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APPENDIX B

Santa Clarita Valley Water Agency 2021 Water Supply Reliability Update Additional Results

1. WATER OPERATION MODEL

1.1 General Methodology

The Water Operations Model (or "Model") is an analytic spreadsheet model developed for SCV Water by MBK Engineers that was used to analyze water supply reliability for this Plan. The Model performs annual water operations for the SCV Water service area over a specified study period, which for this Plan is the 40-year period from 2021 through 2060 (the year assumed in the 2020 UWMP for development buildout in the service area as shown in adopted local land use plans).

Inputs to the Model include:

- Annual service area demands, as they are projected to increase over the study period;
- Annual base supplies (existing and planned) anticipated to be available to meet those demands, including any planned changes in supply during the study period;
- Storage programs available to SCV Water, including maximum storage and extraction capacities and beginning (2021) storages; and
- Various combinations of future water supply reliability projects, including those incorporated into the 2020 UWMP as well as additional scenarios to ensure that there are alternative programs that can be substituted for those in the 2020 UWMP.

The Model steps through each year of the study period, compares annual base supplies to demands, and operates SCV Water storage programs as needed, adding to storage in years when base supplies exceed demand and withdrawing from storage when demand exceeds base supplies.

To reflect the uncertainty in what hydrology might occur over the study period, the Model looks at multiple hydrologic sequences. In this Plan, the sequences are based on historical hydrology from 1922 through 2003, and the Model uses 82 hydrologic sequences. The hydrologic sequences affect certain supplies (i.e., SWP and groundwater), as well as demands during the study period. The Model steps through annual operations over the study period for each of the 82 hydrologic sequences. Results from the 82 sequences are then compiled by year during the study period and are summarized to provide a statistical assessment of various parameters.

For example, the reliability of SCV Water's supplies and storage programs to meet its projected demands for a particular year, such as year 2030, would be assessed by compiling the overall supply surplus or shortfall that occurred in Model results for 2030 from each of the 82 hydrologic sequences. Those 82 supply results for 2030 would then be sorted from large to small to provide a probability of exceedance distribution for overall supplies for that year.

1.2 Reliability Determination

For this Plan, SCV Water specified a reliability goal of 95 percent. The manner in which a reliability goal is applied to the Water Operations Model is as follows:

- The Model steps through each year of the study period, compares annual base supplies to demands, and operates SCV Water storage programs as needed, adding to storage in years when base supplies exceed demand and withdrawing from storage when demand exceeds base supplies.
- The resulting annual supply surplus or shortfall is determined for each year during the study period.
- This is done for each of the 82 hydrologic sequences.
- The supply surplus/shortfall from all 82 sequences is compiled for each year during the study period. For example, annual supply surplus/shortfall results for study period year 2040 are pulled from each of the 82 hydrologic sequences, and that data are then used to determine the reliability for year 2040.

As the 95 percent reliability goal is applied to the Water Operations Model, this is defined as the ability to meet demand in a given year in 95 percent of the hydrologic sequences analyzed. Based on the number of hydrologic sequences analyzed, this means that to meet the 95 percent reliability goal for a given year, demands for that year must be met in at least 78 of the 82 sequences (95 percent of 82 sequences). This is illustrated and described in more detail in Appendix B.

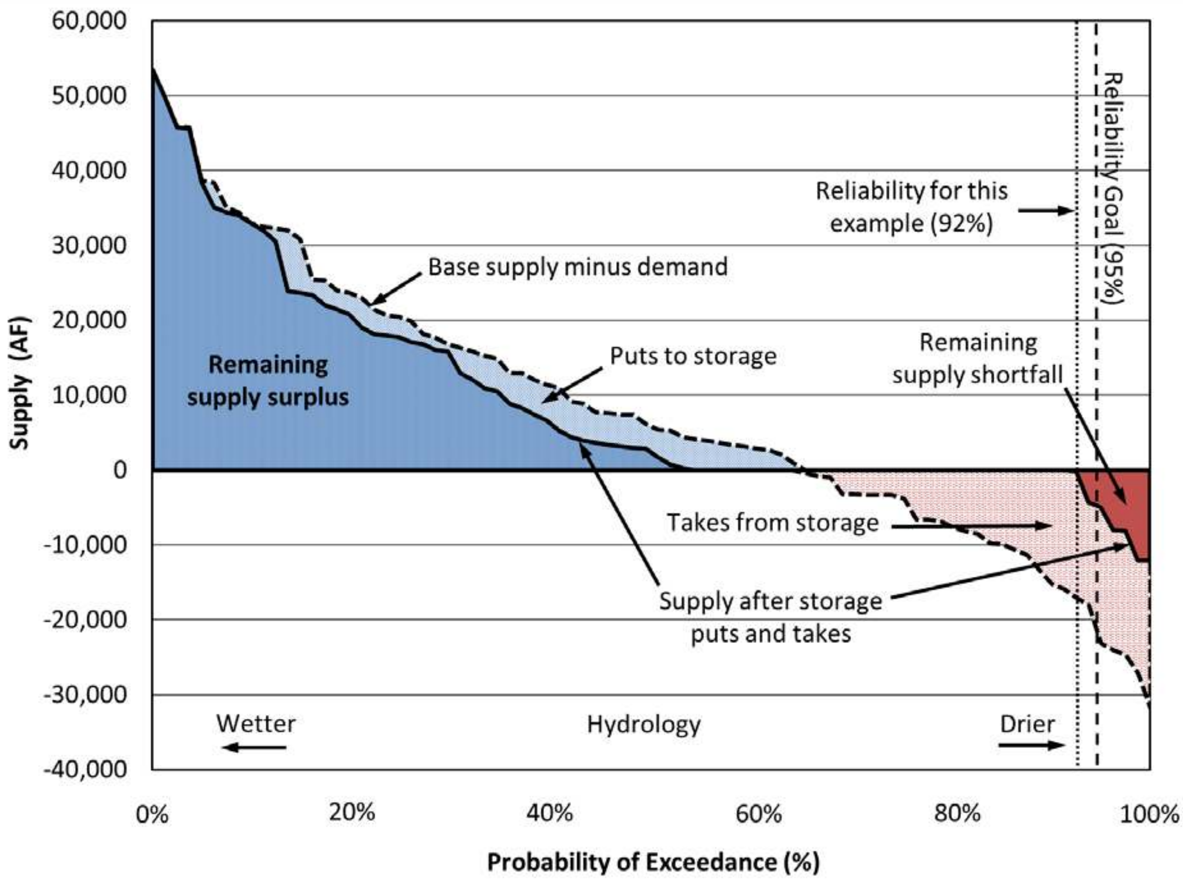
1.3 Interpretation of Water Operations Model Results

The Model produces graphs for a number of parameters calculated within the Model, generally presented in the form of probability of exceedance graphs. The parameters of primary interest for this Plan include: (1) Base supply minus demand (i.e., the supply surplus or shortfall for a given year after summing all base supplies and subtracting weather-adjusted demand); and (2) Supply after storage program puts and takes (i.e., the remaining supply surplus or shortfall for a given year after any additions to (puts) or withdrawals from (takes) storage programs). Base supplies are considered to be supplies that are available every year, such as supplies from the SWP, groundwater, recycled water, Buena Vista/Rosedale-Rio Bravo, and Nickel water. Storage programs, as used here, include SWP flexible storage, groundwater banking programs, and any other dry-year supplies, such as water under the Yuba Accord.

An example of these two parameters for a given year in the study period is shown in Figure B-1, with “Base supply minus demand” represented by the black dashed line, and “Supply after storage puts and takes” represented by the solid black line. The area between these two lines that is above zero on the supply (vertical) axis represents the amount of water put into storage programs;

whereas, the area between the two lines that is below zero represents the amount of takes from storage programs. The darker blue area (below the "Supply after storage puts and takes" line that is above zero on the supply axis) indicates the amount of surplus water that remains after all possible puts to storage programs, where puts may be constrained by vacant storage space available or by put capacity. This remaining supply would be available for water sales, exchanges, or storage in new programs, or would otherwise remain unused. The darker rust-colored area (above the "Supply after storage puts and takes" line that is below zero on the supply axis) indicates the amount of supply shortfall that remains after all possible takes from storage programs, where takes may be constrained by the amount of water stored or by take capacity. The reliability for this scenario is the probability of exceedance at the point where the left side of the darker rust-colored area crosses zero on the supply axis (shown as the dotted vertical line in this graph). For this particular example, that occurs at about 92 percent and is interpreted as a 92-percent probability that remaining supplies after puts and takes would be zero or greater for this example's supply and demand scenario and study period year; or in other words, has a reliability of 92 percent. The reliability in this example does not meet the 95-percent reliability goal (shown as the dashed vertical line in this graph), and so would require additional programs or supplies to achieve that goal.

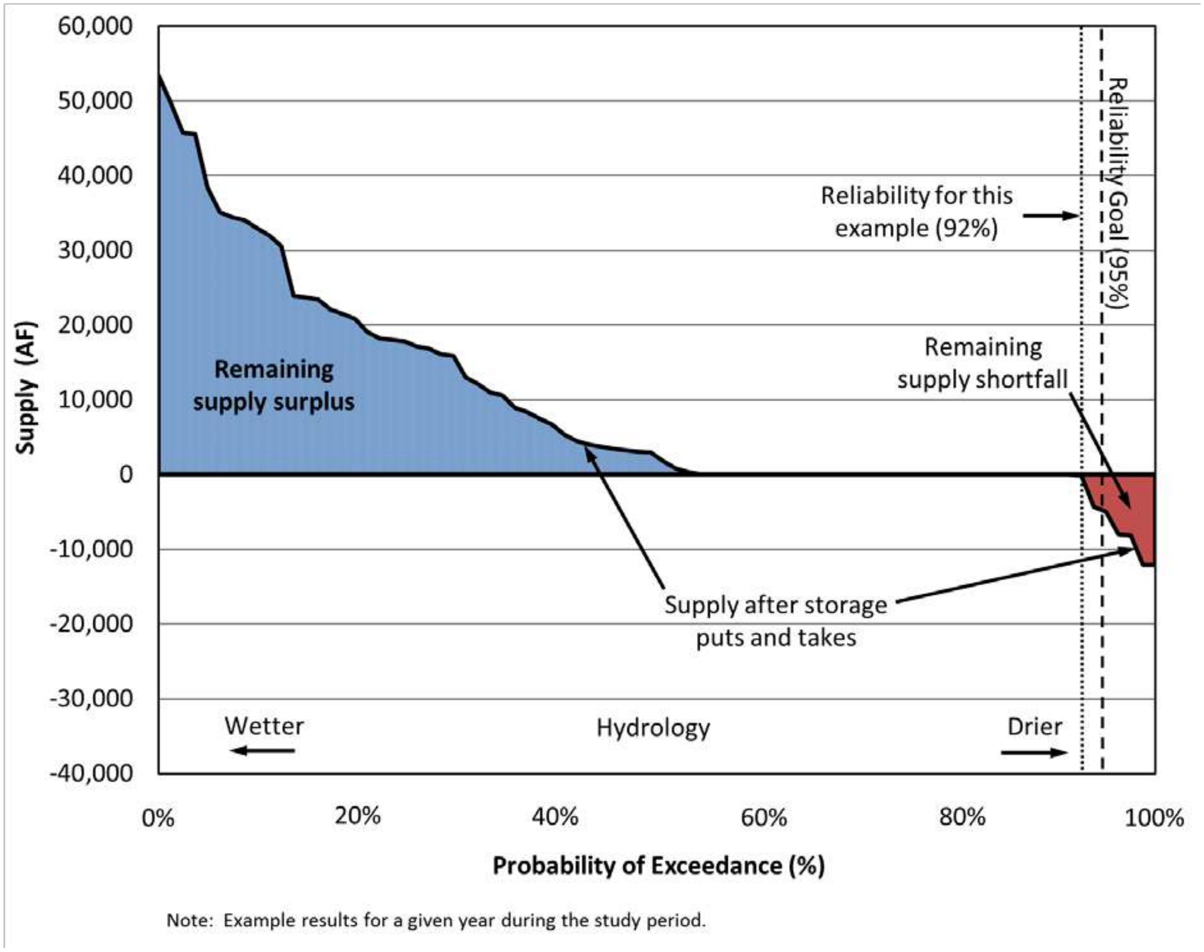
FIGURE B-1
INTERPRETATION OF MODEL RESULTS



Note: Example results for a given year during the study period.

In this Plan, it is the supply that remains after operation of the storage programs that is of primary interest. Therefore, the figures throughout the remainder of this section showing supplies show only the "Supply after storage puts and takes" line, and so are of the form shown in Figure B-2. The supply figures in the rest of this section do not include the shading of surplus and shortfall as shown in Figure B-2, but are interpreted as shown here.

FIGURE B-2
FORM OF MODEL RESULTS PRESENTED



2. SCENARIOS ANALYZED

2.1 Scenario Descriptions

This Plan analyzed six scenarios composed of different water supply components discussed below. Each scenario was run twice: 1) using demand with active conservation; and 2) using demand without active conservation. The mix of component water supplies are summarized in Table B-1 below, and the scenarios are described generally as follows:

- **Base Scenario:** Represents those elements of the SCV Water portfolio that currently exist. As the analysis moves through the study period, restoration of well capacity temporarily taken out for water quality concerns takes place consistent with the 2020 UWMP Tables 4-8 B, 4-8 C, 4-9 B and 4-9 C well case containing the existing and restored groundwater supplies. Imported supplies include SWP supplies based on 2040 climate conditions pursuant to DWR's CALSIM modeling for the 2019 Delivery Capability Report, the firm Buena Vista Rosedale Transfer, and if necessary, in dry years, SWP Flexible Storage, Nickel Water, Yuba Accord water. The Base case also includes the existing banking programs, specifically existing Rosedale Banking supplies at the existing 10,000 AFY of recovery, SCV Water Semitropic and access to the Newhall Land and Farming withdrawal capacity, that are drawn on during years when the other previously mentioned supplies are insufficient to meet demands.

- **Scenario 1:** Represents the supplies used in the 2020 UWMP's reliability analysis. It builds on the Base scenarios by adding additional Saugus Formation pumping capacity for use in dry periods and developing an additional 10,000 AFY of extraction capacity under the existing water banking agreement with Rosedale Rio-Bravo Water Storage District.
- **Scenario 2:** Similar to Scenario 1, but the dry supply from Saugus Formation wells 5 through 8 is replace with participation in the AVEK's High Desert Water Bank.
- **Scenario 3:** Similarly replaces Saugus Formation wells 5 through 8 with participation in the Sites Reservoir.
- **Scenario 4:** Assumes all of the new Saugus Formation wells 3 through 8 are not constructed and replaced with a combination of Sites Reservoir and the AVEK High Desert Water Bank.
- **Scenario 5:** Like Scenario 4 assume no new Saugus Formation Wells and also eliminates the new recovery capacity from the Rosedale banking program. It replaces these with the AVEK High Desert Bank and Sites Reservoir, as well as the participation in the McMullin Aquaterra Water Bank.

TABLE B-1
RELIABILITY PLAN UPDATE SCENARIOS

	Base	**1**	**2**	**3**	**4**	**5**
Alluvial Pumping	✓	✓	✓	✓	✓	✓
Existing Saugus	✓	✓	✓	✓	✓	✓
SWP and BVRRB	✓	✓	✓	✓	✓	✓
Existing Banking Programs	✓	✓	✓	✓	✓	✓
Saugus Wells 3 and 4		✓	✓	✓		
Saugus Wells 5 - 8		✓				
New Rosedale Bank Capacity		✓	✓	✓	✓	
Sites Reservoir				✓	✓	✓
AVEK High Desert Bank			✓		✓	✓
McMullin GSA Aquaterra Bank						✓

2.2 Scenario Assumptions

The Base Scenario serves as the starting point to assess the reliability of current supplies. Base Scenario demand and supply assumptions are described in detail in Section 2. Scenarios 1 through 5 include varying assumptions regarding the availability of groundwater and water supplies and are discussed further below. The supply assumptions for all six scenarios are summarized in Table B-2. A more detailed listing of assumptions is included in Appendix A.

2.2.1 Base Scenario

The Base Scenario is based on those elements of the SCV Water supply portfolio that currently exist. Base Scenario assumptions are summarized in Table B-2.

2.2.2 Scenario 1

Scenario 1 is based on the same demand, supply, and storage program assumptions included in the 2020 UWMP. It builds on the Base scenario by adding additional Saugus Formation pumping capacity in dry periods and developing additional 10,000 AFY of extraction capacity with Rosedale Rio-Bravo Water Storage District. Assumptions for Scenario 1 are summarized in Table B-2, and differ from the Base Scenario as follows:

- **Saugus supplies:** Scenario 1 includes increased Saugus Formation pumping capacity through the addition of wells 3 through 8.
- **Dry-year supply programs:** Scenario 1 includes the development of additional 10,000 AFY of extraction capacity under the existing water banking agreement with Rosedale Rio-Bravo Water Storage District.

2.2.3 Scenario 2

Similar to Scenario 1, but replaces some of the dry-year supply from Saugus Formation wells with participation in the AVEK's High Desert Water Bank. Assumptions for Scenario 2 are summarized in Table B-2 and differ from the Scenario 1 as follows:

- **Saugus supplies:** Assumes that only Saugus Formation wells 3 and 4 are available.
- **Dry-year supply programs:** Scenario 2 includes participation in the AVEK High Desert Water Bank, which has a storage capacity of 70,000 AF and take and put capacities of 20,000 AFY.

2.2.4 Scenario 3

Similar to Scenario 1, but replaces some of the dry-year supply from Saugus Formation wells with participation in the Sites Reservoir. Assumptions for Scenario 3 are summarized in Table B-2 and differ from Scenario 1 as follows:

- **Saugus supplies:** Assumes that only Saugus Formation wells 3 and 4 are available.
- **Dry-year supply programs:** Scenario 3 replaces Saugus Formation wells 5 through 8 with participation in Sites Reservoir.

2.2.5 Scenario 4

Similar to Scenario 1, but assumes that all Saugus Formation wells are not constructed and replaced with a combination of the AVEK High Desert Bank and Sites Reservoir. Assumptions for Scenario 4 are summarized in Table B-2 and differ from Scenario 1 as follows:

- **Saugus supplies:** Assumes that Saugus wells 3 through 8 are not developed.
- **Dry-year supply programs:** Scenario 4 replaces Saugus Formation wells 3 through 8 with participation in Sites Reservoir and AVEK High Desert Bank.

2.2.6 Scenario 5

Similar to Scenario 4, but eliminates new recovery capacity from RRB banking program and substitutes it with participation in the McMullin GSA Aquaterra Water Bank. Assumptions for Scenario 5 are summarized in Table B-2 and differ from Scenario 4 as follows:

- **Saugus supplies:** Assumes that Saugus wells 3 through 8 are not developed.
- **Dry-year supply programs:** Replaces new RRB recovery capacity with participation in AVEK High Desert Bank.

TABLE B-2
SCENARIO ASSUMPTION SUMMARY

	BASE SCENARIO	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
DEMANDS						
Demand without active conservation: • per UWMP	X	X	X	X	X	X
Demand with active conservation: • per UWMP	X	X	X	X	X	X
SUPPLIES						
Groundwater						
Alluvium: • per UWMP	X	X	X	X	X	X
Saugus: • Existing wells	X				X	X
• Existing, restored, replacement, and new wells 3 & 4			X	X		
• existing, restored, replacement, and new wells 3 - 8 (per UWMP)		X				
Recycled Water						
Recycled water: • per UWMP (up to 8,960 AFY)	X	X	X	X	X	X
Imported Supply						
SWP Table A: • per UWMP – SWP supplies based on average deliveries from DWR's 2019 DCR for Future Conditions (52% at buildout due to climate change).	X	X	X	X	X	X
SWP flexible storage: • per UWMP	X	X	X	X	X	X
Buena Vista – Rosedale: • per UWMP	X	X	X	X	X	X

	BASE SCENARIO	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Nickel water: • available 2022-2060	X	X	X	X	X	X
Yuba Accord: • per UWMP	X	X	X	X	X	X
Sites Reservoir: • Dry year supplies available starting in 2030				X	X	X
Banking/Exchange Programs						
Semitropic Bank: • per UWMP	X	X	X	X	X	X
Semitropic – NL Bank: • per UWMP	X	X	X	X	X	X
Rosedale Bank: • per UWMP (up to 20,000 AFY take capacity by 2030)		X	X	X	X	
• Take capacity up to 10,000 AFY	X					X
New AVEK Bank: • per UWMP (70,000 AF storage capacity and 20,000 AFY take capacity in 2023)			X		X	X
New Aquaterra Bank: • per UWMP (70,000 AF storage capacity and 20,000 AFY take capacity in 2023)						X
Antelope Valley East Kern Exchange: • per UWMP	X	X	X	X	X	X
Rosedale & W Kern Exchange: • per UWMP	X	X	X	X	X	X

2.3 Scenario Results

2.3.1 Initial Reliability Results

An initial analysis was conducted to determine the reliability of each of the six supply scenarios, based on the specific scenario assumptions identified in the section above.

2.3.2 Summary Results

Based on the assumptions in each scenario, the 95-percent reliability goal is met over the entire study period for Scenarios 1 through 5, with active conservation. The analyses show that SCV Water has adequate existing and planned supplies to meet SCV Water service area demands throughout the 40-year planning period. Furthermore, SCV Water has alternative paths to reliability should planned supplies prove not to be viable.

In the subsections that follow, more detailed results are presented for each scenario, including the full range of probability for available supplies, for years 2021, 2030, 2040, 2050, and 2060. Note that the supply results presented below are "Supply after storage puts and takes."

(a) Base Scenario

The results of the base scenario indicate that current supplies under demand without active conservation would be sufficient until 2029. The reliability for this year is 100 percent. The results for 2030 and 2032 show a minor probability of a small shortfall of about 800 AF and 3,500 AF, respectively. The reliability for 2030 and 2032 is 98 percent and 96 percent, respectively, which exceeds the reliability goal of 95 percent. The year 2033 is the first year where reliability decreases below the 95 percent reliability goal. The results for 2033 indicate a reliability of 94 percent and a supply shortfall of 4,800 AF. The results for 2040, 2050, and 2060 show a probability of a shortfall as high as about 15,500 AF, 31,300 AF, and 39,800 AF, respectively. The reliability for 2040 is 88 percent, for 2050 is 71 percent, and for 2060 is 69 percent. The reliability for all five of these years exceeds or meets the reliability goal of 95 percent. These results are shown in Figure B-3.

The adequacy of current supplies increases reliability to 2040 when demand under active conservation is implemented. The reliability for 2040 is 100 percent. The results for 2041 and 2047 show a minor probability of a small shortfall of about 200 AF and 4,200 AF, respectively. The reliability for 2041 and 2047 is 98 percent and 95 percent, respectively, which meets or exceeds the reliability goal of 95 percent. The year 2048 is the first year in which reliability decreases below the 95% reliability goal. The results for 2048 indicate a reliability of 94% and a supply shortfall of 5,500 AF. The results for 2049, 2050, and 2060 show a probability of a shortfall as high as about 7,400 AF, 8,400 AF and 10,100 AF, respectively. The reliability for 2040 is 93 percent, for 2050 is 92 percent, and for 2060 is 88 percent. These results are shown in Figure B-4.

The base scenarios assume no safety margin if a supply disruption were to occur, such as supply impacts from PFAS contamination. To achieve reliability in subsequent years, additional investments in those facilities identified in Scenarios 1 through 5 would be required. When these facilities and programs are put in place on the schedule identified in this Pan, reliability is achieved.

FIGURE B-3
BASE SCENARIO WITHOUT ACTIVE CONSERVATION RELIABILITY

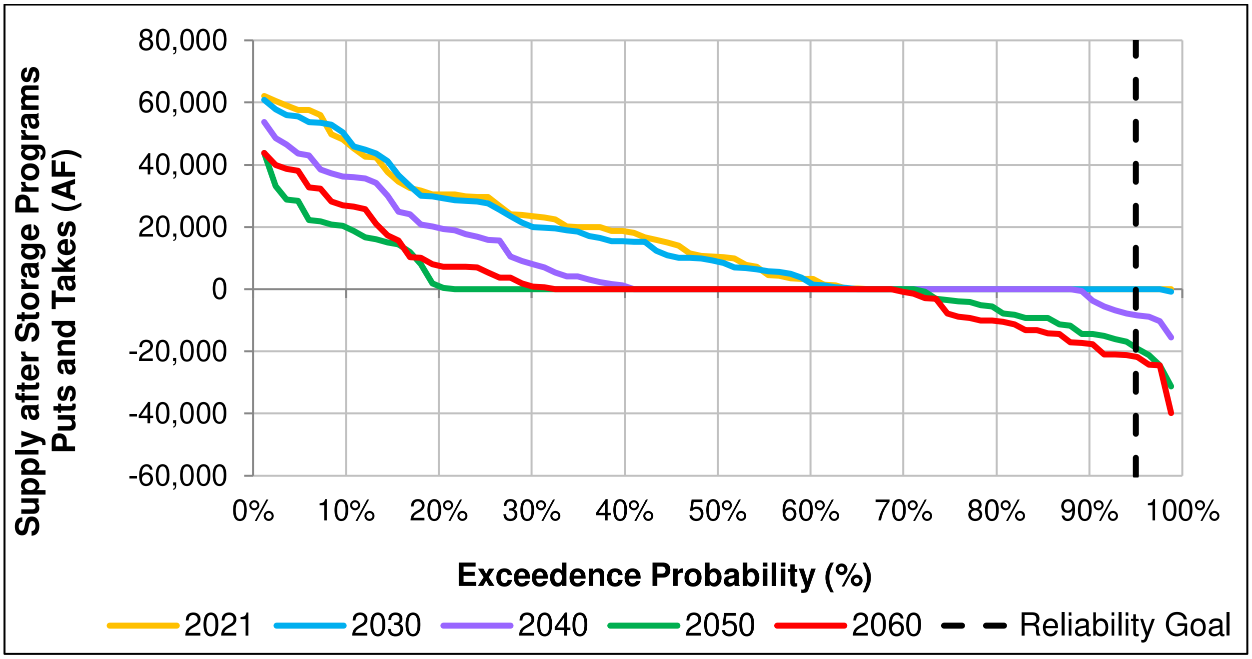
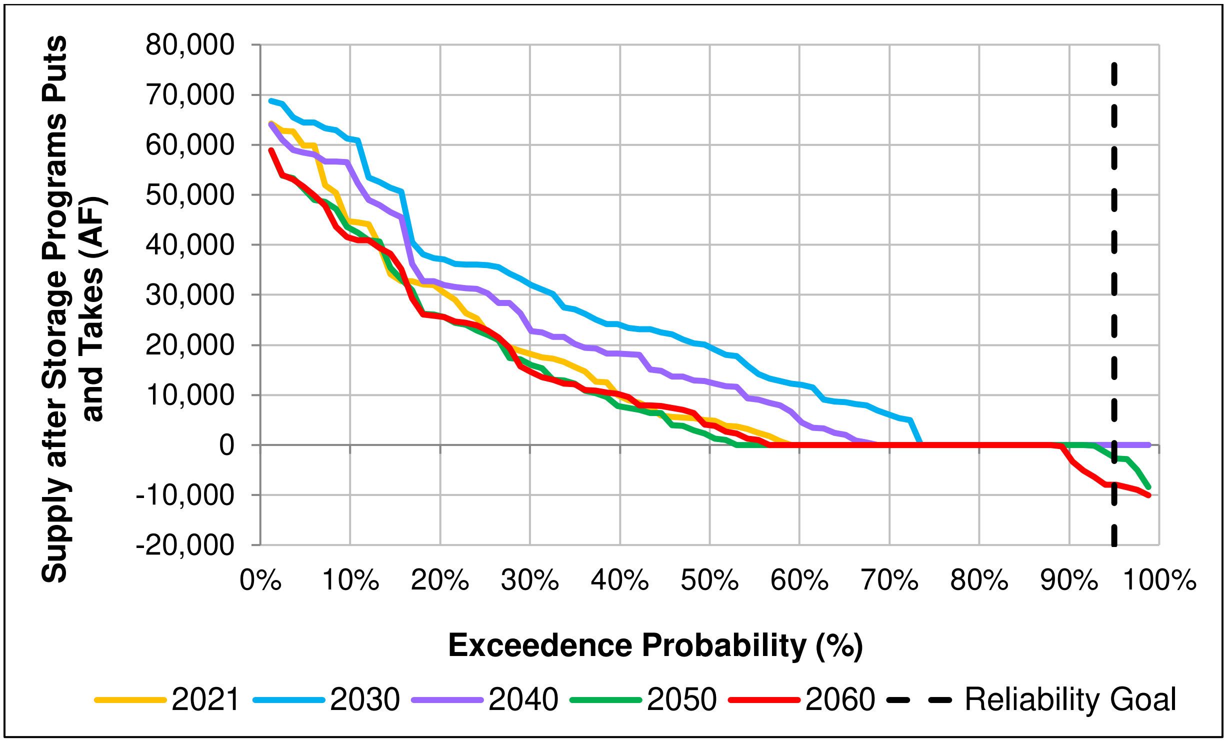


FIGURE B-4
BASE SCENARIO WITH ACTIVE CONSERVATION RELIABILITY



(b) Scenario 1

Results for Scenario 1 with demand under no active conservation indicate that for the demand and supply assumptions included in this scenario, there are no supply shortfalls for 2021 and 2030. The reliability for these two years is 100 percent. The results for 2040 show a minor probability of a small shortfall of about 360 AF. The reliability for 2040 is 98 percent. The years 2050 and 2060 show a supply shortfall as high as 12,800 AF and 30,700 AF, respectively. The reliability for 2050 is 90 percent and reliability for 2060 is 77 percent. These results are shown in Figure B-5.

When Scenario 1 is evaluated under demand with active conservation, the results show no supply shortfalls for 2021, 2030, 2040, and 2050. The reliability for these four years is 100 percent. The results for 2060 show a minor probability of shortfall of about 60 AF with a reliability of 98 percent. The reliability for all five years exceeds the reliability goal of 95 percent. These results are shown in Figure B-6.

One risk of the perceived risks to achieving reliability with Scenario 1 (2020 UWMP) is the extent to which new Saugus Formation wells can be permitted and installed. As noted in Section 4 of the 2020 UWMP, permitting of Saugus 3 and 4 is currently delayed pending permitting by DDW as it relates to proximity to abandoned oil wells. If the current sites prove not to be viable, the most likely course of action would be to relocate these proposed wells. If replacement well sites cannot be located, or if Saugus Pumping is limited because of potential subsidence, there are alternative paths to reliability as demonstrated by Scenarios 2 through 5.

FIGURE B-5
SCENARIO 1 RELIABILITY WITHOUT ACTIVE CONSERVATION

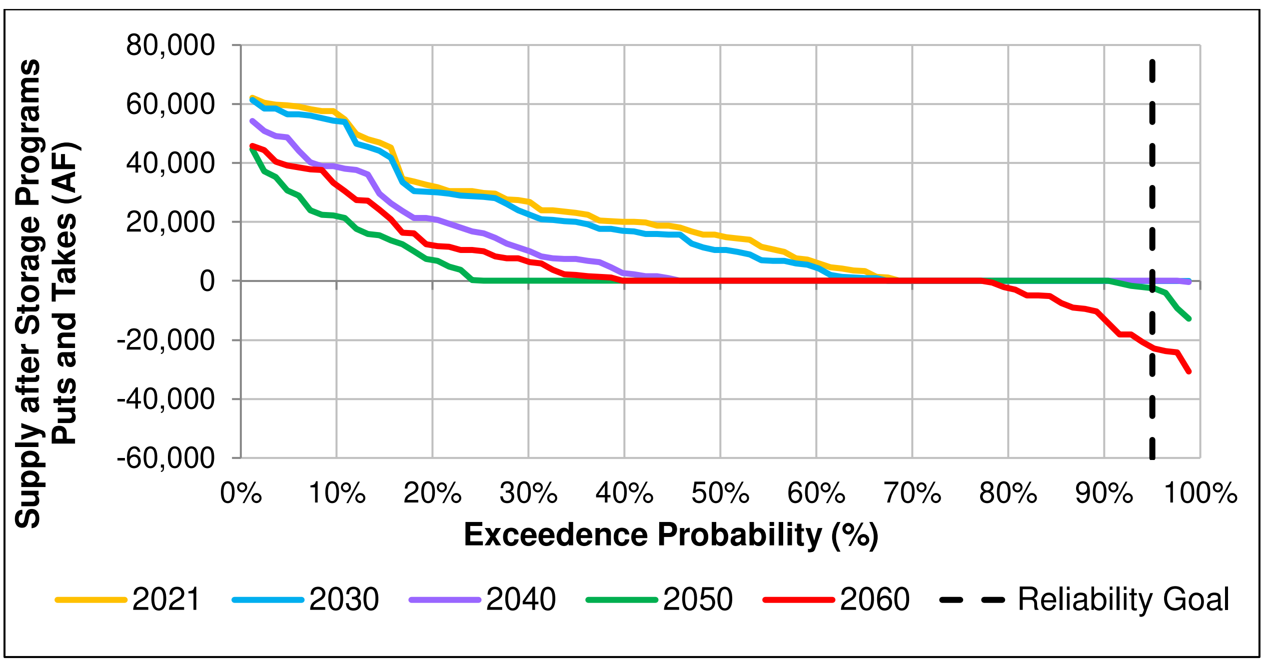
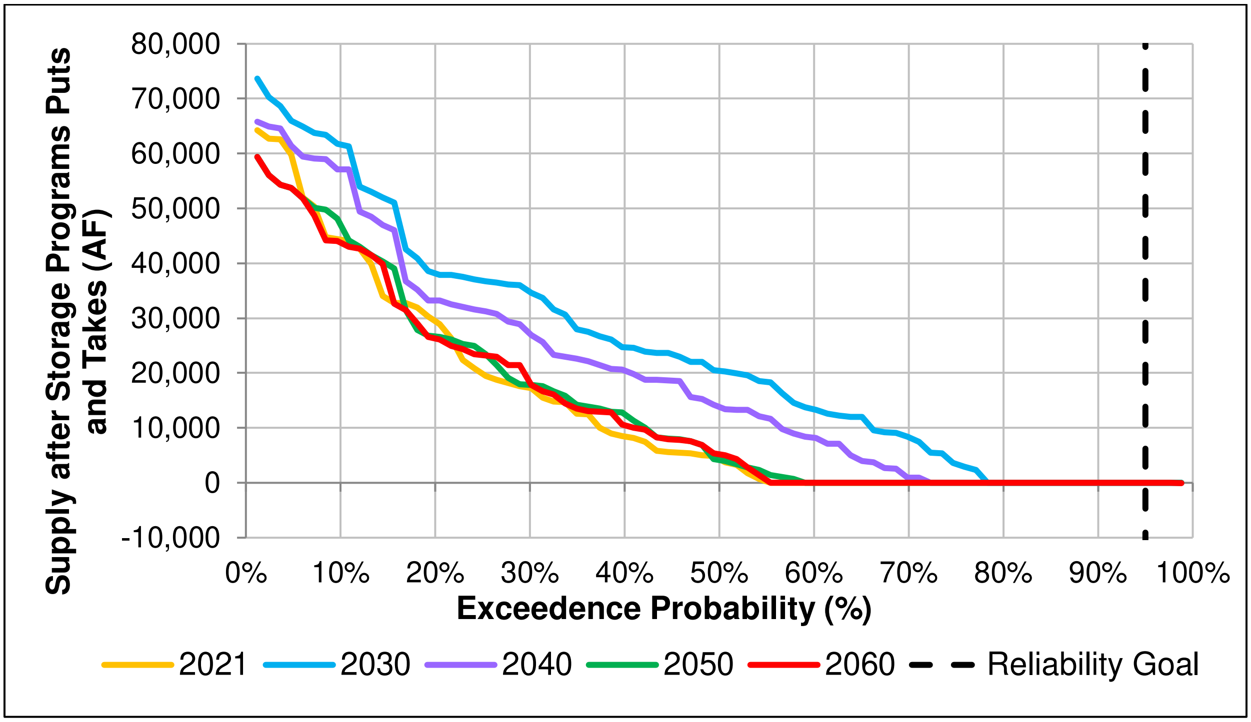


FIGURE B-6
SCENARIO 1 RELIABILITY WITH ACTIVE CONSERVATION



(c) Scenario 2

Scenario 2 replaces Saugus Wells 5 through 8 with the AVEK High Desert Bank. Results for Scenario 2 indicate that for the demand under no active conservation, there are no supply shortfalls for 2020, 2030, and 2040. The reliability for these three years is 100 percent. The results for 2050 and 2060 show a probability of a shortfall as high as about 11,300 AF and 34,400 AF, respectively. The reliability for 2050 is 96 percent and for 2060 is 95 percent. The reliability for all five of these years exceeds or meets the reliability goal of 95 percent. When Scenario 2 is run with demand under active conservation, the reliability for all five of these years is 100 percent, with no supply shortfall. These results are shown in Figures B-7 and B-8.

FIGURE B-7
SCENARIO 2 RELIABILITY WITHOUT ACTIVE CONSERVATION

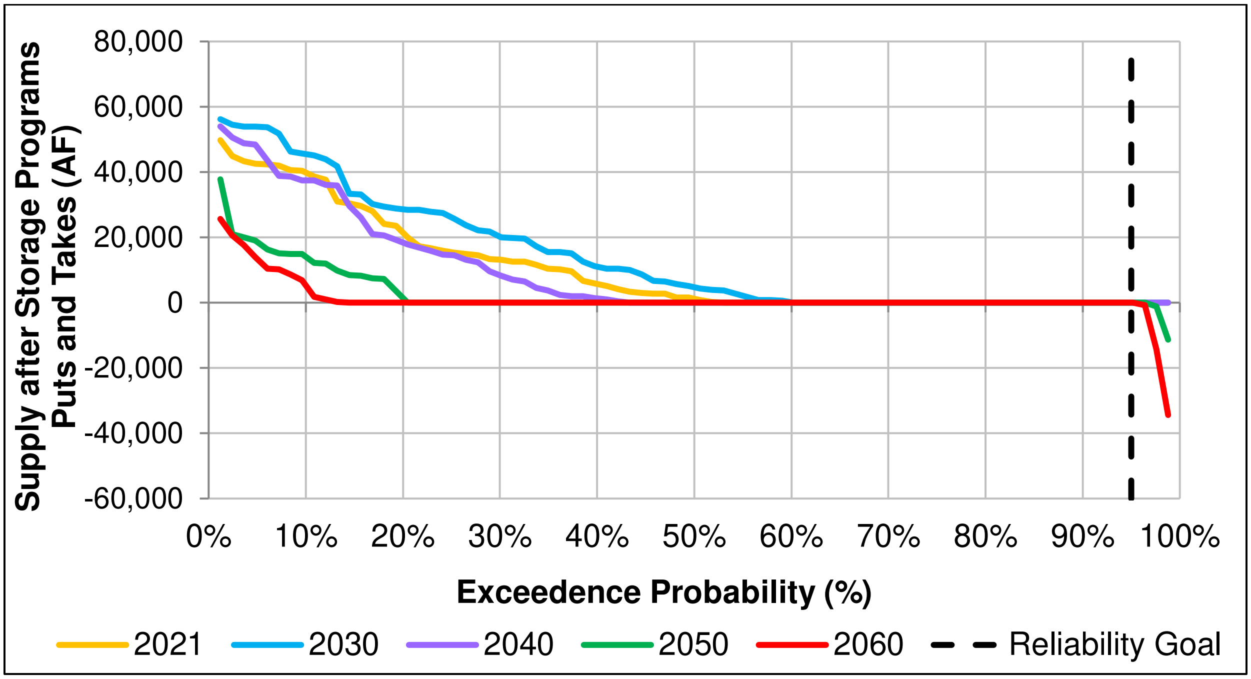
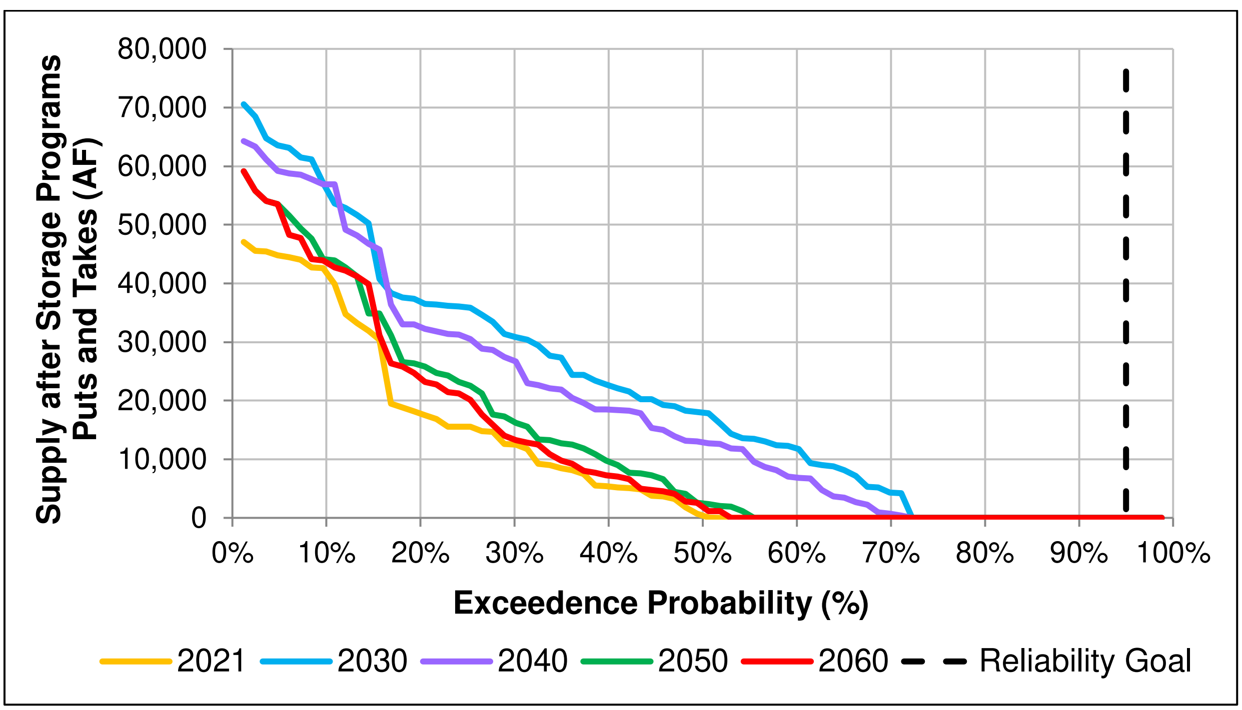


FIGURE B-8
SCENARIO 2 RELIABILITY WITH ACTIVE CONSERVATION



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(d) *Scenario 3*

Scenario 3 substitutes Sites Reservoir for the AVEK High Desert Bank. Results for Scenario 3 with demand under no active conservation indicate 100 percent reliability with no supply shortfalls for the years 2021, 2030, and 2040. The results for 2050 and 2060 show a probability of a shortfall as high as about 9,700 AF and 28,100 AF, respectively. The reliability for 2050 is 98 percent and for 2060 is 95 percent. The reliability for all five of these years exceeds or meets the reliability goal of 95 percent. When Scenario 3 is run with demand under active conservation, the reliability for all five of these years is 100 percent, with no supply shortfall. These results are shown in Figures B-9 and B-10.

FIGURE B-9
SCENARIO 3 RELIABILITY WITHOUT ACTIVE CONSERVATION

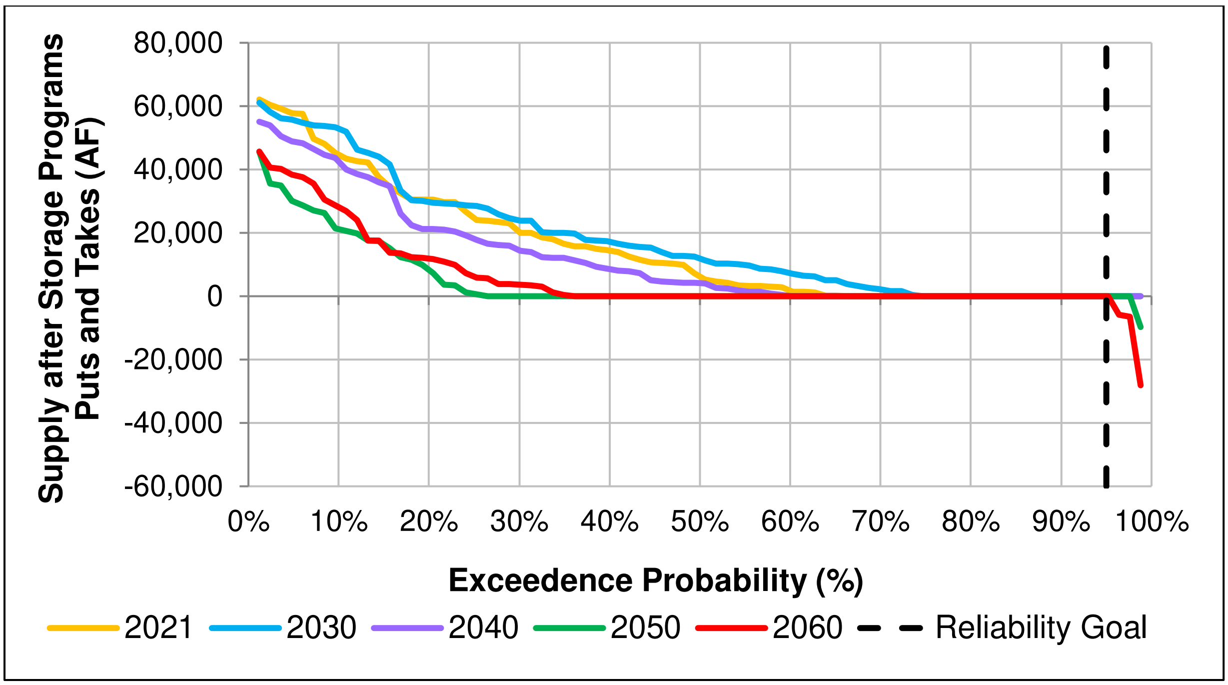
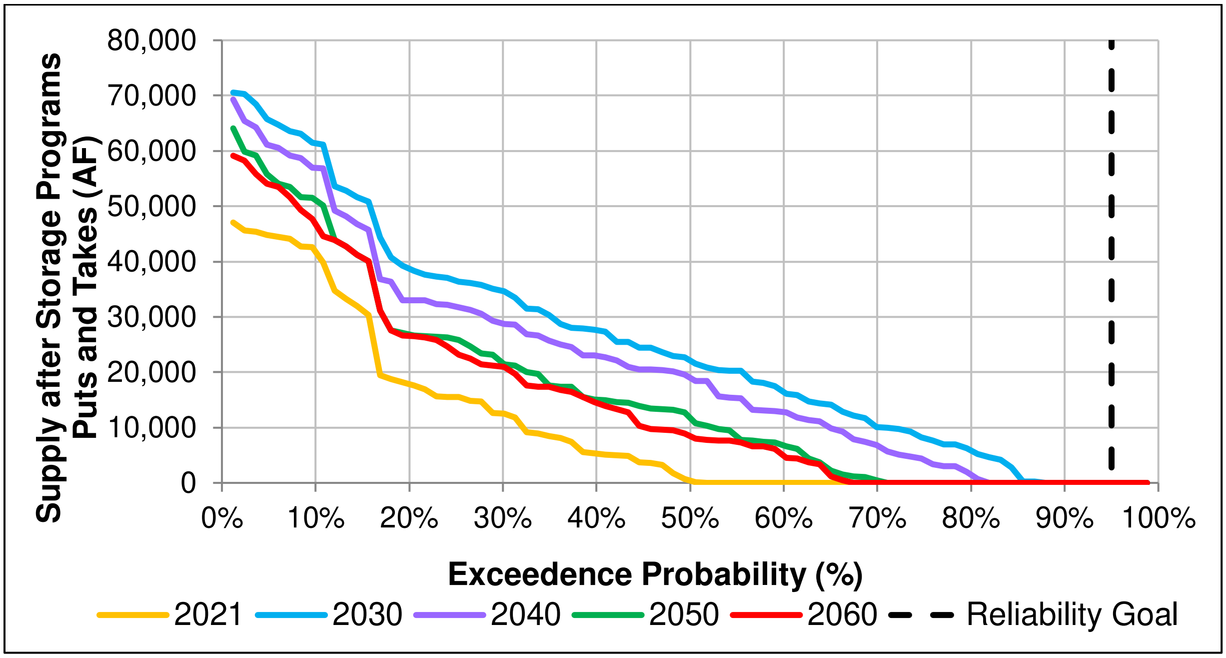


FIGURE B-10
SCENARIO 3 RELIABILITY WITH ACTIVE CONSERVATION



(e) Scenario 4

Scenario 4 is more challenging as it assumes the further deletion of Saugus wells 3 and 4. This scenario requires additional investments in the Rosedale and AVEK banks along with Sites Reservoir to achieve reliability. The results for 2021, 2030, and 2040 show 100 percent reliability. The results for 2050 and 2060 show a supply shortfall as high as 8,700 AF and 15,000 AF, respectively. The reliability for 2050 is 98 percent and for 2060 is 96 percent. The reliability for all five of these years exceeds or meets the reliability goal of 9- percent Reliability increases to 100 percent when demand under active conservation is run and there are no supply shortfalls in each of the five years 2021, 2030, 2040, 2050, and 2060. These results are shown in Figures B-11 and B-12

FIGURE B-11
SCENARIO 4 RELIABILITY WITHOUT ACTIVE CONSERVATION

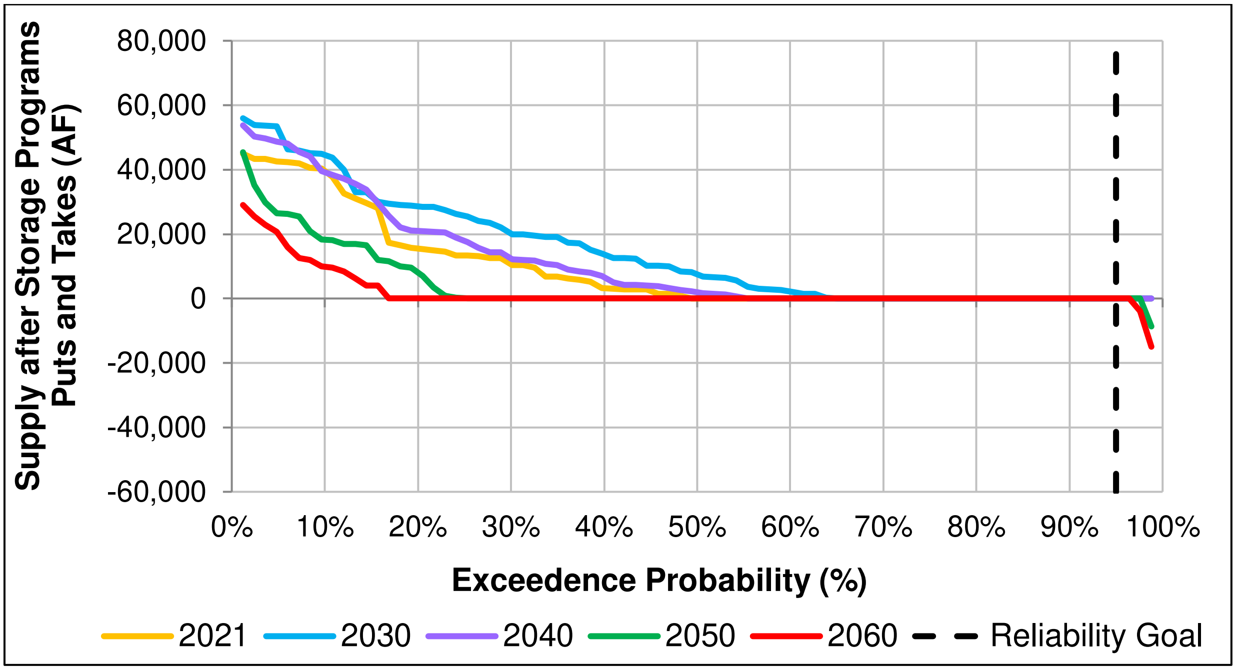
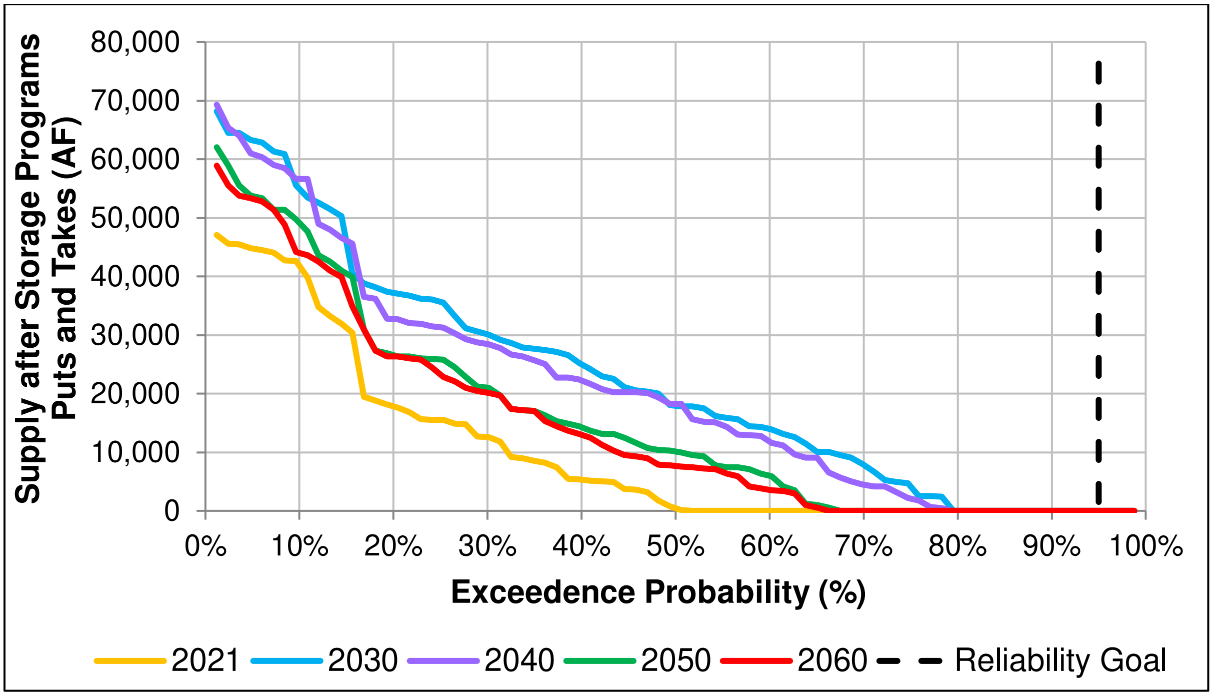


FIGURE B-12
SCENARIO 4 RELIABILITY WITH ACTIVE CONSERVATION



(f) Scenario 5

Scenario 5 is similar to Scenario 4, but substitutes the McMullin GSA Aquaterra Bank for Sites Reservoir. The results for 2021, 2030, 2040, and 2050 show 100 percent reliability. The results for 2060 shows a reliability of 98 percent with a supply shortfall as high as 23,400AF. The reliability for all five of these years exceeds or meets the reliability goal of 95-percent Reliability increases to 100 percent when demand under active conservation is run and there are no supply shortfalls in each of the five years 2021, 2030, 2040, 2050, and 2060. These results are shown in Figures B-13 and B-14.

FIGURE B-13
SCENARIO 5 RELIABILITY WITHOUT ACTIVE CONSERVATION

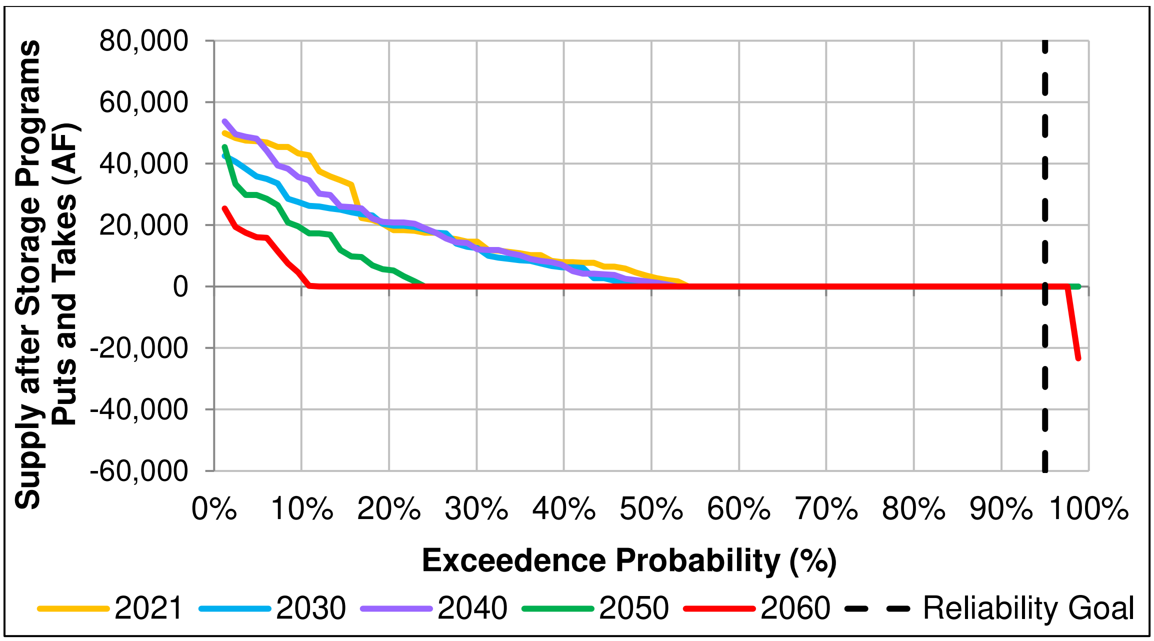
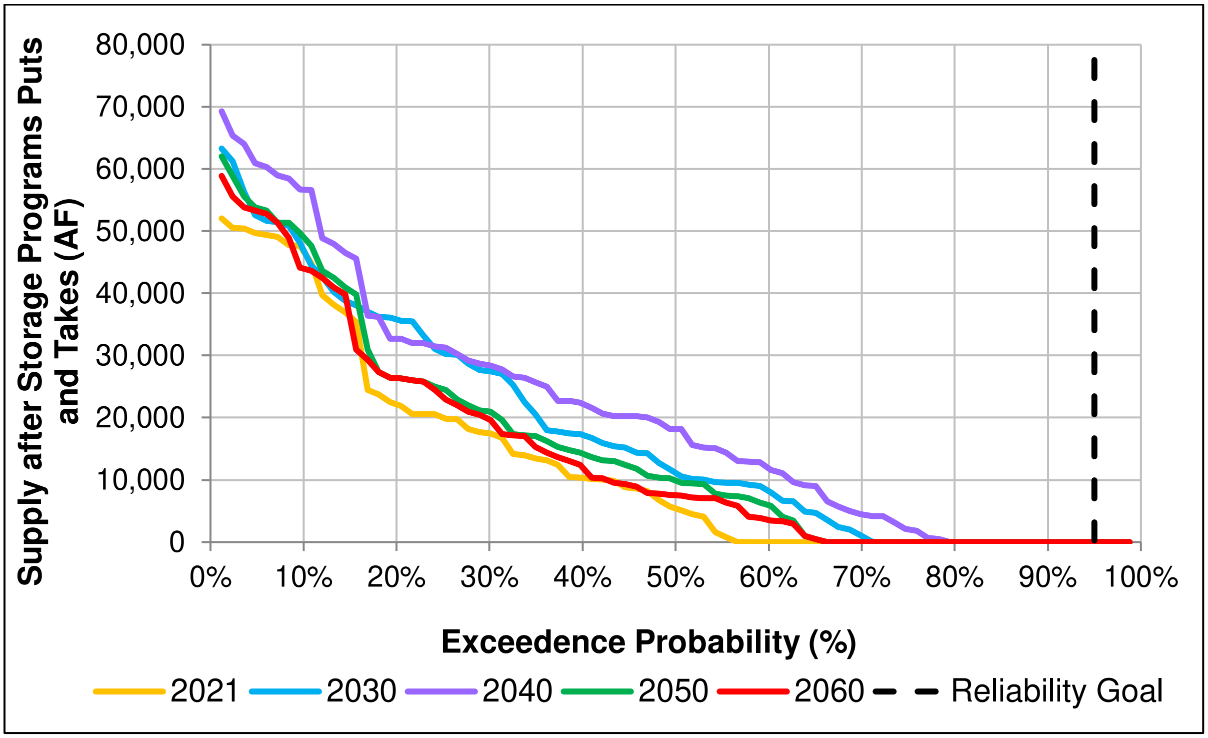


FIGURE B-14
SCENARIO 5 RELIABILITY WITH ACTIVE CONSERVATION



(g) Summary

The scenarios show how the base scenario is used as a starting point to assess the need for additional supplies. The subsequent scenarios build on the base scenario and are run under the assumptions of both demand without conservation and demand with conservation. The demand without conservation provides insight on the importance of conservation for maintaining supply reliability. As shown in the analyses above, SCV Water has adequate existing and planned supplies to meet SCV Water service area demands under active conservation throughout the 40-year planning period. Furthermore, SCV Water has alternative paths to reliability should planned supplies prove not to be viable. These results are summarized in Figures B-15 and B-16.

FIGURE B-15
SUMMARY OF RELIABILITY OF ALL SCENARIOS UNDER DEMAND WITHOUT ACTIVE CONSERVATION

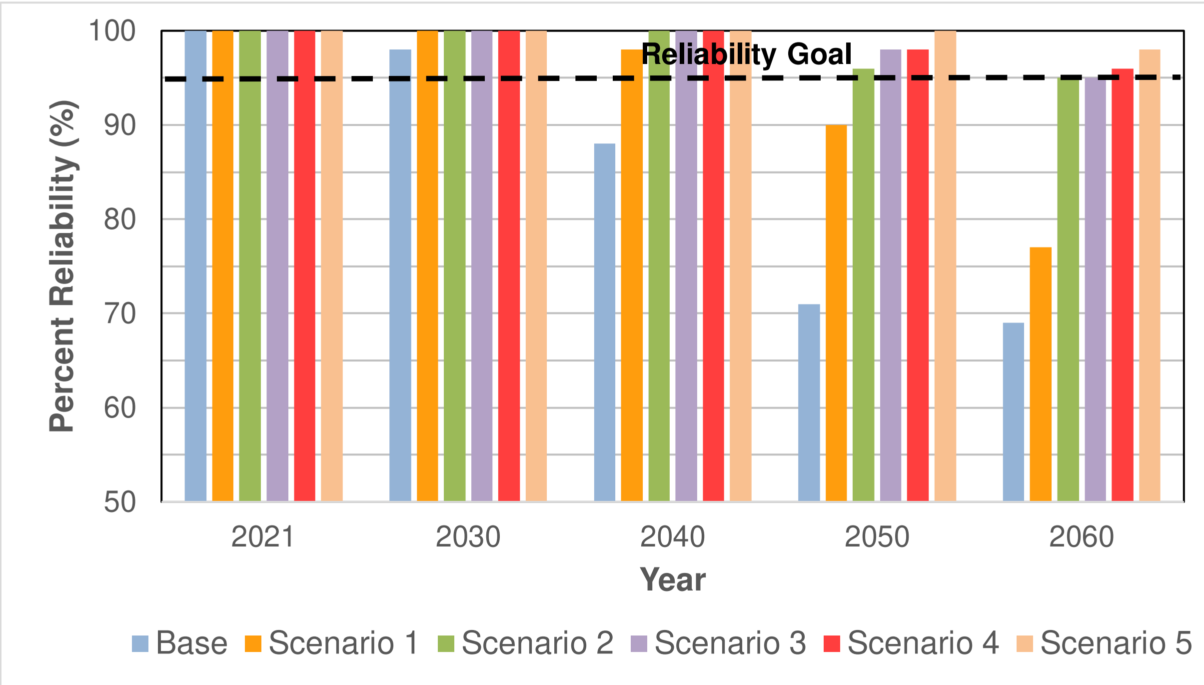


FIGURE B-16
SUMMARY OF RELIABILITY OF ALL SCENARIOS UNDER DEMAND WITH ACTIVE CONSERVATION