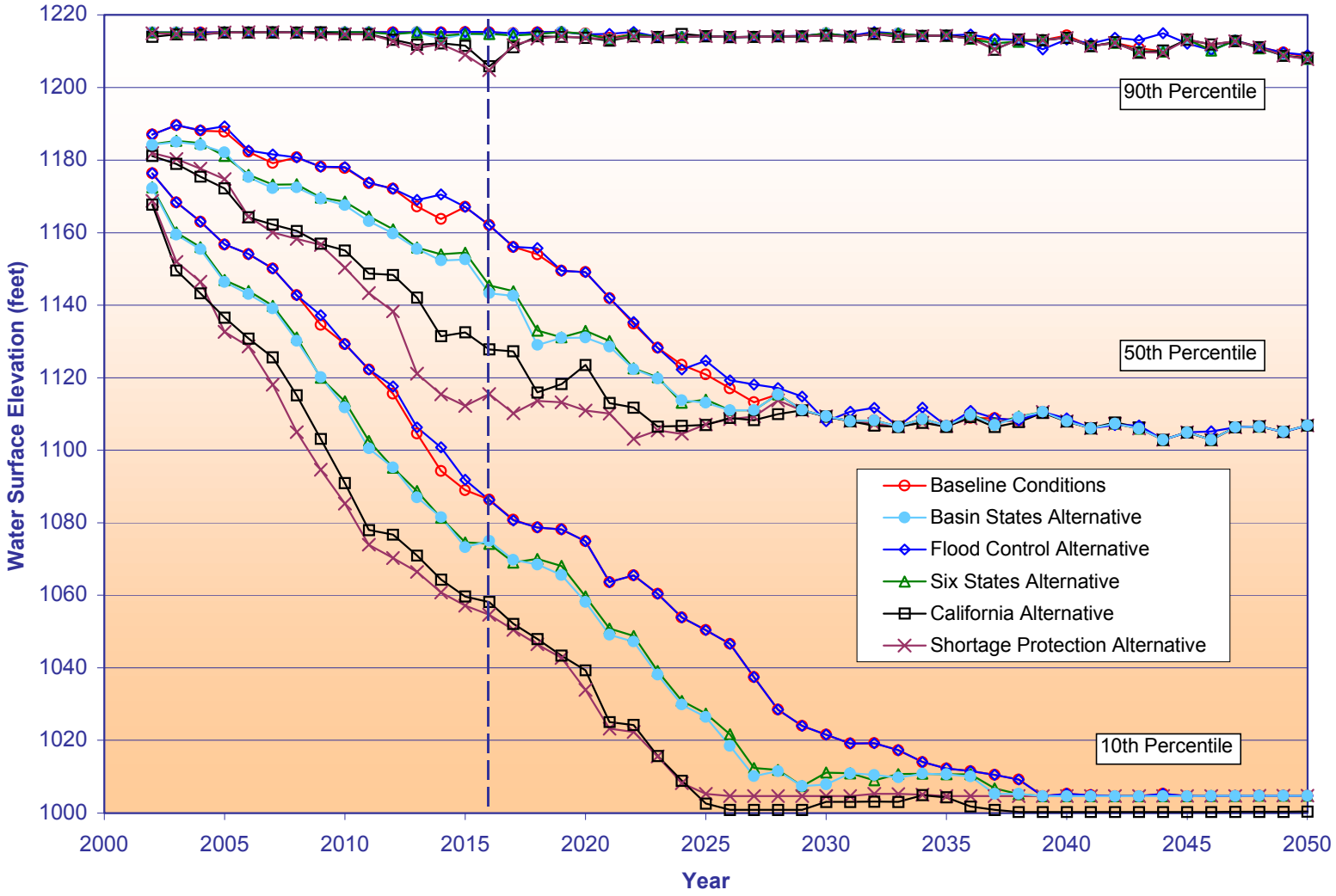

Figure M-4
Lake Mead End-of-December Water Elevations
Comparison of Shortage Assumptions for Baseline Conditions
90th, 50th, and 10th Percentile Values

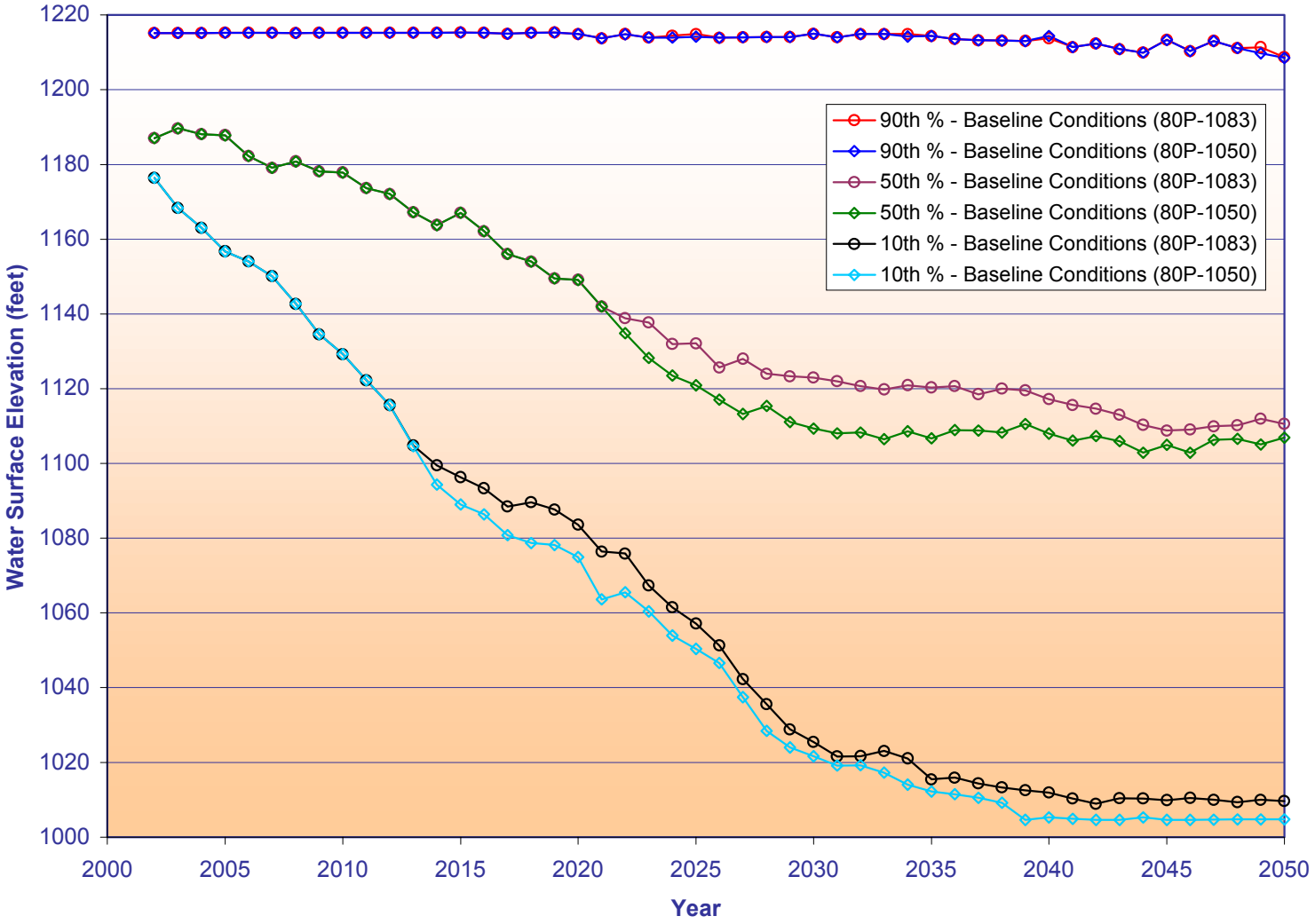

Figure M-5
Lake Mead End-of-December Water Elevations
Comparison of Shortage Assumptions for Basin States Alternative
90th, 50th, and 10th Percentile Values

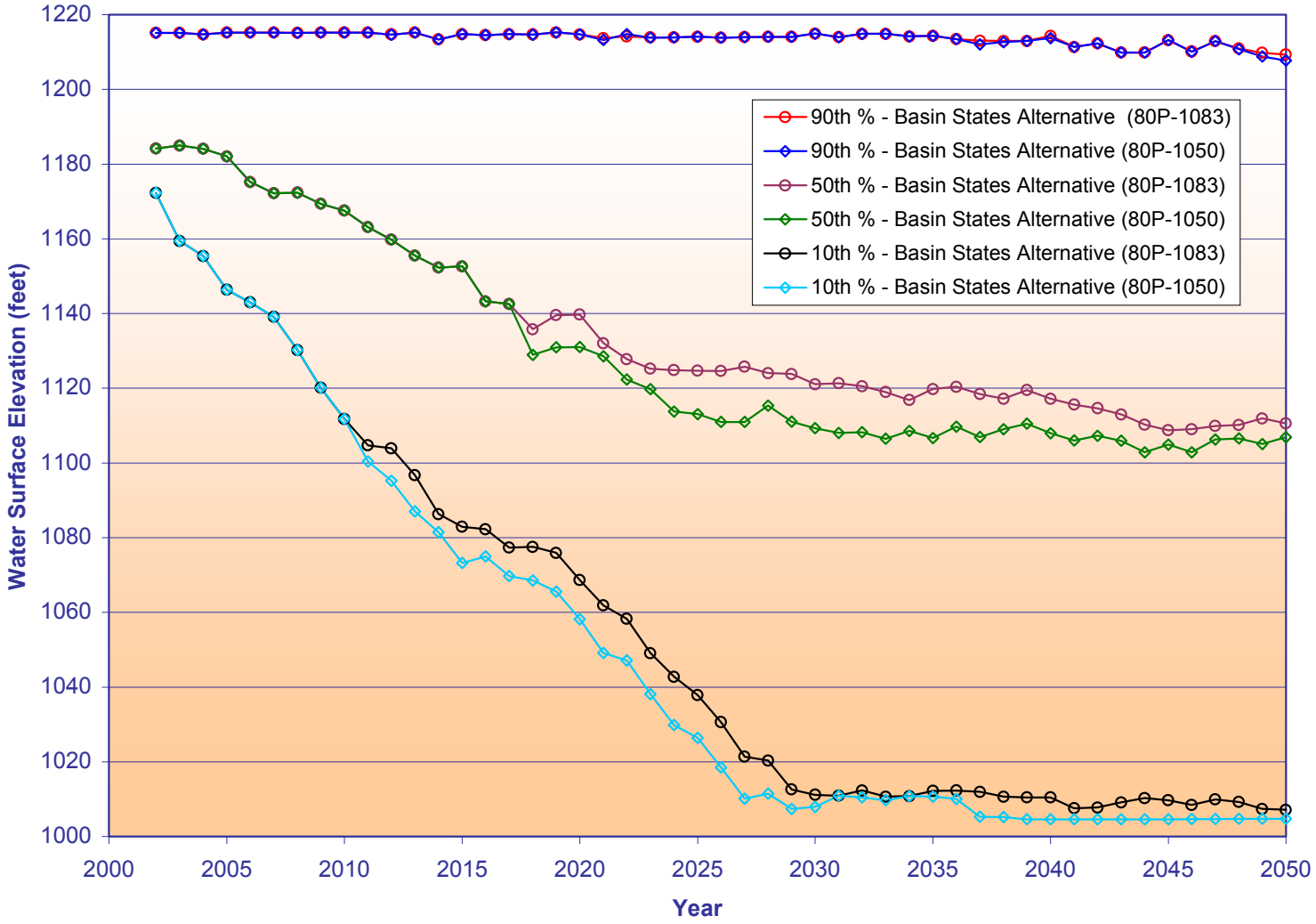

Figure M-6
Lake Mead End-of-December Water Elevations
Comparison of Shortage Assumptions for Shortage Protection Alternative
90th, 50th, and 10th Percentile Values

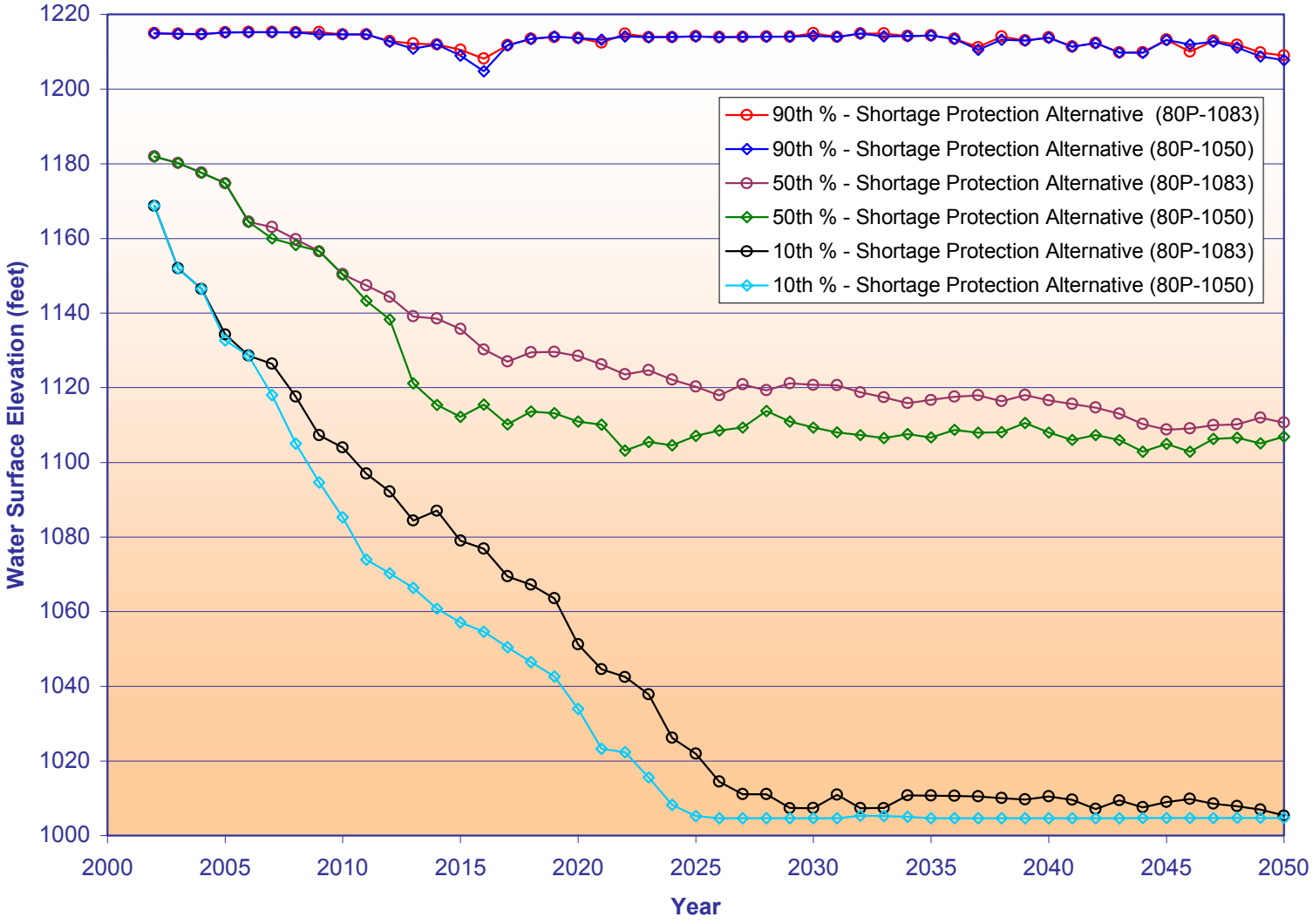

Figure M-7
Lake Powell End-of-July Water Elevations
Comparison of Surplus Alternatives and Baseline for 1050 Shortage Protection
90th, 50th, and 10th Percentile Values

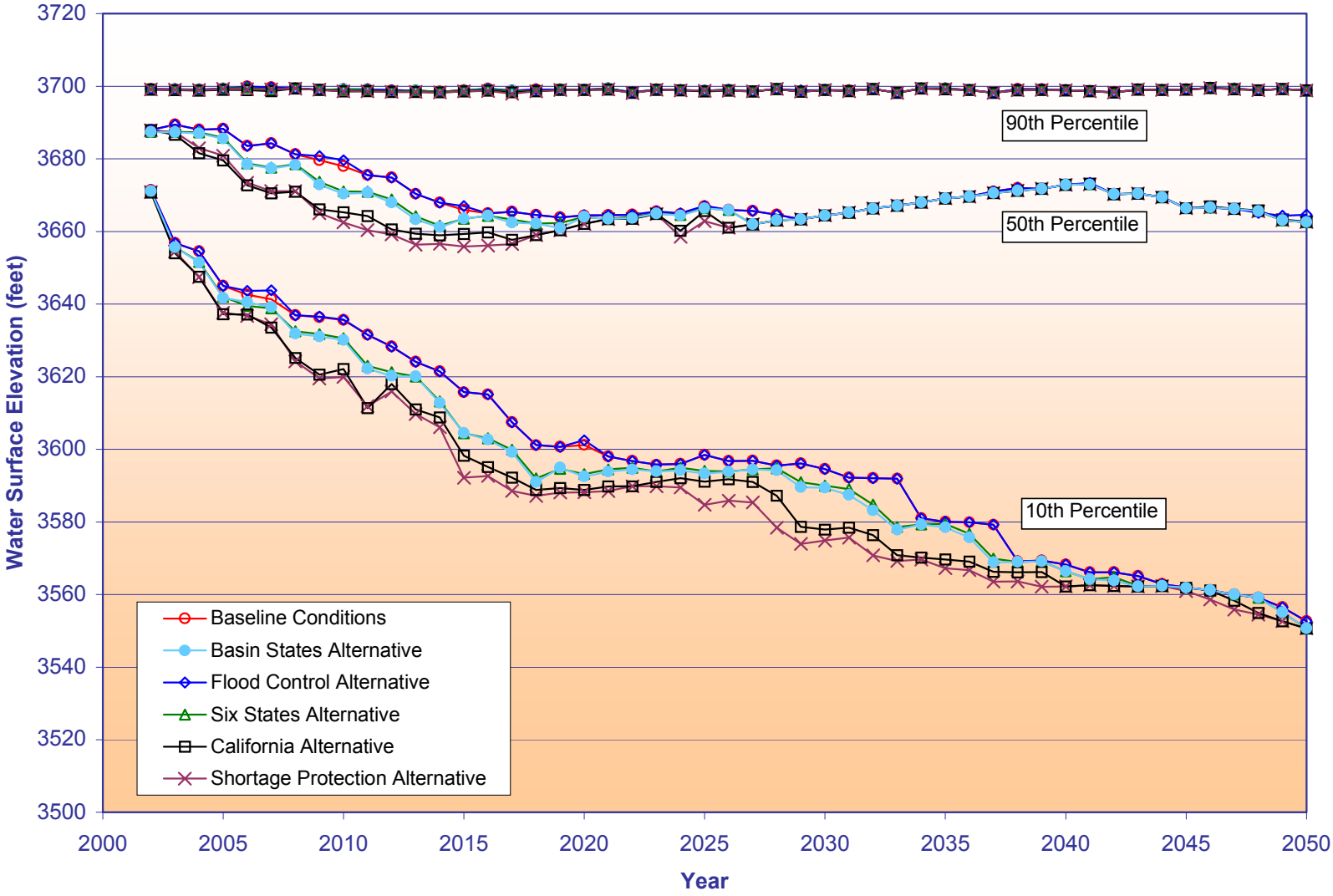

Figure M-8
Lake Powell End-of-July Water Elevations
Comparison of Shortage Assumptions for Baseline Conditions
90th, 50th, and 10th Percentile Values

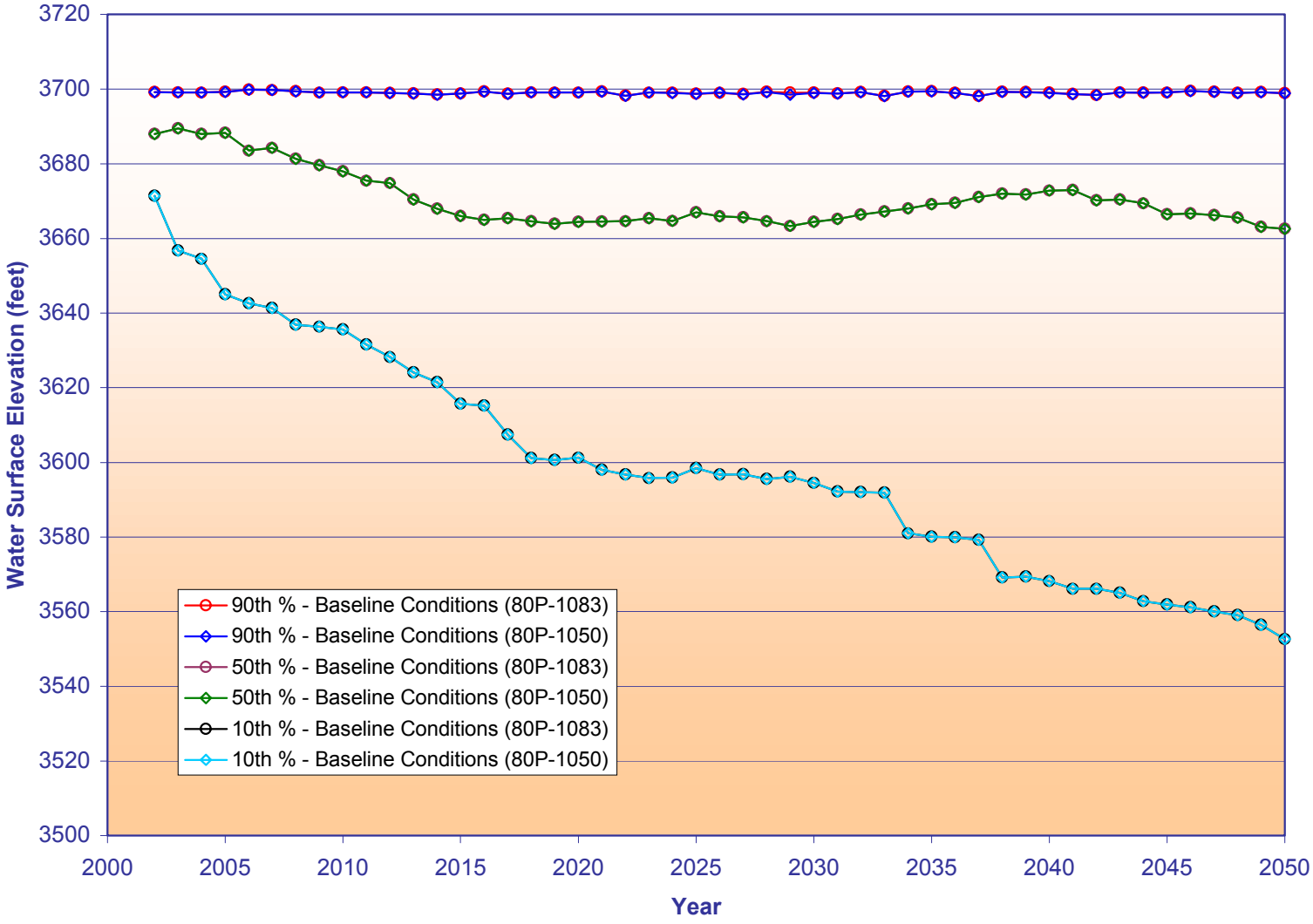

Figure M-9
Lake Powell End-of-July Water Elevations
Comparison of Shortage Assumptions for Basin States Alternative
90th, 50th, and 10th Percentile Values

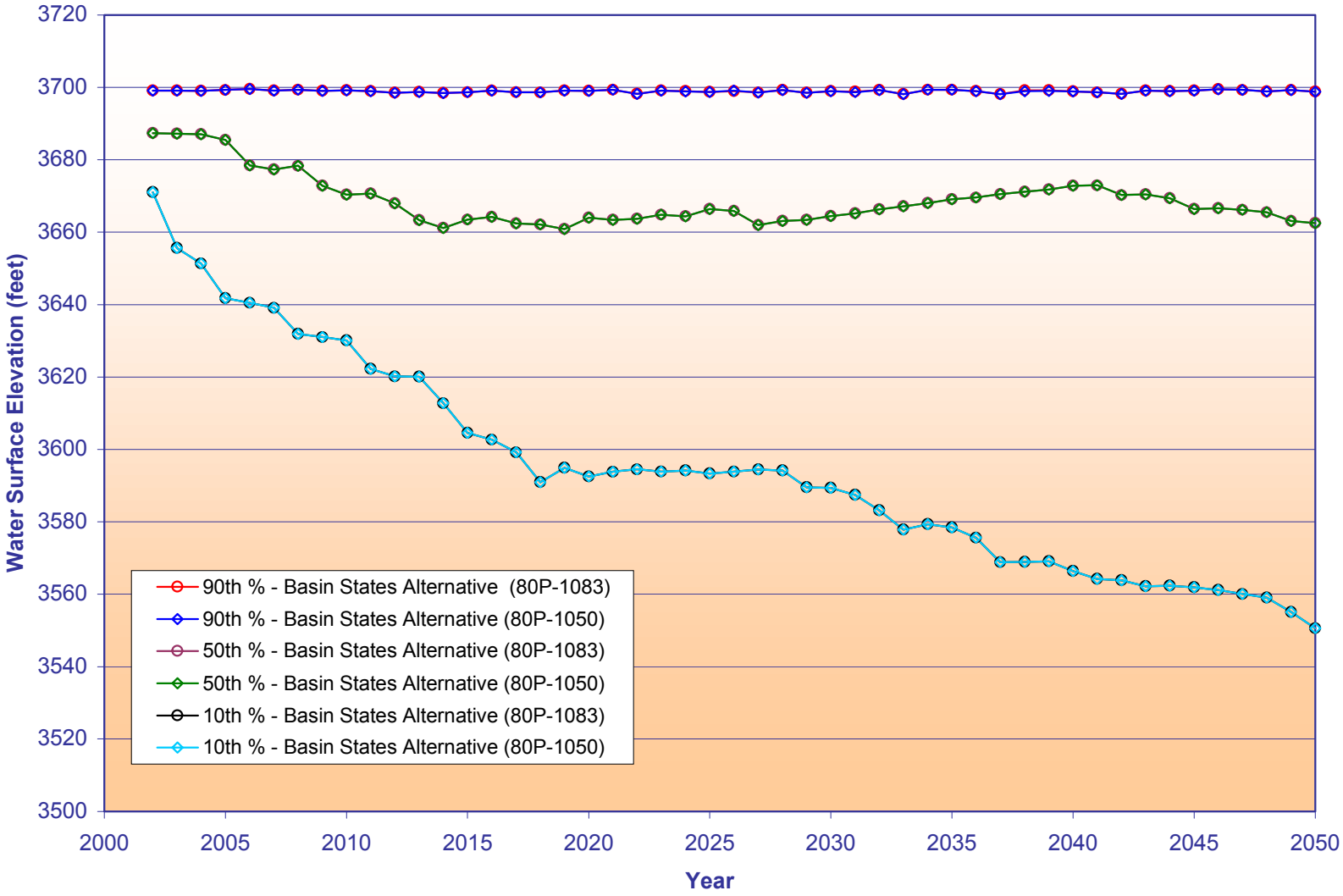

Figure M-10
Lake Powell End-of-July Water Elevations
Comparison of Shortage Assumptions for Shortage Protection Alternative
90th, 50th, and 10th Percentile Values