Appendix Q Regional Economics Technical Appendix

This appendix documents the regional economics technical analysis to support the impact analysis in the Environmental Impact Statement (EIS).

Q.1 Background Information

This section presents regional economic conditions and economic information relevant to the specific industries in which potential economic effects could occur, such as municipal and industrial (M&I) water uses, agriculture, and fishing.

Q.1.1 Regional Economics

Q.1.1.1 *Trinity River Region*

The Trinity River Region includes Trinity, Humboldt and Del Norte Counties.

Q.1.1.1.1 Employment, Labor Income, and Output

Table Q.1-1 presents employment, labor income, and output by industry for the combined regional economies of the Trinity River Region in 2017. This data is compiled using Impact Planning and Analysis (IMPLAN) data files from a variety of sources, including, but not limited to, the United States Bureau of Economic Analysis, the United States Bureau of Labor, and the United States Census Bureau. This section presents IMPLAN data and results for economic output, employment, and labor income. Output is the dollar value of industry production. Employment is measured as the number of jobs. Labor income is the dollar value of total payroll (including benefits) for each industry plus income received by self-employed individuals.

In 2017, services provided the most jobs (40,955 jobs) in the region, followed by government (18,557 jobs) and trade (11,975 jobs). Services also had the highest output ($4,905 million) of all industries in the region, followed by government ($1,905 million) and trade ($1,346 million). Services and government were the top industries in terms of labor income in 2017.

Table Q.1-1. Summary of 2017 Regional Economy in Trinity River Region

Industry	Employment (Jobs)	Output (million dollars)	Labor Income (million dollars)
Agriculture	3,144	$477	$72
Mining	237	$34	$4
Construction	5,413	$993	$125
Manufacturing	3,746	$1,163	$144
Transportation, Information, Power, and Utilities (TIPU)	5,367	$992	$116
Trade	11,975	$1,346	$378

Industry	Employment (Jobs)	Output (million dollars)	Labor Income (million dollars)
Service	40,955	$4,905	$1,154
Government	18,557	$1,905	$1,348
Total	**89,393**	**$11,817**	**$3,340**

Source: Minnesota IMPLAN Group (MIG) 2018
All costs in 2017 dollars
Employment is measured in number of jobs.
Income is the dollar value of total payroll for each industry includes employee compensation and proprietor income.
Output represents the dollar value of industry production.
TIPU = Transportation, Information, Power, and Utilities

Table Q.1-2 presents the civilian labor force unemployment and the unemployment rate for counties in the Trinity River Region.

Table Q.1-2. Summary of 2017 Unemployment Statistics in Trinity River Region Counties

Area	Civilian Labor Force Unemploymen t in 2007	Civilian Labor Force Unemployment in 2017	Unemployment Rate in 2007	Unemployment Rate in 2017
Trinity County	525	301	10.4%	6%
Humboldt County	3,507	2,639	5.9%	4.2%
Del Norte County	830	629	7.5%	6.4%
Trinity River Region[1]	4,862	3,569	6.5%	4.6%
STATE OF CALIFORNIA	961,496	918,883	5.4%	5%

Source: Bureau of Labor Statistics (BLS) 2018.
[1] Calculated sum of unemployed labor force in Trinity River Region counties

Q.1.1.1.2 Household Income

Table Q.1-3 presents median and mean household income and per capita income in Trinity River Region counties relative to California. Median, mean, and per capita income for all three Trinity River Region counties is lower than the state average.

Table Q.1-3. 2013-2017 Trinity River Region Household and Per Capita Income

Area	Median Household Income	Mean Household Income	Per Capita Income
Trinity County	$36,563	$52,189	$23,575
Humboldt County	$43,718	$60,394	$25,208
Del Norte County	$41,287	$55,899	$20,809
Trinity River Region[1]	**$40,523**	**$56,161**	**$23,197**
STATE OF CALIFORNIA	**$67,169**	**$96,104**	**$33,128**

Source: United States Census Bureau 2017
All costs in 2017 dollars.
[1] Calculated average of median, mean, and per capital income for Trinity River Region counties

Q.1.1.2 *Sacramento Valley Region*

The Sacramento Valley Region includes Butte, Colusa, El Dorado, Glenn, Nevada, Placer, Plumas, Shasta, Sutter, Tehama, and Yuba Counties. Sacramento, Solano, and Yolo Counties are discussed under the Delta Region.

Q.1.1.2.1 Employment, Labor Income, and Output

Table Q.1-4 presents employment, labor income, and output by industry for the combined regional economies of the Sacramento Valley Region in 2017.

In 2017, services provided the most jobs (377,349) in the area, followed by trade (97,314) and government (93,104). Services also had the highest output ($50,883 million) of all industries in the region, followed by trade ($11,758 million) and manufacturing ($11,334 million). Services and government were the top industries in terms of labor income in 2017.

Table Q.1-4. Summary of 2017 Regional Economy in Sacramento Valley Region

Industry	Employment (jobs)	Output (million dollars)	Labor Income (million dollars)
Agriculture	36,284	$3,944	$810
Mining	2,815	$454	$56
Construction	51,303	$9,438	$2,069
Manufacturing	29,605	$11,334	$1,740
TIPU	26,181	$7,612	$1,518
Trade	97,314	$11,758	$3,373
Service	377,349	$50,883	$14,157
Government	93,104	$11,153	$7,773
Total	**713,955**	**$106,574**	**$31,495**

Source: MIG 2018.
All costs in 2017 dollars.
Employment is measured in number of jobs.
Income is the dollar value of total payroll for each industry includes employee compensation and proprietor income.
Output represents the dollar value of industry production.
TIPU = Transportation, Information, Power, and Utilities

Table Q.1-5 presents the civilian labor force unemployment and the unemployment rate for the counties in the Sacramento Valley.

Table Q.1-5. Summary of 2017 Unemployment Statistics in Sacramento Valley Counties

County	Civilian Labor Force Unemployment in 2007	Civilian Labor Force Unemployment in 2017	Unemployment Rate in 2007	Unemployment Rate in 2017
Butte County	6,739	5,916	6.7%	5.7%
Colusa County	1,202	1,543	11.8%	14.3%
El Dorado County	4,675	3,920	5.2%	4.4%
Glenn County	1,054	963	8.8%	7.5%
Nevada County	2,406	1,998	4.8%	4.1%

County	Civilian Labor Force Unemployment in 2007	Civilian Labor Force Unemployment in 2017	Unemployment Rate in 2007	Unemployment Rate in 2017
Placer County	8,231	7,004	4.8%	3.8%
Plumas County	849	692	8.5%	8.9%
Shasta County	6,190	4,321	7.5%	5.8%
Sutter County	3,965	3,935	9.7%	8.6%
Tehama County	1,798	1,630	7.2%	6.4%
Yuba County	2,532	2,125	9.3%	7.4%
Sacramento Valley[1]	**39,641**	**34,047**	**6.4%**	**5.4%**
STATE OF CALIFORNIA	**961,496**	**918,883**	**5.4%**	**5%**

Source: BLS 2018
[1] Calculated sum of unemployed labor force in Sacramento Valley Region counties

Q.1.1.2.2 Household income

Table Q.1-6 presents household income and per capita income in Sacramento Valley counties relative to California. All counties except Placer and El Dorado Counties within the Sacramento Valley Region have lower median household, mean household, and per capita incomes than the state average.

Table Q.1-6. 2013-2017 Sacramento Valley Region Household and Per Capita Income

County	Median Household Income	Mean Household Income	Per Capita Income
Butte County	$46,516	$66,251	$26,304
Colusa County	$56,481	$75,868	$25,676
El Dorado County	$74,885	$99,817	$38,156
Glenn County	$46,260	$58,822	$21,029
Nevada County	$60,610	$83,616	$35,581
Placer County	$80,488	$104,490	$39,734
Plumas County	$50,266	$68,728	$32,056
Shasta County	$47,258	$65,004	$26,455
Sutter County	$54,347	$72,302	$24,849
Tehama County	$42,512	$58,732	$22,631
Yuba County	$51,776	$64,398	$22,814
Sacramento Valley[1]	**$55,582**	**$74,366**	**$28,662**
STATE OF CALIFORNIA	**$67,169**	**$96,104**	**$33,128**

Source: United States Census Bureau 2017
All costs in 2017 dollars.
[1] Calculated average median, mean and per capital income for all Sacramento Valley Region counties

Q.1.1.3 *San Joaquin Valley Region*

The San Joaquin Valley Region includes Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern Counties. San Joaquin County is discussed under the Delta Region. Changes in Central Valley Project (CVP) and State Water Project (SWP) operations are not anticipated to affect Calaveras, Mariposa, and Tuolumne Counties and are not discussed in this section.

Q.1.1.3.1 Employment, Labor Income, and Output

Table Q.1-7 presents employment, labor income, and output by industry for the combined regional economies of the San Joaquin Valley Region in 2017. In 2017, services provided the most jobs (643,256) in the region, followed by government (253,031) and agriculture (234,825). Services also had the highest output ($83,096 million) of all industries in the region, followed by manufacturing ($52,204 million) and government ($28,917 million). Services and government were the top industries in terms of labor income in 2017.

Table Q.1-7. Summary of 2017 Regional Economy in San Joaquin Valley Region (in 2017 Dollars)

Industry	Employment (Jobs)	Output (million dollars)	Labor Income (million dollars)
Agriculture	234,825	$28,019	$7,481
Mining	15,042	$4,195	$1,386
Construction	72,389	$12,382	$3,047
Manufacturing	100,094	$52,204	$6,223
TIPU	74,550	$16,231	$4,045
Trade	199,383	$24,962	$7,131
Service	643,256	$83,096	$23,292
Government	253,031	$28,917	$21,738
Total	**1,592,569**	**$250,006**	**$74,341**

Source: MIG 2018
All costs in 2017 dollars.
Employment is measured in number of jobs.
Income is the dollar value of total payroll for each industry includes employee compensation and proprietor income.
Output represents the dollar value of industry production.
TIPU = Transportation, Information, Power, and Utilities

Table Q.1-8 presents the civilian labor force unemployment and the unemployment rate for counties in the San Joaquin Valley.

Table Q.1-8. Summary of 2017 Unemployment Statistics in San Joaquin Valley Counties

County	Civilian Labor Force Unemployment in 2007	Civilian Labor Force Unemployment in 2017	Unemployment Rate in 2007	Unemployment Rate in 2017
Stanislaus County	19,687	18,165	8.7%	7.5%
Madera County	4,745	4,949	7.5%	8.1%
Merced County	10,046	10,801	10.1%	9.3%
Fresno County	35,790	38,070	8.6%	8.5%
Tulare County	17,713	21,401	9.2%	10.4%
Kings County	4,974	5,119	8.7%	8.9%
Kern County	28,228	35,442	8.2%	9.2%
San Joaquin Valley[1]	**121,183**	**133,947**	**8.6%**	**8.8%**
STATE OF CALIFORNIA	**961,496**	**918,883**	**5.4%**	**5%**

Source: BLS 2018
[1] Calculated average median, mean, and per capital income for all San Joaquin Valley Region counties

Q.1.1.3.2 Household Income

Table Q.1-9 presents household income and per capita income in San Joaquin Valley Region counties relative to California. All counties in the San Joaquin Valley Region have median household, mean household, and per capita incomes lower than the state average.

Table Q.1-9. San Joaquin Valley Region Household and Per Capita Income

County	Median Household Income	Mean Household Income	Per Capita Income
Stanislaus County	$54,260	$72,388	$24,007
Madera County	$48,210	$65,121	$19,975
Merced County	$46,338	$64,445	$20,120
Fresno County	$48,730	$68,620	$22,234
Tulare County	$44,871	$62,325	$18,962
Kings County	$49,742	$66,431	$19,835
Kern County	$50,826	$69,236	$21,716
San Joaquin Valley[1]	**$48,997**	**$66,938**	**$20,978**
STATE OF CALIFORNIA	**$67,169**	**$96,104**	**$33,128**

Source: United States Census Bureau 2017
All costs in 2017 dollars.
[1] Calculated average median, mean and per capital income for all San Joaquin Valley Region counties

Q.1.1.4 *Delta Region*

The Delta Region in this analysis includes Sacramento, Yolo, Solano, San Joaquin, and Contra Costa Counties.

Q.1.1.4.1 Employment, Labor Income, and Output

Table Q.1-10 presents employment, labor income, and output by industry for the combined regional economies of the Delta Region in 2017.

In 2017, services provided the most jobs (1,106,322) in the area, followed by government (333,027) and trade (255,098). Services also had the highest output ($165,711 million) of all industries in the region, followed by manufacturing ($71,321 million) and government ($44,627 million). Services and government were the top industries in terms of labor income in 2017.

Table Q.1-10. Summary of 2017 Regional Economy in Delta Region

Industry	Employment (jobs)	Output (million dollars)	Labor Income (million dollars)
Agriculture	37,685	$4,610	$1,166
Mining	3,113	$528	$95
Construction	119,520	$22,905	$6,429
Manufacturing	80,411	$71,321	$7,375
TIPU	140,061	$36,173	$7,888
Trade	255,098	$33,886	$10,717

Industry	Employment (jobs)	Output (million dollars)	Labor Income (million dollars)
Service	1,106,322	$165,711	$51,459
Government	333,027	$44,627	$35,591
Total	**2,075,237**	**$379,760**	**$120,720**

Source: MIG 2018
All costs in 2017 dollars.
Employment is measured in number of jobs.
Income is the dollar value of total payroll for each industry includes employee compensation and proprietor income.
Output represents the dollar value of industry production.
TIPU = Transportation, Information, Power, and Utilities

Table Q.1-11 presents the civilian labor force unemployment and the unemployment rate for counties in the Delta Region.

Table Q.1-11. Summary of 2017 Unemployment Statistics in Delta Region Counties

Area	Civilian Labor Force Unemployment in 2007	Civilian Labor Force Unemployment in 2017	Unemployment Rate in 2007	Unemployment Rate in 2017
Contra Costa County	24,097	21,418	4.7%	3.8%
Sacramento County	36,725	32,580	5.4%	4.6%
San Joaquin County	23,359	22,612	8.1%	7%
Solano County	10,982	9,942	5.3%	4.8%
Yolo County	5,590	5,402	5.7%	5%
Delta Region [1]	**100,753**	**91,954**	**5.6%**	**4.8%**
STATE OF CALIFORNIA	**961,496**	**918,883**	**5.4%**	**5%**

Source: BLS 2018
[1] Calculated average median, mean and per capital income for all Delta Region counties

Q.1.1.4.2 Household Income

Table Q.1-12 presents household income and per capita income in the Delta Region relative to California. Contra Costa and Solano Counties have higher median compared to the state average.

Table Q.1-12. 2013-2017 Delta Region Household and Per Capita Income

County	Median Household Income	Mean Household Income	Per Capita Income
Contra Costa County	$88,456	$120,800	$42,898
Sacramento County	$60,239	$80,705	$29,693
San Joaquin County	$57,813	$76,851	$24,694
Solano County	$72,950	$90,972	$31,934
Yolo County	$61,621	$86,723	$30,615
Delta Region Subtotal	**$68,216**	**$91,210**	**$31,967**
STATE OF CALIFORNIA	**$67,169**	**$96,104**	**$33,128**

Source: United States Census Bureau 2017
All costs in 2017 dollars.
[1] Calculated average of median, mean and per capital income for all Delta Region counties

Q.1.1.5 *San Francisco Bay Area Region*

The San Francisco Bay Area Region includes Alameda, Napa, Santa Clara, and San Benito Counties within the CVP and SWP service areas.

Q.1.1.5.1 Employment, Labor Income, and Output

Table Q.1-13 presents employment, labor income, and output by industry for the combined regional economies of the San Francisco Bay Area Region in 2017. In 2017, services provided the most jobs (1,499,825) in the area, followed by trade (289,220) and manufacturing (271,216). Services also had the highest output ($273,065 million) of all industries in the region, followed by manufacturing ($200,891 million) and Transportation, Information, Power, and Utilities (TIPU) ($99,131 million). Services and manufacturing were the top industries in terms of labor income in 2017.

Table Q.1-13. Summary of 2017 Regional Economy for Counties in the San Francisco Bay Area Region

Industry	Employment (Jobs)	Output (million dollars)	Labor Income (million dollars)
Agriculture	17,504	$1,324	$569
Mining	2,841	$415	$61
Construction	128,594	$27,555	$8,774
Manufacturing	271,216	$200,891	$48,782
TIPU	204,400	$99,131	$39,044
Trade	289,220	$54,929	$20,220
Service	1,499,825	$273,065	$111,390
Government	223,302	$29,581	$24,552
Total	**2,636,903**	**$686,891**	**$253,391**

Source: MIG 2018
All costs in 2017 dollars.
Employment is measured in number of jobs.
Income is the dollar value of total payroll for each industry includes employee compensation and proprietor income.
Output represents the dollar value of industry production.
TIPU = Transportation, Information, Power, and Utilities

Table Q.1-14 presents the civilian labor force unemployment and the unemployment rate for the counties in the San Francisco Bay Area Region.

Table Q.1-14. Summary of 2017 Unemployment Statistics in San Francisco Bay Area Region

Area	Civilian Labor Force Unemployment in 2007	Civilian Labor Force Unemployment in 2017	Unemployment Rate in 2007	Unemployment Rate in 2017
Alameda County	35,054	30,902	4.7%	3.6%
Santa Clara County	39,560	33,415	4.7%	3.2%
San Benito County	1,736	1,765	7.2%	5.8%
Napa County	2,946	2,701	4%	3.7%
San Francisco Bay Area[1]	**79,296**	**68,783**	**4.7%**	**3.5%**
STATE OF CALIFORNIA	**961,496**	**918,883**	**5.4%**	**5%**

Source: BLS 2018
[1] Calculated average median, mean and per capital income for all San Francisco Bay Area Region counties

Q.1.1.5.2 Household Income

Table Q.1-15 presents household income and per capita income in the San Francisco Bay Area Region relative to California. The mean and median household incomes for all counties in the San Francisco Bay Area Region are higher than the state average.

Table Q.1-15. 2013-2017 San Francisco Bay Area Region Household and Per Capita Income (in 2017 Dollars)

County	Median Household Income	Mean Household Income	Per Capita Income
Alameda County	$85,743	$114,330	$41,363
Santa Clara County	$106,761	$143,191	$48,689
San Benito County	$80,760	$97,131	$30,012
Napa County	$79,637	$111,168	$40,632
San Francisco Bay Area	**$88,225**	**$116,455**	**$40,174**
STATE OF CALIFORNIA	**$67,169**	**$96,104**	**$33,128**

Source: United States Census Bureau 2017
All costs in 2017 dollars.
[1] Calculated average of median, mean and per capital income for all Delta Region counties

Q.1.1.6 *Central Coast Region*

The Central Coast Region includes San Luis Obispo and Santa Barbara Counties served by the SWP.

Q.1.1.6.1 Employment, Labor Income, and Output

Table Q.1-16 presents employment, labor income, and output by industry for the combined regional economies of the Central Coast Region in 2017. In 2017, services provided the most jobs (238,038) in the area, followed by government (61,203) and trade (51,340). Services also had the highest output ($31,281 million) of all industries in the region, followed by manufacturing ($8,815 million) and government ($7,524 million). Services and government were the top industries in terms of labor income in 2017.

Table Q.1-16. Summary of 2017 Regional Economy for Counties in Central Coast Region

Industry	Employment (Jobs)	Output (million dollars)	Labor Income (million dollars)
Agriculture	30,831	$2,907	$979
Mining	2,133	$769	$220
Construction	24,663	$4,474	$973
Manufacturing	22,648	$8,815	$1,645
TIPU	17,386	$6,621	$1,486
Trade	51,340	$6,616	$1,966
Service	238,038	$31,281	$8,624
Government	61,203	$7,524	$5,455
Total	**448,241**	**$69,006**	**$21,347**

Source: MIG 2018
All costs in 2017 dollars.
Employment is measured in number of jobs.
Income is the dollar value of total payroll for each industry includes employee compensation and proprietor income.
Output represents the dollar value of industry production.
TIPU = Transportation, Information, Power, and Utilities

Table Q.1-17 presents the civilian labor force unemployment and the unemployment rate for the counties in the Central Coast Region.

Table Q.1-17. Summary of 2017 Unemployment Statistics in Central Coast Region

Area	Civilian Labor Force Unemployment in 2007	Civilian Labor Force Unemployment in 2017	Unemployment Rate in 2007	Unemployment Rate in 2017
San Luis Obispo County	5,750	5,089	4.3%	3.6%
Santa Barbara County	9,310	9,741	4.4%	4.5%
Central Coast Region[1]	**15,060**	**14,830**	**4.3%**	**4.1%**
STATE OF CALIFORNIA	**961,496**	**918,883**	**5.4%**	**5%**

Source: BLS 2018
[1] Calculated average median, mean and per capital income for all Southern California Region counties

Q.1.1.6.2 Household Income

Table Q.1-18 presents household income and per capita income in the Southern California Region relative to California.

Table Q.1-18. 2013-2017 Southern California Region Household and Per Capita Income (in 2017 Dollars)

County	Median Household Income	Mean Household Income	Per Capita Income
San Luis Obispo County	$67,175	$87,933	$33,972
Santa Barbara County	$68,023	$97,025	$32,872
Central Coast Region	**$67,599**	**$92,479**	**$33,422**
STATE OF CALIFORNIA	**$67,169**	**$96,104**	**$33,128**

Source: United States Census Bureau 2017
All costs in 2017 dollars.
[1] Calculated average of median, mean and per capital income for all Delta Region counties

Q.1.1.7 *Southern California Region*

The Southern California Region includes Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino Counties.

Q.1.1.7.1 Employment, Labor Income, and Output

Table Q.1-19 presents employment, labor income, and output by industry for the combined regional economies of the Southern California Region in 2017.

In 2017, services provided the most jobs (7,952,744) in the area, followed by trade (1,742,128) and government (1,502,445). Services also had the highest output ($1,150,474 million) of all industries in the region, followed by manufacturing ($347,541 million) and TIPU ($317,862 million). Services and government were the top industries in terms of labor income in 2017.

Table Q.1-19. Summary of 2017 Regional Economy for Counties in the Southern California Region (in 2017 Dollars)

Industry	Employment (Jobs)	Output (million dollars)	Labor Income (million dollars)
Agriculture	67,735	$5,963	$1,826
Mining	24,188	$4,961	$880
Construction	634,346	$114,689	$29,755
Manufacturing	769,544	$338,726	$66,849
TIPU	924,908	$311,242	$69,039
Trade	1,690,788	$250,042	$78,902
Service	7,714,706	$1,119,193	$343,769
Government	1,441,242	$201,471	$141,822
Total	**13,267,457**	**$2,346,286**	**$732,843**

Source: MIG 2018
All costs in 2017 dollars.
Employment is measured in number of jobs.
Income is the dollar value of total payroll for each industry includes employee compensation and proprietor income.
Output represents the dollar value of industry production.
TIPU = Transportation, Information, Power, and Utilities

Table Q.1-20 presents the civilian labor force unemployment and the unemployment rate for counties in the Southern California Region.

Table Q.1-20. Summary of 2017 Unemployment Statistics in Southern California Region

Area	Civilian Labor Force Unemployment in 2007	Civilian Labor Force Unemployment in 2017	Unemployment Rate in 2007	Unemployment Rate in 2017
Ventura County	20,666	19,140	4.9%	4.5%
Los Angeles County	249,384	240,293	5.1%	4.7%
Orange County	62,474	56,627	3.9%	3.5%
San Diego County	69,004	63,465	4.6%	4%
Riverside County	54,429	56,252	6%	5.2%
San Bernardino County	48,324	46,582	5.6%	4.9%
Southern California Region[1]	**504,281**	**482,359**	**5.0%**	**4.5%**
STATE OF CALIFORNIA	**961,496**	**918,883**	**5.4%**	**5%**

Source: BLS 2018
Note: [1] Calculated average median, mean and per capital income for all Southern California Region counties

Q.1.1.7.2 Household Income

Table Q.1-21 presents household income and per capita income in the Southern California Region relative to California.

Table Q.1-21. 2013-2017 Southern California Region Household and Per Capita Income (in 2017 Dollars)

County	Median Household Income	Mean Household Income	Per Capita Income
Ventura County	$81,972	$107,872	$35,771
Los Angeles County	$61,015	$89,855	$30,798
Orange County	$81,851	$111,775	$37,603
San Diego County	$70,588	$96,153	$34,350
Riverside County	$60,807	$80,056	$25,700
San Bernardino County	$57,156	$74,105	$22,867
Southern California Region	**$68,898**	**$93,303**	**$31,182**
STATE OF CALIFORNIA	**$67,169**	**$96,104**	**$33,128**

Source: United States Census Bureau 2017
All costs in 2017 dollars.
[1] Calculated average of median, mean and per capital income for all Delta Region counties

Q.1.2 Agricultural Economics

California is the highest producer (by value) of agricultural commodities in the United States. California produced up to 400 agricultural commodities and accounted for over 13% of the nation's total agricultural value in 2017 (U.S. Department of Agriculture [USDA] 2018). In 2017, the San Joaquin Valley Region counties accounted for approximately 55% ($32.4 million) of the agricultural produce (by value) in California. Southern California counties accounted for approximately 10% ($5.8 million) followed by Sacramento Valley and Delta counties at 7% ($4.1 million) and 6.5% ($3.8 million).

Table Q.1-22 summarizes farm and farm tenure characteristics by region in 2017.

Table Q.1-22. 2012 Farm and Farm Tenure Characteristics by Region

	Trinity River	Sacramento Valley	San Joaquin Valley	Delta	San Francisco Bay Area	Central Coast	Southern California
Number of farms	1,298	13,185	21,744	7,405	3,768	4,263	13,686
Median farm size (acres)	100	520	342	125	88	60	36
Land in farms (acres)	769,545	3,494,595	8,364,366	2,029,450	1,265,414	2,039,913	1,076,013
Total cropland (acres)	31,629	1,353,147	4,399,483	1,146,722	160,278	387,701	501,115
Irrigated land (acres)	27,894	1,205,320	3,278,506	959,463	84,431	178,331	347,768
Full owners	933	10,206	16,440	5,332	3,005	3,238	11,928
Part owners	214	1,736	3,353	1,122	373	408	610
Tenants	151	1,243	1,951	951	390	617	1,148

Source: USDA 2014

In response to changes in CVP and SWP water operations, growers could idle fields or increase agricultural production. Table Q.1-23 presents key regional economics for the crop sectors that would be impacted by changes in CVP and SWP operation.

Table Q.1-23. Summary of 2017 Regional Economy for select farming sectors

Industry	Trinity River	Sacramento Valley	San Joaquin Valley	Delta	San Francisco Bay Area	Central Coast	Southern California
Grain Sector							
Employment (Jobs)	1	1,071	98	111	5	5	8
Output (thousand dollars)	$325	$578,734	$107,065	$87,921	$1,616	$3,196	$3,517
Labor Income (thousand dollars)	$17	$54,886	$10,165	$7,777	$103	$255	$162
Vegetables and melon farming							
Employment (Jobs)	35	1,106	6,985	2,086	1,712	3,161	5,024
Output (thousand dollars)	$4,677	$187,889	$1,945,862	$514,838	$205,374	$718,979	$794,853
Labor Income (thousand dollars)	$1,011	$62,321	$603,742	$149,781	$92,321	$237,809	$253,048
Fruit farming							
Employment (Jobs)	224	7,609	49,390	12,212	5,647	12,086	31,212
Output (thousand dollars)	$15,152	$518,285	$5,797,560	$1,288,296	$416,043	$1,108,040	$2,147,743
Labor Income (thousand dollars)	-$1,084	$150,944	$2,057,731	$379,949	$136,096	$418,661	$834,234
All other crop farming							
Employment (Jobs)	171	2,365	4,699	2,102	350	294	2,488
Output (thousand dollars)	$3,799	$80,074	$549,888	$154,284	$10,879	$13,165	$118,724
Labor Income (thousand dollars)	$669	$28,258	$200,606	$51,887	$5,856	$3,278	$45,944

Source: MIG 2018
All costs in 2017 dollars.
Employment is measured in number of jobs.
Income is the dollar value of total payroll for each industry includes employee compensation and proprietor income.
Output represents the dollar value of industry production.

Q.1.3 Commercial and Recreational Fisheries Economics

The commercial and recreational ocean salmon fisheries along the Southern Oregon/Northern California Coast (SONCC) are affected by the population of salmon that rely upon the Northern California rivers, including the Sacramento and San Joaquin rivers. Changes in CVP and SWP water operations would affect the flow patterns and water quality of the Sacramento and San Joaquin Rivers and the survivability of the salmon that use those rivers for habitat, as described in *Appendix O, Aquatic Resources Technical Appendix*. This technical appendix discusses the economic contributions of the Pacific Coast salmon fishery.

Management of the California ocean salmon fishery is a combined effort of the California Department of Fish and Wildlife (CDFW) and the Pacific Fishery Management Council (PFMC), a regional council of the National Oceanic and Atmospheric Administration (NOAA). CDFW manages salmon harvest from the shoreline to 3 nautical miles off the California coast. From 3 nautical miles to 200 nautical miles offshore is managed by PFMC. PFMC is responsible for developing the Pacific Coast Salmon Fishery Management Plan (FMP) that guides management of the ocean commercial and recreational fishery in California, Oregon, and Washington (PFMC 2014). The annual ocean salmon fishery regulations promote the maximum amount of harvest while ensuring that suitable population levels are maintained (NOAA 2014).

Q.1.3.1 *Commercial Salmon Fishery along the Southern Oregon and Northern California Coasts*

Ocean salmon fishing plays a large role in the overall California commercial ocean fishery industry. Chinook Salmon (*Oncorhynchus tshawytscha*) ranked within the top 10 commercially harvested ocean species in 7 of the last 10 years. In 2008 and 2009, commercial and recreational salmon fishing along the coast of California and portions of Oregon were restricted in response to low Sacramento River fall Chinook Salmon and Coho Salmon (*Oncorhynchus kisutch*) numbers.

The economic contribution of the California commercial ocean salmon fishery extends beyond the revenues received by fishermen. Supporting industries include fish processors, boat manufacturers, repair, and maintenance. The economic contribution of the commercial ocean salmon fishery to support industries can be estimated using Input-Output models. When the commercial fishery is reduced or absent, the net impact on local communities will depend on the economic base of the community and on people's responses to the reduced fishery. These economic contributions are estimated by PFMC using the Input-Output model for Pacific Coast Fisheries (IO-PAC). As summarized in Table Q.1-24, economic impacts from reduced commercial ocean salmon fisheries were estimated by management area.

Q.1-24. Estimated Economic Impacts to Commercial Fishery Support Industries by Management Area (in 2018 Dollars)

Year	Klamath Management Zone, Oregon (in thousand dollars)[1]	Klamath Management Zone, California (in thousand dollars)[2]	Fort Bragg (in thousand dollars)	San Francisco (in thousand dollars)	Monterey (in thousand dollars)	Total (in thousand dollars)
2001-2005	$1,068	$945	$7,145	$17,221	$4,645	$31,024
2011	$317	$260	$1,593	$3,203	$598	$5,971
2012	$271	$490	$4,358	$2,761	$672	$8,552
2013	$368	$718	$4,004	$12,675	$3,830	$21,595
2014	$640	$1,901	$10,448	$20,269	$2,057	$35,315
2015	$1,239	$892	$6,678	$9,893	$582	$19,284
2016	$541	$402	$4,607	$4,826	$889	$11,265
2017	$136	$60	$1,643	$4,733	$993	$7,565
2013	$84	$39	$379	$5,486	$1,211	$7,199
2018[3]	$372	$707	$920	$8,499	$1,103	$11,601

Source: PFMC 2019

[1] Klamath Management Zone, Oregon represents the area from Humbug Mountain to the Oregon-California Border, and includes landings at the Brookings port and season length and quota values for the entire area including Chetco River Ocean Terminal Area between Twin Rocks and the Oregon-California border. Data for Brookings, Oregon include values from landings outside of the Klamath Management Zone.

[2] Klamath Management Zone, California represents the area from Oregon-California Border to Humboldt South Jetty and includes landings at the Crescent City and Eureka ports.

[3] Preliminary prices

Q.1.3.2 *Recreational Salmon Fishery along the Southern Oregon and Northern California Coasts*

PFMC and CDFW also manage the recreational (ocean sport) fishery. The economic contribution of the ocean sport salmon fishery can be estimated using Input-Output models. Economic contributions are estimated by PFMC using IO-PAC, as summarized in Table Q.1-25.

Q.1-25. Estimated Economic Impacts to Recreation Fisheries Support Industries by Management Area

Year	Klamath Management Zone, Oregon (in thousand dollars)[1]	Klamath Management Zone, California (in thousand dollars)[2]	Fort Bragg (in thousand dollars)	San Francisco (in thousand dollars)	Monterey (in thousand dollars)	Total (in thousand dollars)
2001-2005	$803	$1,073	$2,163	$9,620	$3,874	$17,533
2011	$351	$531	$766	$2,932	$1,215	$5,795
2012	$365	$1,746	$2,158	$7,323	$3,705	$15,297
2013	$1,106	$3,731	$2,174	$12,906	$6,056	$25,973
2014	$1,226	$3,614	$2,616	$15,537	$3,844	$26,837
2015	$1,027	$2,548	$2,622	$12,553	$3,590	$22,340
2016	$525	$1,156	$1,739	$10,758	$1,875	$16,053
2017	$244	$1,123	$1,351	$9,901	$949	$13,568
2013	$117	$0	$623	$12,389	$1,719	$14,848
2018[3]	$408	$896	$1,478	$15,162	$1,653	$19,597

Source: PFMC 2019
All costs in 2018 dollars.
[1] Klamath Management Zone, Oregon represents the area from Humbug Mountain to the Oregon-California Border, and includes landings at the Brookings port and season length and quota values for the entire area including Chetco River Ocean Terminal Area between Twin Rocks and the Oregon-California border. Data for Brookings, Oregon include values from landings outside of the Klamath Management Zone.
[2] Klamath Management Zone, California represents the area from Oregon-California Border to Humboldt South Jetty and includes landings at the Crescent City and Eureka ports.
[3] Preliminary prices

Q.2 Evaluation of Alternatives

This section presents the evaluation of environmental consequences associated with the CVP/SWP alternatives and the No Action Alternative.

Q.2.1 Methods and Tools

The regional economic effects include changes to employment, income, or output that could result from implementation of the project alternatives. The analysis uses quantitative and qualitative methods to evaluate potential regional economic effects.

Q.2.1.1 *Municipal and Industrial Water Supply Effects*

Regional economic effects from changes to M&I water supply was evaluated quantitatively using California Water Economics Spreadsheet Tool (CWEST) and IMPLAN models.

CWEST is a regional model that considers the economic costs to M&I water users including the cost of CVP and SWP water supplies, regional surface water supplies (including recycled water), conveyance costs, shortage costs, and changes in groundwater pumping costs. The model operates on an annual time step. Annual supplies are calculated for each water user based upon annual CVP and SWP water supplies, local surface water and groundwater supplies, surface water and groundwater storage, wastewater effluent and stormwater recycling water treatment, and desalination water treatment. The amount of supplies and costs are based upon information presented in 2010 Urban Water Management Plans developed by the CVP and SWP contractors. Attachment 2, *CWEST Model Documentation*, presents detailed discussion on the CWEST Model and Modeling Methodology.

The CalSim II hydrologic model simulated CVP and SWP water supply deliveries in 2030, which were input to the CWEST model for the 81-year hydrologic period. The CWEST model analyzes the changes in annual conditions over the 81-year long-term condition and averages annual costs for each alternative over the 81-year long-term condition. The CWEST model evaluates responses to changes in CVP and SWP water supplies for different water year types (wet, above normal, below normal, dry and critical dry year types).

The CWEST model is intended to minimize the cost for the water providers and end-users to meet 2030 water demand. In years when the combination of average existing water supplies (either for the wetter or drier conditions) is greater than the 2030 water demand, the CWEST model assumes any overage water amount would be placed into surface water or groundwater storage, if available. If storage is not available, groundwater pumping would be reduced so that the other available supplies can be utilized. The CWEST model assumes that local surface water, other imported water supplies, recycled water use, and desalinated water use would not be reduced. However, during wet years, total CVP and SWP water deliveries may not be delivered if groundwater pumping is reduced to zero and local storage facilities are full.

In years when annual supplies are less than the 2030 water demand, the model assumes that water users with local surface water and groundwater storage would first fully utilize those supplies and participate in temporary water transfers or a similar annual option if necessary. If shortage and transfer costs occur frequently, the model can select to purchase additional fixed-yield supplies, such as additional recycled water, desalination water treatment, or groundwater capacity. The model optimizes these long-term supply decisions to provide the lowest-cost water supply portfolio to meet 2030 demands throughout the 81-year hydrologic period.

The lowest-cost water supply portfolio estimated using CWEST is inputted into the IMPLAN model to analyze changes in regional economics. IMPLAN is an input-output software and data package, which calculates the economic impacts of a change in value of production. Attachment 1, *IMPLAN Modeling Documentation,* presents detailed discussion on the IMPLAN Model and Modeling Methodology. As described in detail in Attachment 1, *IMPLAN Modeling Documentation*, this analysis assumes that increased costs of water supply estimated from CWEST could be passed on to regional water users. Consequently, regional water users would reduce their spending by an amount equal to the water supply cost increase. This reduction in spending is distributed over regional industries according to coefficients provided by IMPLAN. It should be noted that this is a conservative assumption and water agencies may not pass on cost increases to water customers and could find other ways to fund water supply cost increase. If water supply cost increases are not passed on to water customers, this would result in lower impacts to the regional economy.

IMPLAN estimates effects of various economic measures, including employment, labor income, and total value output. Employment is the number of jobs, including full-time, part-time, and seasonal. Labor income consists of employee compensation and proprietor’s income. Value of output is the dollar value of production. IMPLAN estimates effects on an annual basis. The 2017 IMPLAN data sets were used for this analysis.

Q.2.1.2 *Agricultural Water Supply Effects*

Regional economic effects from changes to agricultural water supply were evaluated quantitatively using the Statewide Agricultural Production (SWAP) and IMPLAN models. SWAP is a regional model of irrigated agricultural production and economics that simulates the decisions of producers (farmers) in the Central Valley Region (includes Sacramento River and San Joaquin River Regions). Attachment 3, *SWAP Model Documentation*, presents detailed discussion on the SWAP Model and Modeling Methodology. The model selects the crops, water supplies, and other inputs that maximize profit subject to constraints on water and land, and subject to economic conditions regarding prices, yields, and costs. The SWAP model incorporates CVP and SWP water supplies, other local water supplies represented in the CalSim II model, and groundwater. As water supply conditions change within a SWAP subregion (i.e., the quantity of available project water supply declines), the model optimizes production by adjusting the crop mix, water sources and quantities used, and other inputs. The model also fallows land when that appears to be the most cost-effective response to resource conditions. The analysis only reduces groundwater withdrawals based upon an optimization of agricultural production costs. The analysis does not restrict groundwater withdrawals based upon groundwater overdraft or groundwater quality conditions.

Changes to agricultural production estimated using SWAP are inputted into the IMPLAN model to analyze changes in regional economics. IMPLAN is used to estimate the regional effects of crop production in the regions. Direct, indirect, and induced effects from an industry change are analyzed. Direct effects would occur in the agricultural sectors. Expenditures of affected regional industries, including purchases of inputs, cause indirect effects. Expenditure of household income causes induced effects. Attachment 1, *IMPLAN Modeling Documentation,* presents detailed discussion on the IMPLAN Model and Modeling Methodology.

Regional economic effects from changes to agricultural water supply to regions outside the SWAP model area of analysis (i.e. Delta Region, San Francisco Bay Area Region, Central Coasts Region and Southern California Region) were evaluated qualitatively.

Q.2.1.3 *Fisheries Effects*

Changes in CVP and SWP operations under the alternatives could change the salmon population. Commercial, sport, and tribal fishing primarily rely upon Fall–Run Chinook Salmon because the populations of other runs of salmon are substantially lower. Specific population changes for Fall–Run Chinook Salmon are not projected in this EIS. Therefore, this appendix presents a qualitative analysis of potential changes in socioeconomic factors under the alternatives compared to the No Action Alternative.

Q.2.1.4 *Construction and Habitat Restoration Effects*

Construction actions under the action alternatives would create jobs and generate additional economic activity within the region during the period of construction. Habitat restoration action under the action alternatives have the potential to remove some land from agriculture permanently. These impacts are evaluated qualitatively.

Q.2.2 No Action Alternative

The No Action Alternative discussed in this chapter analyzes CVP/SWP water supplies under existing conditions and future water demands (i.e. 2030 water demands). Under the No Action Alternative, there would be an increase in demand due to population growth but CVP/SWP water supplies would not change. For M&I contractors, this could result in an increase in water supply costs as they would need develop alternate water supplies to meet their increase in demand. For agricultural contractors, this could result in an increase in groundwater pumping.

Q.2.3 Alternative 1

Q.2.3.1 *Project-Level Effects*

Q.2.3.1.1 Potential M&I-related changes to the regional economies

Trinity River Region

There are no M&I CVP or SWP water service contractors in the Trinity River Region. Therefore, there would be no changes to CVP and SWP water supplies in the Trinity River Region. Consequently, there would be no impacts to regional economy related to changes in M&I water supply in the Trinity River Region under Alternative 1.

Sacramento River Region

Alternative 1 would increase water supplies to M&I water contractors in the Sacramento River Region on average by approximately 2,000 acre-feet per year (AFY) compared to the No Action Alternative. These increases in CVP and SWP water supplies would help meet 2030 water demands without development of other alternative water supplies. Additionally, increased water supplies under Alternative 1 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-1 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $127,000 under Alternative 1 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions under Alternative 1. Reduced reliance on groundwater is also expected to decrease groundwater pumping costs compared to the No Action Alternative. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 1, there would be a reduction in water supply costs and consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposal income and could result in more spending in the regional economy.

Table Q.2-1. Sacramento River Region M&I Water Supply Costs under Alternative 1

	Alternative 1 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	2
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$42
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	$0
Transfer Costs (thousand dollars)[7]	-$108
Shortage Costs (thousand dollars)[8]	$0

	Alternative 1 compared to No Action Alternative
Groundwater Pumping Costs (thousand dollars)[9]	-$34
Excess Water Costs (thousand dollars)[10]	-$27
Average Annual Changes in Water Supply Costs (thousand dollars)	-$127

All costs in 2018 dollars
TAF = thousand acre-feet
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-2 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result in an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-2. Sacramento River Region M&I Water Supply related Regional Economic Effects under Alternative 1 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	$71	$193
Mining	0	$12	$87
Construction	0	$918	$2,301
Manufacturing	0	$141	$1,210
TIPU	0	$1,478	$6,015
Trade	<1	$4,440	$12,786
Service	<1	$13,238	$50,083
Government	<1	$8,532	$10,889
Total	<1	$28,828	$83,564

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

San Joaquin River Region

Alternative 1 would increase water supplies to M&I water contractors in the San Joaquin River Region on average by approximately 21,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, San Joaquin River Region M&I contractors would not need to invest in alternate water supplies under Alternative 1, which is 1,000 acre-feet less than the alternative supplies developed under No Action Alternative. Additionally, increased water supplies under Alternative 1 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-3 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $490,000 under Alternative 1 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions and development of alternate water supplies. Reduced reliance on groundwater is also expected to decrease groundwater pumping costs under Alternative 1. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 1, water supply costs would reduce compared to the No Action Alternative and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposal income and could result in more spending in the regional economy.

Table Q.2-4 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-3. San Joaquin River Region M&I Water Supply Costs under the Alternative 1 compared to the No Action Alternative

	Alternative 1 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	21
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$1,976
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	-1
Annualized Alternate Supply Costs (thousand dollars)[4]	-$267
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	-$4
Transfer Costs (thousand dollars)[7]	-$307
Shortage Costs (thousand dollars)[8]	-$3
Groundwater Pumping Costs (thousand dollars)[9]	-$74
Excess Water Costs (thousand dollars)[10]	-$1,812
Average Annual Changes in Water Supply Costs (thousand dollars)	-$490

All costs in 2018 dollars

[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors

[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates

[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.

[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.

[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.

[6] Loss of revenue from retail water sales.

[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable

[8] Estimated consumer surplus loss to water shortages

[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.

[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-4. San Joaquin River Region M&I Water Supply related Regional Economic Effects under Alternative 1 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars	Output (in dollars)
Agriculture	0	$764	$2,199
Mining	0	$138	$477
Construction	0	$1,969	$5,440
Manufacturing	0	$1,214	$11,651
TIPU	<1	$6,293	$21,722
Trade	<1	$17,926	$49,731
Service	1	$41,916	$167,096
Government	<1	$19,578	$26,531
Total	**2**	**$89,798**	**$284,848**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Bay-Delta Region

Alternative 1 would increase water supplies to M&I water contractors in the Bay-Delta Region on average by approximately 200 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, Bay-Delta Region M&I contractors would not need to invest in alternate water supplies. Additionally, increased water supplies under Alternative 1 would reduce reliance on water transfers in the region. There would also be some reduction in groundwater pumping in the region under Alternative 1.

Table Q.2-5 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $755,000 under Alternative 1 compared to the No Action Alternative. Cost reductions are mostly because of transfer cost reductions. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 1, there would be reduction in water supply costs compared to the No Action Alternative, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-6 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-5. Bay-Delta Region M&I Water Supply Costs under the Alternative 1 compared to the No Action Alternative

	Alternative 1 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	<1
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$29
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	$321
Lost Water Sales Revenues (thousand dollars)[6]	-$92
Transfer Costs (thousand dollars)[7]	-$1,001
Shortage Costs (thousand dollars)[8]	-$31
Groundwater Pumping Costs (thousand dollars)[9]	$1
Excess Water Costs (thousand dollars)[10]	$18
Average Annual Changes in Water Supply Costs (thousand dollars)	-$755

All costs in 2018 dollars

[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors

[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates

[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.

[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.

[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.

[6] Loss of revenue from retail water sales.

[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable

[8] Estimated consumer surplus loss to water shortages

[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.

[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-6. Bay-Delta Region M&I Water Supply related Regional Economic Effects under Alternative 1 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	$443	$1,171
Mining	0	$33	$143
Construction	<1	$3,876	$9,712
Manufacturing	0	$2,206	$21,075
TIPU	<1	$10,399	$43,154
Trade	<1	$25,465	$68,783
Service	2	$83,665	$305,881
Government	<1	$49,067	$60,676
Total	**3**	**$175,153**	**$510,596**

All costs in 2018 dollars

TIPU = Transportation, Information, Power, and Utilities

San Francisco Bay Area Region

Alternative 1 would increase water supplies to M&I water contractors in the San Francisco Bay Area Region on average by approximately 32,000 AFY compared to the No Action Alternative. Though there is an overall increase in CVP and SWP supplies, it is estimated that there would be reductions in CVP and SWP supplies during some water year types. Therefore, contractors would need to invest in alternate water supply projects such as desalination for shortage years. This would result in an increase in alternative water supply costs; however, the overall increase in CVP and SWP supplies would result in a reduction in water transfers and groundwater pumping in the region.

Table Q.2-7 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $3.1 million under Alternative 1 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions and lost water sales revenue under Alternative 1. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 1, there would be reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-8 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area may increase spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-7. San Francisco Bay Area Region M&I Water Supply Costs under the Alternative 1 compared to the No Action Alternative

	Alternative 1 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	32
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$1,156
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	7
Annualized Alternate Supply Costs (thousand dollars)[4]	$4,251
Water Storage Costs (thousand dollars)[5]	$1,026
Lost Water Sales Revenues (thousand dollars)[6]	-$2,339
Transfer Costs (thousand dollars)[7]	-$5,793
Shortage Costs (thousand dollars)[8]	-$841
Groundwater Pumping Costs (thousand dollars)[9]	-$570
Excess Water Costs (thousand dollars)[10]	-$89
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$3,199**

All costs in 2018 dollars

[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors

[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates

[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.

[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.

[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-8. San Francisco Bay Area Region M&I Water Supply related Regional Economic Effects under Alternative 1 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	$1,141	$2,263
Mining	0	$137	$874
Construction	<1	$21,610	$49,684
Manufacturing	<1	$12,308	$67,179
TIPU	<1	$51,566	$169,664
Trade	2	$108,524	$255,558
Service	6	$333,997	$1,052,677
Government	2	$256,545	$289,800
Total	**10**	**$785,828**	**$1,887,698**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Central Coast Region

Alternative 1 would increase water supplies to M&I water contractors in the Central Coast Region on average by approximately 3,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, Central Coast Region M&I contractors would not need to invest in alternate water supplies under Alternative 1.

Table Q.2-9 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to increase by approximately $37,000 under Alternative 1 compared to the No Action Alternative. Cost increases are primarily due to the increase in delivery costs for the increased CVP and SWP water supplies to the region. Water supply cost increases are passed on to water customers through water rate increases. This would result in a decrease in disposal income and could result in less spending in the regional economy.

Table Q.2-10 summarizes the regional economic effects to employment, labor income, and revenue from increased water supply costs and decreased disposable income to CVP and SWP M&I contractors. Decreases in disposable income in the area would result in spending decreases in the region. Decreases in spending would primarily occur in the services sector.

Table Q.2-9. Central Coast Region M&I Water Supply Costs Under the Alternative 1 Compared to the No Action Alternative

	Alternative 1 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	3
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$535
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	$0
Transfer Costs (thousand dollars)[7]	$25
Shortage Costs (thousand dollars)[8]	$0
Groundwater Pumping Costs (thousand dollars)[9]	$40
Excess Water Costs (thousand dollars)[10]	-$562
Average Annual Changes in Water Supply Costs (thousand dollars)	**$37**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-10. Central Coast Region M&I Water Supply related Regional Economic Effects under Alternative 1 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	-$31	-$69
Mining	0	-$28	-$102
Construction	0	-$262	-$666
Manufacturing	0	(-$32	-$381
TIPU	0	-$477	-$1,877
Trade	0	-$1,546	-$3,966
Service	<1 job lost	-$4,906	-$17,257
Government	0	-$2,958	-$3,655
Total	<1 job lost	-$10,240	-$27,973

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Southern California Region

Alternative 1 would increase water supplies to M&I water contractors in the Southern California Region on average by approximately 263,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, Southern California Region M&I contractors would not need to invest in alternate water supplies under Alternative 1. Additionally, increased water supplies under Alternative 1 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-11 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $25.6 million under Alternative 1 compared to the No Action Alternative. Cost reductions are mostly due to reduction in groundwater pumping and increased reliability of water supplies under Alternative 1. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 1, there would be a reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This could result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-12 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-11. Southern California Region M&I Water Supply Costs Under the Alternative 1 compared to the No Action Alternative

	Alternative 1 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	263
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$38,019
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	-58
Annualized Alternate Supply Costs (thousand dollars)[4]	-$21,299
Water Storage Costs (thousand dollars)[5]	-$393
Lost Water Sales Revenues (thousand dollars)[6]	-$7,825
Transfer Costs (thousand dollars)[7]	-$4,088
Shortage Costs (thousand dollars)[8]	-$8,984
Groundwater Pumping Costs (thousand dollars)[9]	-$19,126
Excess Water Costs (thousand dollars)[10]	-$1,886
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$25,583**

All costs in 2018 dollars

[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors

[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates

[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.

[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.

[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.

[6] Loss of revenue from retail water sales.

[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable

[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-12. Southern California Region M&I Water Supply related Regional Economic Effects under Alternative 1 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	<1	$14,522	$38,948
Mining	<1	$6,801	$25,630
Construction	2	$126,021	$331,500
Manufacturing	2	$173,348	$1,198,642
TIPU	6	$490,815	$1,865,251
Trade	18	$863,324	$2,297,933
Service	64	$3,182,368	$10,179,839
Government	12	$1,375,786	$1,721,235
Total	104	$6,232,986	$17,658,979

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Q.2.3.1.2 Potential agriculture-related changes to the regional economy

Trinity River Region

There are no agricultural lands irrigated with CVP and SWP water supplies in the Trinity River Region. Therefore, there would be no changes in irrigated lands under Alternative 1. Consequently, there would be no impacts to regional economy from changes to water supply to agricultural contractors in the Trinity River Region under Alternative 1.

Sacramento River Region

Alternative 1 is expected to increase average annual agricultural water supply deliveries by 25,000 AFY during average conditions and 26,000 AFY under dry conditions. As summarized in Table Q.2-13, this increase in CVP or SWP deliveries could reduce groundwater usage in the Sacramento River Region under dry conditions. Consequently, operation costs associated with crop production would be lower and would result in increased profitability to the growers. Increased deliveries in the Sacramento River Region are very small and are not expected to change irrigated acreage or agricultural revenue in the region. Therefore, the regional economic effects from water supply increases would be minimal.

Table Q.2-13. Sacramento River Region Agricultural Water Supply Costs under the Alternative 1 compared to the No Action Alternative

	Alternative 1 compared to No Action Alternative
Average Conditions[1]	
Average Annual CVP/SWP Deliveries (TAF)	25
Annual Groundwater Pumping (TAF)	0
Groundwater Pumping Cost (million dollars)	$0
Irrigated Acreage (thousand acres)	0
Agricultural Revenue (million dollars)	$0
Dry Conditions[2]	
Average Annual CVP/SWP Deliveries (TAF)	26
Annual Groundwater Pumping (TAF)	-21
Groundwater Pumping Cost (million dollars)	-$2
Irrigated Acreage (thousand acres)	0
Agricultural Revenue (million dollars)	$0

All costs in 2018 dollars
[1] Average Conditions refers to an average of all year types in the 81-year simulation period.
[2] Dry Conditions refer to an average of dry years only, using Sacramento River Index.

San Joaquin River Region

Alternative 1 is expected to increase average annual agricultural water supply deliveries by 309,000 AFY during average conditions and by 195,000 AFY during dry conditions in the San Joaquin River Region. Therefore, Alternative 1 reduces the occurrences of water supply shortages to agricultural contractors during all year types. Consequently, agricultural contractors would reduce their reliance on groundwater supplies in lieu of increased surface water deliveries. Table Q.2-14 summarizes the projected groundwater pumping volumes and groundwater pumping costs under Alternative 1 compared to the No Action Alternative. Overall groundwater pumping volumes under Alternative 1 would be lower than under the No Action Alternative because of increased surface water deliveries. Reduction in groundwater pumping would result in reduced groundwater pumping costs. Consequently, operation costs associated with crop production would be lower and could result in increased profitability to the growers.

As summarized in Table Q.2-14, SWAP model estimates an increase in irrigated acreage under Alternative 1. This increase in irrigated acreage would result in increased agricultural revenues for the growers as summarized in Table Q.2-14. Additionally, this would affect businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing. Table Q.2-15 and Table Q.2-16 summarizes the regional economic effects on employment, labor income, and revenue from increased CVP and SWP deliveries to agricultural contractors. Regional economic effects were analyzed by distributing revenue changes under Grain, Field, Forage, Vegetable, and Fruit Farming sectors.

Table Q.2-14. San Joaquin River Region Agricultural Water Supply Costs under the Alternative 1 compared to the No Action Alternative

	Alternative 1 compared to No Action Alternative
Average Conditions[1]	
Average Annual CVP/SWP Deliveries (TAF)	309
Annual Groundwater Pumping (TAF)	-231
Groundwater Pumping Cost (million dollars)	-$50
Irrigated Acreage (thousand acres)	3
Agricultural Revenue (million dollars)	$10
Dry Conditions[2]	
Average Annual CVP/SWP Deliveries (TAF)	195
Annual Groundwater Pumping (TAF)	-111
Groundwater Pumping Cost (million dollars)	-$30
Irrigated Acreage (thousand acres)	24
Agricultural Revenue (million dollars)	$50

All costs in 2018 dollars
Note: Average Conditions refers to an average of all year types in the 81-year simulation period. Dry Conditions refer to an average of dry years only, using Sacramento River Index.

Table Q.2-15. San Joaquin River Region Agricultural Water Supply Related Regional Economic Effects under Alternative 1 compared to the No Action Alternative under Average Conditions

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	105	$4,511,275	$11,620,587
Mining	<1	$10,693	$44,763
Construction	1	$59,627	$162,427
Manufacturing	<1	$45,214	$483,685
TIPU	2	$151,601	$431,678
Trade	6	$262,280	$787,861
Service	21	$895,936	$2,924,692
Government	<1	$64,076	$184,607
Total	136	$6,000,702	$16,640,300

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Table Q.2-16. San Joaquin River Region Agricultural Water Supply Related Regional Economic Effects under Alternative 1 compared to the No Action Alternative under Dry Conditions

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	330	$17,494,773	$57,553,572
Mining	<1	$80,465	$351,341
Construction	5	$298,805	$813,170
Manufacturing	3	$267,379	$2,973,589
TIPU	12	$834,642	$2,319,951
Trade	29	$1,342,282	$4,159,685

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Service	98	$4,195,798	$14,121,972
Government	4	$334,992	$964,803
Total	482	$24,849,136	$83,258,083

All costs in 2018 dollars

Bay-Delta Region

Alternative 1 is expected to increase average annual agricultural water supply deliveries in the Bay-Delta Region. Effects from increased water supply to agricultural contractors in the Bay-Delta Region are evaluated under Sacramento and San Joaquin River Region analysis. Increases in agricultural water supply in the region could result in an increase in irrigated acreage and agricultural revenues in the region. This would have a beneficial impact to the region economy as it would increase employment, labor income, and output for sectors that support farming activities.

San Francisco Bay Area Region

Alternative 1 is expected to increase average annual agricultural water supply deliveries in the San Francisco Bay Area Region by 9,000 AFY under average conditions and by 6,000 AFY under dry conditions. Increase in agricultural water supply in the region could result in an increase in irrigated acreage and agricultural revenues in the region. This would have a beneficial impact to the region economy.

Central Coast Region

There are no agricultural lands irrigated with CVP and SWP water supplies in the Central Coast Region. Therefore, there would be no changes in irrigated lands under Alternative 1. Consequently, there would be no impacts to regional economy from changes in deliveries to agricultural contractors in the Central Coast Region under Alternative 1.

Southern California Region

Alternative 1 is expected to increase average annual agricultural water supply deliveries in the Southern California Region by 1,000 AFY under average conditions and by 500 AFY under dry conditions. Increase in agricultural water supply in the region could result in an increase in irrigated acreage and agricultural revenues in the region. This would have a beneficial impact to the region economy.

Q.2.3.1.3 Potential fisheries-related changes to the regional economy

The commercial and recreational (ocean sports) ocean salmon fishery along the SONCC are affected by the population of salmon that rely upon the Northern California rivers, including the Sacramento and San Joaquin rivers. Appendix O, *Aquatic Resources Technical Appendix* describes changes in CVP and SWP water operations would affect the flow patterns and water quality of the Sacramento and San Joaquin rivers, and the survivability of the salmon that use those rivers for habitat. Appendix O*, Aquatic Resources Technical Appendix* also describes that the population of salmon along the SONCC would be higher under all action alternatives compared to No Action Alternative. Increase in salmon population could potentially increase commercial and recreational ocean salmon harvest. Increase in commercial ocean salmon harvest would increase revenues received by fisherman. Ocean fisheries support industries such as fish processors, boat manufacturers, repair and maintenance would also see an increase in revenue. Overall increased fisheries under Alternative 1 would be beneficial to the regional economy.

Q.2.3.2 *Program-Level effects*

Q.2.3.3 Potential changes to the regional economy

Alternative 1 includes several program actions that would require construction, such as American River Drought Temperature Facility Improvements, Tracy Fish Collection Facility Improvements, Skinner Fish Facility Improvements, Delta Fish Species Conservation Hatchery, Upper Sacramento Small Screen Program, Upper Sacramento Cold Water Management Tools, and Juvenile Trap and Haul Programs in the Sacramento River. Construction could occur in Shasta, Sacramento, San Joaquin, and Contra Costa Counties. Construction activities associated with program actions would temporarily increase construction-related employment and spending in the regions with construction sites. Construction would temporarily benefit the regional economy by increasing employment, labor income, and revenue during the construction period.

Alternative 1 would also include habitat restoration projects along the upper reaches of Sacramento River, American River, Stanislaus River, and Lower San Joaquin River and an additional 8,000 acres of tidal habitat restoration projects. Some of these habitat restoration projects could remove agricultural lands or grazing lands out of production. These impacts could reduce irrigated acreage and agricultural revenues which would adversely affect growers and businesses and individuals who support farming activities. Tidal restoration projects would mainly occur in the Delta Region and could improve recreational fishing and day use opportunities in the long-term. These impacts could be beneficial to the region as it could increase visitors from within and outside the region. Visitors from outside the region would generate new economic activity in the region due to increased spending in the region. This would be beneficial to the regional economy.

Q.2.4 Alternative 2

Q.2.4.1 *Project-Level effects*

Q.2.4.1.1 Potential M&I-related changes to the regional economy

Trinity River Region

There are no M&I CVP or SWP water service contractors in the Trinity River Region. Therefore, there would be no changes to CVP and SWP water supplies in the Trinity River Region. Consequently, there would be no impacts to regional economy related to M&I water supplies in the Trinity River Region under Alternative 2.

Sacramento River Region

Alternative 2 would increase water supplies to M&I water contractors in the Sacramento River Region on average by approximately 2,000 AFY compared to the No Action Alternative. These increases in CVP and SWP water supplies would help meet 2030 water demands without development of other alternative water supplies. Additionally, increased water supplies under Alternative 2 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-17 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $60,000 under Alternative 2 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions under Alternative 2. Reduced reliance on groundwater is also expected to decrease groundwater pumping costs. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 2, there would be a reduction in water supply costs compared to the No Action Alternative, and consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-18 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the restaurant sector.

Table Q.2-17. Sacramento River Region M&I Water Supply Costs Under the Alternative 2 Compared to the No Action Alternative

	Alternative 2 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	2
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$43
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	$0
Transfer Costs (thousand dollars)[7]	-$44
Shortage Costs (thousand dollars)[8]	$0
Groundwater Pumping Costs (thousand dollars)[9]	-$28
Excess Water Costs (thousand dollars)[10]	-$31
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$60**

All costs in 2018 dollars

[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors

[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates

[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.

[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.

[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.

[6] Loss of revenue from retail water sales.

[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable

[8] Estimated consumer surplus loss to water shortages

[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.

[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-18. Sacramento River Region M&I Water Supply related Regional Economic Effects Under Alternative 2 Compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	$33	$91
Mining	0	$5	$41
Construction	0	$432	$1,084
Manufacturing	0	$66	$570
TIPU	0	$696	$2,833
Trade	<1	$2,091	$6,023
Service	<1	$6,236	$23,592
Government	0	$4,019	$5,130
Total	**<1**	**$13,580**	**$39,364**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

San Joaquin River Region

Alternative 2 would increase water supplies to M&I water contractors in the San Joaquin River Region on average by approximately 50,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, San Joaquin River Region M&I contractors would not need to invest in alternate water supplies under Alternative 2, which is 1,000 AF less than the alternative supplies developed under No Action Alternative. Additionally, increased water supplies under Alternative 2 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-19 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $4.1 million under Alternative 2 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions and development of alternate water supplies under Alternative 2. Reduced reliance on groundwater is also expected to decrease groundwater pumping costs under Alternative 2 compared to the No Action Alternative. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 2, water supply costs would be reduced, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposal income and could result in more spending in the regional economy.

Table Q.2-20 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the restaurant sector.

Table Q.2-19. San Joaquin River Region M&I Water Supply Costs under the Alternative 2 compared to the No Action Alternative

	Alternative 2 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	50
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$4,706
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	-1
Annualized Alternate Supply Costs (thousand dollars)[4]	-$286
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	-$38
Transfer Costs (thousand dollars)[7]	-$3,667
Shortage Costs (thousand dollars)[8]	-$14
Groundwater Pumping Costs (thousand dollars)[9]	-$1,248
Excess Water Costs (thousand dollars)[10]	-$3,465
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$4,012**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-20. San Joaquin River Region M&I Water Supply related Regional Economic Effects under Alternative 2 Compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	<1	$6,268	$18,052
Mining	0	$1,134	$3,914
Construction	<1	$16,162	$44,653
Manufacturing	<1	$9,965	$95,626
TIPU	<1	$51,648	$178,289
Trade	4	$147,130	$408,180
Service	9	$344,038	$1,371,485
Government	2	$160,692	$217,762
Total	16	$737,038	$2,337,960

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Bay-Delta Region

Alternative 2 would increase water supplies to M&I water contractors in the Bay-Delta Region on average by approximately 10,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, Bay-Delta Region M&I contractors would not need to invest in alternate water supplies under Alternative 2. Additionally, increased water supplies under Alternative 2 would reduce reliance on water transfers in the region.

Table Q.2-21 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $1.3 million under Alternative 2 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions under Alternative 2. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 2, there would be reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposal income and could result in more spending in the regional economy.

Table Q.2-22 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the restaurant sector.

Table Q.2-21. Bay-Delta Region M&I Water Supply Costs Under the Alternative 2 compared to the No Action Alternative

	Alternative 2 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	10
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$146
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	-$523
Lost Water Sales Revenues (thousand dollars)[6]	-$284
Transfer Costs (thousand dollars)[7]	-$485
Shortage Costs (thousand dollars)[8]	-$95
Groundwater Pumping Costs (thousand dollars)[9]	$50
Excess Water Costs (thousand dollars)[10]	-$147
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$1,338**

All costs in 2018 dollars

[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors

[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates

[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.

[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.

[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.

[6] Loss of revenue from retail water sales.

[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable

[8] Estimated consumer surplus loss to water shortages

[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-22. Bay-Delta Region M&I Water Supply related Regional Economic Effects under Alternative 2 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	$762	$2,011
Mining	0	$56	$246
Construction	<1	$6,656	$16,680
Manufacturing	0	$3,789	$36,197
TIPU	<1	$17,860	$74,117
Trade	1	$43,736	$118,134
Service	3	$143,694	$525,350
Government	1	$84,272	$104,211
Total	5	$300,825	$876,947

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

San Francisco Bay Area Region

Alternative 2 would increase water supplies to M&I water contractors in the San Francisco Bay Area Region on average by approximately 54,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, San Francisco Bay Area Region M&I contractors would not need to invest in alternate water supplies under Alternative 2. Additionally, increased water supplies under Alternative 2 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-23 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $9.1 million under Alternative 2 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions and lost water sales revenue. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 2, there would be a reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-24 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-23. San Francisco Bay Area Region M&I Water Supply Costs Under the Alternative 2 Compared to the No Action Alternative

	Alternative 2 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	54
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$1,960
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	-3
Annualized Alternate Supply Costs (thousand dollars)[4]	-$526
Water Storage Costs (thousand dollars)[5]	$252
Lost Water Sales Revenues (thousand dollars)[6]	-$2,891
Transfer Costs (thousand dollars)[7]	-$6,000
Shortage Costs (thousand dollars)[8]	-$965
Groundwater Pumping Costs (thousand dollars)[9]	-$411
Excess Water Costs (thousand dollars)[10]	-$449
Average Annual Changes in Water Supply Costs (thousand dollars)	-$9,029

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-24. San Francisco Bay Area Region M&I Water Supply related Regional Economic Effects under Alternative 2 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	<1	$3,903	$7,740
Mining	0	$468	$2,988
Construction	<1	$73,903	$169,911
Manufacturing	<1	$42,092	$229,741
TIPU	2	$176,347	$580,222
Trade	4	$371,134	$873,967
Service	20	$1,142,215	$3,599,988
Government	7	$877,342	$991,070
Total	35	$2,687,405	$6,455,628

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Central Coast Region

Alternative 2 would increase water supplies to M&I water contractors in the Central Coast Region on average by approximately 12,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, Central Coast Region M&I contractors would not need to invest in alternate water supplies under Alternative 2.

Table Q.2-25 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $417,000 under Alternative 2 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions and lost water sales revenue under Alternative 2. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 2, there would be a reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-26 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-25. Central Coast Region M&I Water Supply Costs under the Alternative 2 compared to the No Action Alternative

	Alternative 2 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	12
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$2,258
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	$0
Transfer Costs (thousand dollars)[7]	$0
Shortage Costs (thousand dollars)[8]	$0
Groundwater Pumping Costs (thousand dollars)[9]	-$884
Excess Water Costs (thousand dollars)[10]	-$1,791
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$417**

All costs in 2018 dollars

[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors

[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates

[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.

[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.

[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.

[6] Loss of revenue from retail water sales.

[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable

[8] Estimated consumer surplus loss to water shortages

[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-26. Central Coast Region M&I Water Supply related Regional Economic Effects under Alternative 2 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	$340	$769
Mining	0	$308	$1,140
Construction	0	$2,923	$7,418
Manufacturing	0	$361	$4,242
TIPU	<1	$5,316	$20,914
Trade	<1	$17,233	$44,204
Service	1	$54,679	$192,335
Government	<1	$32,966	$40,741
Total	**2**	**$114,126**	**$311,765**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Southern California Region

Alternative 2 would increase water supplies to M&I water contractors in the Southern California Region on average by approximately 518,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, Southern California Region M&I contractors would not need to invest in alternate water supplies under Alternative 2. Additionally, increased water supplies under Alternative 2 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-27 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $65.1 million under Alternative 2 compared to the No Action Alternative. Cost reductions are mostly due to reduction in groundwater pumping and increased reliability of water supplies. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 2, there would be a reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-28 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-27. Southern California Region M&I Water Supply Costs Under the Alternative 2 Compared to the No Action Alternative

	Alternative 2 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	518
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$74,165
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	-73
Annualized Alternate Supply Costs (thousand dollars)[4]	-$25,145
Water Storage Costs (thousand dollars)[5]	-$3,483
Lost Water Sales Revenues (thousand dollars)[6]	-$22,967
Transfer Costs (thousand dollars)[7]	-$13,813
Shortage Costs (thousand dollars)[8]	-$28,004
Groundwater Pumping Costs (thousand dollars)[9]	-$39,856
Excess Water Costs (thousand dollars)[10]	-$5,951
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$65,054**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-28. Southern California Region M&I Water Supply related Regional Economic Effects under Alternative 2 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	<1	$32,415	$86,935
Mining	<1	$15,181	$57,208
Construction	4	$281,290	$739,936
Manufacturing	5	$386,928	$2,675,474
TIPU	14	$1,095,541	$4,163,403
Trade	40	$1,927,014	$5,129,186
Service	142	$7,103,322	$22,722,285
Government	26	$3,070,873	$3,841,946
Total	233	$13,912,565	$39,416,373

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Q.2.4.1.2 Potential agriculture-related changes to the regional economy

Trinity River Region

There are no agricultural lands irrigated with CVP and SWP water supplies in the Trinity River Region. Therefore, there would be no changes in irrigated lands under Alternative 2. Consequently, there would be no impacts to regional economy in the Trinity River Region under Alternative 2.

Sacramento River Region

Alternative 2 is expected to increase average annual agricultural water supply deliveries by 24,000 AFY during average conditions and by 15,000 AFY during dry conditions. As summarized in Table Q.2-29, this increase in CVP or SWP deliveries could reduce groundwater usage in the Sacramento River Region under dry conditions. Consequently, operation costs associated with crop production would be lower and would result in increased profitability to the growers. Increased deliveries in the Sacramento River Region are very small and are not expected to change irrigated acreage or agricultural revenue in the region. Therefore, the regional economic effects from water supply increases would be minimal.

Table Q.2-29. Sacramento River Region Agricultural Water Supply Costs under the Alternative 2 compared to the No Action Alternative

	Alternative 2 compared to No Action Alternative
Average Conditions[1]	
Average Annual CVP/SWP Deliveries (TAF)	24
Annual Groundwater Pumping (TAF)	0
Groundwater Pumping Cost (million dollars)	$0
Irrigated Acreage (thousand acres)	0
Agricultural Revenue (million dollars)	$0
Dry Conditions[2]	
Average Annual CVP/SWP Deliveries (TAF)	15
Annual Groundwater Pumping (TAF)	-13
Groundwater Pumping Cost (million dollars)	-$1
Irrigated Acreage (thousand acres)	0
Agricultural Revenue (million dollars)	$0

All costs in 2018 dollars
Note: Average Conditions refers to an average of all year types in the 81-year simulation period
Dry Conditions refer to an average of dry years only, using Sacramento River Index.

San Joaquin River Region

Alternative 2 is expected to increase average annual agricultural water supply deliveries by 662,000 AFY during average conditions and by 432,000 AFY during dry conditions in the San Joaquin River Region. Therefore, Alternative 2 reduces the occurrences of water supply shortages to agricultural contractors during all year types. Consequently, agricultural contractors would reduce their reliance on groundwater supplies in lieu of increased surface water deliveries. Table Q.2-28 summarizes the projected groundwater pumping volumes and groundwater pumping costs under Alternative 2 compared to the No Action Alternative. Overall groundwater pumping volumes under Alternatives 2 would be lower than under the No Action Alternative due to increased surface water deliveries. Reduction in groundwater pumping would result in reduced groundwater pumping costs. Consequently, operation costs associated with crop production would be lower and could result in increased profitability to the growers.

As summarized in Table Q.2-30, SWAP model estimates an increase in irrigated acreage under Alternative 2 compared to the No Action Alternative. This increase in irrigated acreage would result in increased agricultural revenues for the growers as summarized in Table Q.2-30. Additionally, this would affect businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing. Table Q.2-31 and Table Q.2-32 summarizes the regional economic effects on employment, labor income, and revenue from increased CVP and SWP deliveries to agricultural contractors.

Table Q.2-30. San Joaquin River Region Agricultural Water Supply Costs under the Alternative 2 compared to the No Action Alternative

	Alternative 2 compared to No Action Alternative
Average Conditions[1]	
Average Annual CVP/SWP Deliveries (TAF)	662
Annual Groundwater Pumping (TAF)	-523
Groundwater Pumping Cost (million dollars)	-$106
Irrigated Acreage (thousand acres)	5
Agricultural Revenue (million dollars)	$14
Dry Conditions[2]	
Average Annual CVP/SWP Deliveries (TAF)	432
Annual Groundwater Pumping (TAF)	-222
Groundwater Pumping Cost (million dollars)	-$57
Irrigated Acreage (thousand acres)	56
Agricultural Revenue (million dollars)	$121

All costs in 2018 dollars
Note: Average Conditions refers to an average of all year types in the 81-year simulation period
Dry Conditions refer to an average of dry years only, using Sacramento River Index.

Table Q.2-31. San Joaquin River Region Agricultural Water Supply Related Regional Economic Effects under Alternative 2 compared to the No Action Alternative under Average Conditions

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	140	$6,050,353	$16,466,642
Mining	<1	$17,389	$73,980
Construction	1	$85,558	$232,988
Manufacturing	1	$67,413	$731,135
TIPU	3	$221,378	$626,709
Trade	9	$374,841	$1,134,787
Service	29	$1,259,684	$4,147,279
Government	1	$92,019	$264,944
Total	184	$8,168,634	$23,678,462

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Table Q.2-32. San Joaquin River Region Agricultural Water Supply Related Regional Economic Effects under Alternative 2 compared to the No Action Alternative under Dry Conditions

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	1087	$47,760,839	$141,319,845
Mining	2	$180,491	$781,873
Construction	12	$737,105	$2,006,678
Manufacturing	8	$620,888	$6,882,473
TIPU	28	$1,987,809	$5,585,191
Trade	73	$3,265,512	$9,996,170
Service	249	$10,723,949	$35,760,960
Government	9	$810,794	$2,333,691
Total	1467	$66,087,387	$204,666,881

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Bay-Delta Region

Alternative 2 is expected to increase average annual agricultural water supply deliveries in the Bay-Delta Region. Impacts from increased water supply to agricultural contractors in the Bay-Delta Region are evaluated under Sacramento and San Joaquin River Region analysis. Increase in agricultural water supply in the region could result in an increase in irrigated acreage and agricultural revenues in the region. This would have a beneficial impact to the regional economy as it would impact businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing.

San Francisco Bay Area Region

Alternative 2 is expected to increase average annual agricultural water supply deliveries in the San Francisco Bay Area Region by 15,000 AFY under average conditions and by 10,000 AFY under dry conditions. Increase in agricultural water supply in the region could result in an increase in irrigated acreage and agricultural revenues in the region. This would have a beneficial impact to the regional economy as it would impact businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing.

Central Coast Region

There are no agricultural lands irrigated with CVP and SWP water supplies in the Central Coast Region. Therefore, there would be no changes in irrigated lands under Alternative 2. Consequently, there would be no impacts to the regional economy in the Central Coast Region under Alternative 2.

Southern California Region

Alternative 2 is expected to increase average annual agricultural water supply deliveries in the Southern California Region by 2,000 AFY under average conditions and by 2,000 AFY under dry conditions. Increase in agricultural water supply in the region could result in an increase in irrigated acreage and agricultural revenues in the region. This would have a beneficial impact to the region economy as it would affect businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing.

Q.2.4.1.3 Potential fisheries-related changes to the regional economy

Under Alternative 2, population of salmon along the SONCC would be lower compared to the No Action Alternative. Decreases in salmon population could potentially decrease commercial and recreational ocean salmon harvest. This could have a detrimental impact to fishermen and other ocean fisheries support industries such as fish processors and boat manufacturers. Overall, decreased fisheries under Alternative 2 would be detrimental to the regional economy.

Q.2.4.2 *Program-Level effects*

Q.2.4.2.1 Potential changes to the regional economy

Alternative 2 does not have any components considered at a program level. Therefore, there would be no program level effects to the regional economy.

Q.2.5 Alternative 3

Q.2.5.1 *Project-Level effects*

Q.2.5.1.1 Potential M&I-related changes to the regional economy

Trinity River Region

There are no M&I CVP or SWP water service contractors in the Trinity River Region. Therefore, there would be no changes to CVP and SWP water supplies in the Trinity River Region. Consequently, there would be no impacts to regional economy in the Trinity River Region under Alternative 3.

Sacramento River Region

Alternative 3 would increase water supplies to M&I water contractors in the Sacramento River Region on average by approximately 2,000 AFY compared to the No Action Alternative. These increases in CVP and SWP water supplies would help meet 2030 water demands without development of other alternative water supplies. Additionally, increased water supplies under Alternative 3 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-33 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $50,000 under Alternative 3 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions. Reduced reliance on groundwater is also expected to decrease groundwater pumping costs under Alternative 3. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 3, there would be a reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-34 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-33. Sacramento River Region M&I Water Supply Costs Under the Alternative 3 Compared to the No Action Alternative

	Alternative 3 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	2
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$37
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	$0
Transfer Costs (thousand dollars)[7]	-$35
Shortage Costs (thousand dollars)[8]	$0
Groundwater Pumping Costs (thousand dollars)[9]	-$26
Excess Water Costs (thousand dollars)[10]	-$27
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$50**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-34. Sacramento River Region M&I Water Supply related Regional Economic Effects under Alternative 3 Compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	$28	$77
Mining	0	$5	$35
Construction	0	$366	$916
Manufacturing	0	$56	$482
TIPU	0	$589	$2,396
Trade	0	$1,769	$5,093
Service	< 1	$5,273	$19,950
Government	0	$3,399	$4,337
Total	**< 1**	**$11,483**	**$33,287**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

San Joaquin River Region

Alternative 3 would increase water supplies to M&I water contractors in the San Joaquin River Region on average by approximately 49,000 AFY compared to the No Action Alternative. M&I contractors in the San Joaquin River Region would also not need to invest in 1,000 AFY under the No Action Alternative, which would be a cost saving relative to the No Action Alternative. Additionally, increased water supplies under Alternative 3 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-35 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $4.1 million under Alternative 3 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions and development of alternate water supplies under Alternative 3. Reduced reliance on groundwater is also expected to decrease groundwater pumping costs under Alternative 3 compared to the No Action Alternative. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 3, there would be a reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-36 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-35. San Joaquin River Region M&I Water Supply Costs under the Alternative 3 compared to the No Action Alternative

	Alternative 3 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	49
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$4,591
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	-1
Annualized Alternate Supply Costs (thousand dollars)[4]	-$286
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	-$41
Transfer Costs (thousand dollars)[7]	-$3,491
Shortage Costs (thousand dollars)[8]	-$14
Groundwater Pumping Costs (thousand dollars)[9]	-$1,286
Excess Water Costs (thousand dollars)[10]	-$3,352
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$3,878**

All costs in 2018 dollars

[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors

[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates

[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.

[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.

[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-36. San Joaquin River Region M&I Water Supply related Regional Economic Effects under Alternative 3 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	< 1	$6,058	$17,448
Mining	0	$1,097	$3,783
Construction	< 1	$15,622	$43,158
Manufacturing	< 1	$9,632	$92,426
TIPU	< 1	$49,920	$172,323
Trade	4	$142,207	$394,522
Service	9	$332,526	$1,325,594
Government	2	$155,315	$210,475
Total	**16**	**$712,376**	**$2,259,730**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Bay-Delta Region

Alternative 3 would increase water supplies to M&I water contractors in the Bay-Delta Region on average by approximately 10,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, Bay-Delta Region M&I contractors would not need to invest in alternate water supplies under Alternative 3. Additionally, increased water supplies under Alternative 3 would reduce reliance on water transfers in the region.

Table Q.2-37 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $1.4 million under Alternative 3 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 3, there would be a reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-38 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-37. Bay-Delta Region M&I Water Supply Costs under the Alternative 3 compared to the No Action Alternative

	Alternative 3 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	10
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$140
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	-$523
Lost Water Sales Revenues (thousand dollars)[6]	-$284
Transfer Costs (thousand dollars)[7]	-$510
Shortage Costs (thousand dollars)[8]	-$95
Groundwater Pumping Costs (thousand dollars)[9]	$51
Excess Water Costs (thousand dollars)[10]	-$140
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$1,361**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-38. Bay-Delta Region M&I Water Supply related Regional Economic Effects under Alternative 3 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	$776	$2,049
Mining	0	$57	$251
Construction	< 1	$6,781	$16,993
Manufacturing	0	$3,860	$36,877
TIPU	< 1	$18,195	$75,509
Trade	1	$44,558	$120,353
Service	3	$146,393	$535,218
Government	< 1	$85,855	$106,169
Total	**5**	**$306,475**	**$893,419**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

San Francisco Bay Area Region

Alternative 3 would increase water supplies to M&I water contractors in the San Francisco Bay Area Region on average by approximately 54,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, San Francisco Bay Area Region M&I contractors would not need to invest in alternate water supplies under Alternative 3. Additionally, increased water supplies under Alternative 3 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-39 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $9.1 million under Alternative 3 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions and lost water sales revenue. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 3, there would be a reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-40 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-39. San Francisco Bay Area Region M&I Water Supply Costs under the Alternative 3 compared to the No Action Alternative

	Alternative 3 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	54
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$1,971
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	-3
Annualized Alternate Supply Costs (thousand dollars)[4]	-$526
Water Storage Costs (thousand dollars)[5]	$252
Lost Water Sales Revenues (thousand dollars)[6]	-$2,891
Transfer Costs (thousand dollars)[7]	-$6,000
Shortage Costs (thousand dollars)[8]	-$965
Groundwater Pumping Costs (thousand dollars)[9]	-$411
Excess Water Costs (thousand dollars)[10]	-$459
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$9,029**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages

[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-40. San Francisco Bay Area Region M&I Water Supply related Regional Economic Effects under Alternative 3 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	< 1	$3,903	$7,740
Mining	0	$468	$2,988
Construction	< 1	$73,903	$169,911
Manufacturing	< 1	$42,092	$229,741
TIPU	2	$176,347	$580,222
Trade	6	$371,134	$873,967
Service	20	$1,142,215	$3,599,988
Government	7	$877,342	$991,070
Total	**36**	**$2,687,405**	**$6,455,628**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Central Coast Region

Alternative 3 would increase water supplies to M&I water contractors in the Central Coast Region on average by approximately 12,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, Central Coast Region M&I contractors would not need to invest in alternate water supplies under Alternative 3.

Table Q.2-41 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $398,000 under Alternative 3 compared to the No Action Alternative. Cost reductions are mostly due to transfer cost reductions and lost water sales revenue. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 3, there would be a reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-42 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-41. Central Coast Region M&I Water Supply Costs under the Alternative 3 compared to the No Action Alternative

	Alternative 3 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	12
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$2,232
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	$0
Transfer Costs (thousand dollars)[7]	$0
Shortage Costs (thousand dollars)[8]	$0
Groundwater Pumping Costs (thousand dollars)[9]	-$844
Excess Water Costs (thousand dollars)[10]	-$1,786
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$398**

All costs in 2018 dollars

[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors

[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates

[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.

[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.

[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.

[6] Loss of revenue from retail water sales.

[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable

[8] Estimated consumer surplus loss to water shortages

[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.

[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-42. Central Coast Region M&I Water Supply related Regional Economic Effects under Alternative 3 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	$325	$735
Mining	0	$294	$1,089
Construction	0	$2,792	$7,085
Manufacturing	0	$345	$4,052
TIPU	< 1	$5,077	$19,976
Trade	< 1	$16,460	$42,222
Service	1	$52,226	$183,709
Government	< 1	$31,487	$38,914
Total	**2**	**$109,008**	**$297,782**

All costs in 2018 dollars

TIPU = Transportation, Information, Power, and Utilities

Southern California Region

Alternative 3 would increase water supplies to M&I water contractors in the Southern California Region on average by approximately 498,000 AFY compared to the No Action Alternative. With these increases in CVP and SWP water supplies, Southern California Region M&I contractors would not need to invest in alternate water supplies under Alternative 3. Additionally, increased water supplies under Alternative 3 would reduce reliance on water transfers and groundwater pumping in the region.

Table Q.2-43 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to reduce by approximately $64.8 million under Alternative 3 compared to the No Action Alternative. Cost reductions are mostly due to reduction in groundwater pumping and increased reliability of water supplies. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 3, there would be a reduction in water supply costs, and, consequently, water rates would be lower than the No Action Alternative. This would result in an increase in disposable income and could result in more spending in the regional economy.

Table Q.2-44 summarizes the regional economic effects to employment, labor income, and revenue from decreased water supply costs and increased disposable income to CVP and SWP M&I contractors. An increase in disposable income in the area would result an increase in spending in the region. Increases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-43. Southern California Region M&I Water Supply Costs under the Alternative 3 compared to the No Action Alternative

	Alternative 3 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	498
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	$71,746
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	-66
Annualized Alternate Supply Costs (thousand dollars)[4]	-$23,394
Water Storage Costs (thousand dollars)[5]	-$3,303
Lost Water Sales Revenues (thousand dollars)[6]	-$22,940
Transfer Costs (thousand dollars)[7]	-$14,203
Shortage Costs (thousand dollars)[8]	-$28,016
Groundwater Pumping Costs (thousand dollars)[9]	-$39,343
Excess Water Costs (thousand dollars)[10]	-$5,330
Average Annual Changes in Water Supply Costs (thousand dollars)	**-$64,782**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable

[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-44. Southern California Region M&I Water Supply related Regional Economic Effects under Alternative 3 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	< 1	$32,166	$86,269
Mining	< 1	$15,065	$56,770
Construction	4	$279,135	$734,267
Manufacturing	5	$383,964	$2,654,973
TIPU	14	$1,087,146	$4,131,501
Trade	40	$1,912,249	$5,089,884
Service	141	$7,048,894	$22,548,178
Government	26	$3,047,343	$3,812,507
Total	231	$13,805,962	$39,114,349

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Q.2.5.1.2 Potential agriculture-related changes to the regional economy

Trinity River Region

There are no agricultural lands irrigated with CVP/SWP water supplies in the Trinity River Region. Therefore, there would be no changes in irrigated lands under Alternative 3. Consequently, there would be no impacts to regional economy in the Trinity River Region under Alternative 3.

Sacramento River Region

Alternative 3 is expected to increase average annual agricultural water supply deliveries by 22,000 AFY during average conditions and by 13,000 AFY during dry conditions. As summarized in Table Q.2-45, this increase in CVP or SWP deliveries could reduce groundwater usage in the Sacramento River Region under dry conditions. Consequently, operation costs associated with crop production would be lower and would result in increased profitability to the growers. Increased deliveries in the Sacramento River Region are very small and are not expected to change irrigated acreage or agricultural revenue in the region. Therefore, the regional economic effects from water supply increases would be minimal.

Table Q.2-45. Sacramento River Region Agricultural Water Supply Costs under the Alternative 3 compared to the No Action Alternative

	Alternative 3 compared to No Action Alternative
Average Conditions[1]	
Average Annual CVP/SWP Deliveries (TAF)	22
Annual Groundwater Pumping (TAF)	0
Groundwater Pumping Cost (million dollars)	$0
Irrigated Acreage (thousand acres)	0
Agricultural Revenue (million dollars)	$0
Dry Conditions[2]	
Average Annual CVP/SWP Deliveries (TAF)	13
Annual Groundwater Pumping (TAF)	-11
Groundwater Pumping Cost (million dollars)	-$1
Irrigated Acreage (thousand acres)	0
Agricultural Revenue (million dollars)	$0

All costs in 2018 dollars
Note: Average Conditions refers to an average of all year types in the 81-year simulation period. Dry Conditions refer to an average of dry years only, using Sacramento River Index.

San Joaquin River Region

Alternative 3 is expected to increase average annual agricultural water supply deliveries by 666,000 AFY during average conditions and by 428,000 AFY during dry conditions in the San Joaquin River Region. Therefore, Alternative 3 reduces the occurrences of water supply shortages to agricultural contractors during all year types. Consequently, agricultural contractors would reduce their reliance on groundwater supplies in lieu of increased surface water deliveries. Table Q.2-46 summarizes the projected groundwater pumping volumes and groundwater pumping costs under Alternative 3 compared to the No Action Alternative. Overall groundwater pumping volumes under Alternative 3 would be lower than under the No Action Alternative due to increased surface water deliveries. Reduction in groundwater pumping would result in reduced groundwater pumping costs. Consequently, operation costs associated with crop production would be lower and could result in increased profitability to the growers.

As summarized in Table Q.2-46, SWAP model estimates an increase in irrigated acreage under Alternative 3 compared to the No Action Alternative. This increase in irrigated acreage would result in increased agricultural revenues for the growers as summarized in Table Q.2-46. Additionally, this would affect businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing. Table Q.2-47 and Table Q.2-48 summarizes the regional economic effects on employment, labor income, and revenue from increased CVP and SWP deliveries to agricultural contractors.

Table Q.2-46. San Joaquin River Region Agricultural Water Supply Costs under the Alternative 3 compared to the No Action Alternative

	Alternative 3 compared to No Action Alternative
Average Conditions[1]	
Average Annual CVP/SWP Deliveries (TAF)	644
Annual Groundwater Pumping (TAF)	-508
Groundwater Pumping Cost (million dollars)	-$103
Irrigated Acreage (thousand acres)	5
Agricultural Revenue (million dollars)	$15
Dry Conditions[2]	
Average Annual CVP/SWP Deliveries (TAF)	414
Annual Groundwater Pumping (TAF)	-214
Groundwater Pumping Cost (million dollars)	-$54
Irrigated Acreage (thousand acres)	56
Agricultural Revenue (million dollars)	$121

All costs in 2018 dollars
Average Conditions refers to an average of all year types in the 81-year simulation period
Dry Conditions refer to an average of dry years only, using Sacramento River Index.

Table Q.2-47. San Joaquin River Region Agricultural Water Supply Related Regional Economic Effects under Alternative 3 compared to the No Action Alternative under Average Conditions

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	149	$6,431,507	$17,530,096
Mining	<1	$18,591	$79,131
Construction	2	$91,094	$248,062
Manufacturing	1	$71,869	$779,857
TIPU	3	$235,891	$667,704
Trade	9	$399,165	$1,208,678
Service	31	$1,340,969	$4,416,030
Government	1	$98,014	$282,202
Total	196	$8,687,100	$25,211,759

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Table Q.2-48. San Joaquin River Region Agricultural Water Supply Related Regional Economic Effects under Alternative 3 compared to the No Action Alternative under Dry Conditions

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	1083	$47,591,046	$140,880,956
Mining	2	$179,927	$779,446
Construction	12	$735,170	$2,001,398
Manufacturing	8	$619,114	$6,862,175
TIPU	28	$1,981,782	$5,567,972
Trade	72	$3,255,304	$9,965,378

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Service	248	$10,688,600	$35,644,437
Government	9	$808,163	$2,326,073
Total	1461	$65,859,107	$204,027,835

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Bay-Delta Region

Alternative 3 is expected to increase average annual agricultural water supply deliveries in the Bay-Delta Region. Impacts from increased water supply to agricultural contractors in the Bay-Delta Region are evaluated under Sacramento and San Joaquin River Region analysis. Increase in agricultural water supply in the region could result in an increase in irrigated acreage and agricultural revenues in the region. This would have a beneficial impact to the regional economy as it would impact businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing.

San Francisco Bay Area Region

Alternative 3 is expected to increase average annual agricultural water supply deliveries in the San Francisco Bay Area Region by 14,000 AFY under average conditions and by 9,000 AFY under dry conditions. Increase in agricultural water supply in the region could result in an increase in irrigated acreage and agricultural revenues in the region. This would have a beneficial impact to the regional economy as it would impact businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing.

Central Coast Region

There are no agricultural lands irrigated with CVP and SWP water supplies in the Central Coast Region. Therefore, there would be no changes in irrigated lands under Alternative 3. Consequently, there would be no impacts to regional economy in the Central Coast Region under Alternative 3.

Southern California Region

Alternative 3 is expected to increase average annual agricultural water supply deliveries in the Southern California Region by 3,000 AFY under average conditions and by 2,000 AFY under dry conditions. Increase in agricultural water supply in the region could result in an increase in irrigated acreage and agricultural revenues in the region. This would have a beneficial impact to the region economy as it would affect businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing.

Q.2.5.1.3 Potential fisheries-related changes to the regional economy

Similar to Alternative 2, Alternative 3 would also cause a reduction in salmon population along the SONCC. The magnitude of reduction under Alternative 3 would be lower compared to Alternative 2. Decreases in salmon population could potentially decrease commercial and recreational ocean salmon harvest. This could have a detrimental impact to fishermen and other ocean fisheries-supported industries.

Q.2.5.2 *Program-Level effects*

Q.2.5.2.1 Potential changes to the regional economy

Alternative 3 includes several program actions that would require construction such as American River Drought Temperature Facility Improvements, Tracy Fish Collection Facility Improvements, Skinner Fish Facility Improvements, Delta Fish Species Conservation Hatchery, Upper Sacramento Small Screen Program, Juvenile Trap and Haul Programs in the Sacramento River. Construction activities associated with program action would temporarily increase construction-related employment and spending in the areas near the construction sites. These impacts would be beneficial to the regional economy and would result in a temporary increase in employment, labor income, and revenue in Shasta, Sacramento, San Joaquin, and Contra Costa Counties.

In addition to the construction actions, Alternative 3 would also include habitat restoration projects along the upper reaches of the Sacramento River, American River, Stanislaus River, and Lower San Joaquin River. Alternative 3 also includes 8,000 acres of tidal habitat restoration projects and 25,000 acres of additional habitat restoration within the Delta would be implemented under Alternative 3. These habitat restoration projects could remove agricultural lands or grazing lands out of production. These impacts could reduce irrigated acreage and agricultural revenues which would impact growers and businesses and individuals who support farming activities negatively. Tidal restoration projects would mainly occur in the Delta Region and could improve recreational fishing and day use opportunities in the long-term. These impacts could be beneficial to the region as they could increase visitors from within and outside the region. Visitors from outside the region would generate new economic activity in the region due to increased spending. This would be beneficial to the regional economy.

Q.2.6 Alternative 4

Q.2.6.1 *Project-Level effects*

Q.2.6.1.1 Potential M&I water supply related changes to the regional economy

Trinity River Region

There are no M&I CVP or SWP water service contractors in the Trinity River Region. Therefore, there would be no changes to CVP and SWP water supplies in the Trinity River Region. Consequently, there would be no impacts to regional economy in the Trinity River Region under Alternative 4.

Sacramento River Region

Alternative 4 would decrease water supplies to M&I water contractors in the Sacramento River Region on average by approximately 2,000 AFY compared to the No Action Alternative. These decreases in CVP and SWP water supplies would increase the supply gap to meet 2030 water demands. Therefore, M&I contractors would need to develop other alternate water supplies to meet their demands.

Table Q.2-49 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to increase by approximately $137,000 under Alternative 4 compared to the No Action Alternative. The cost increases are mostly because of increased water transfer costs. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 4, there would be an increase in water supply costs, and, consequently, water rates would be higher than the No Action Alternative. This would result in a decrease in disposable income and could result in less spending in the regional economy.

Table Q.2-50 summarizes the regional economic effects to employment, labor income, and revenue from increased water supply costs and decreased disposable income to CVP and SWP M&I contractors. A decrease in disposable income in the area would result a decrease in spending in the region. Decreases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-49. Sacramento River Region M&I Water Supply Costs Under the Alternative 4 Compared to the No Action Alternative

	Alternative 4 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	-2
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	-$33
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	$8
Transfer Costs (thousand dollars)[7]	$121
Shortage Costs (thousand dollars)[8]	$2
Groundwater Pumping Costs (thousand dollars)[9]	$14
Excess Water Costs (thousand dollars)[10]	$23
Average Annual Changes in Water Supply Costs (thousand dollars)	**$137**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-50. Sacramento River Region M&I Water Supply related Regional Economic Effects under Alternative 4 Compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	-$75	-$205
Mining	0	-$12	-$93
Construction	0	-$975	-$2,445
Manufacturing	0	-$149	-$1,286
TIPU	0	-$1,571	-$6,391
Trade	<1 job lost	-$4,718	-$13,587
Service	<1 job lost	-$14,067	-$53,220
Government	<1 job lost	-$9,067	-$11,571
Total	-1	-$30,634	-$88,798

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

San Joaquin River Region

Alternative 4 would decrease water supplies to M&I water contractors in the San Joaquin River Region on average by approximately 10,000 AFY compared to the No Action Alternative. With these decreases in CVP and SWP water supplies, San Joaquin River Region M&I contractors would need to invest in alternate water supplies to meet their 2030 water demand.

Table Q.2-51 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to increase by approximately $1.2 million under Alternative 4 compared to the No Action Alternative. The cost increases are mostly because of investments in new supply project and transfer costs. Additionally, the decrease in surface water supply would increase reliance on groundwater and consequently increase groundwater pumping costs. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 4, there would be an increase in water supply costs, and, consequently, water rates would be higher than the No Action Alternative. This would result in a decrease in disposable income and could result in less spending in the regional economy.

Table Q.2-52 summarizes the regional economic effects to employment, labor income, and revenue from increased water supply costs and decreased disposable income to CVP and SWP M&I contractors. A decrease in disposable income in the area would result a decrease in spending in the region. Decreases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-51. San Joaquin River Region M&I Water Supply Costs under the Alternative 4 compared to the No Action Alternative

	Alternative 4 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	-10
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	-$900
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	<1
Annualized Alternate Supply Costs (thousand dollars)[4]	$89
Water Storage Costs (thousand dollars)[5]	$0

	Alternative 4 compared to No Action Alternative
Lost Water Sales Revenues (thousand dollars)[6]	$0
Transfer Costs (thousand dollars)[7]	$1,115
Shortage Costs (thousand dollars)[8]	$0
Groundwater Pumping Costs (thousand dollars)[9]	$521
Excess Water Costs (thousand dollars)[10]	$385
Average Annual Changes in Water Supply Costs (thousand dollars)	**$1,211**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-52. San Joaquin River Region M&I Water Supply related Regional Economic Effects under Alternative 4 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	-$1,898	-$5,468
Mining	0	-$344	-$1,186
Construction	0	-$4,895	-$13,525
Manufacturing	0	-$3,018	-$28,964
TIPU	0	-$15,643	-$54,001
Trade	-1	-$44,564	-$123,632
Service	-3	-$104,205	-$415,404
Government	-1	-$48,671	-$65,957
Total	**-5**	**-$223,239**	**-$708,136**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Bay-Delta Region

Alternative 4 would decrease water supplies to M&I water contractors in the Bay-Delta Region on average by approximately 14,000 AFY compared to the No Action Alternative. With these decreases in CVP and SWP water supplies, Bay-Delta Region M&I contractors would need to invest in alternate water supply sources to meet 2030 water demands.

Table Q.2-53 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to increase by approximately $1.5 million under Alternative 4 compared to the No Action Alternative. The cost increase is mostly because of the increase in water transfers and increased reliance in groundwater. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 4, there would be an increase in water supply costs, and, consequently, water rates would be higher than the No Action Alternative. This would result in a decrease in disposable income and could result in less spending in the regional economy.

Table Q.2-54 summarizes the regional economic effects to employment, labor income, and revenue from increased water supply costs and decreased disposable income to CVP and SWP M&I contractors. A decrease in disposable income in the area would result a decrease in spending in the region. Decreases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-53. Bay-Delta Region M&I Water Supply Costs under the Alternative 4 compared to the No Action Alternative

	Alternative 4 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	-14
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	-$351
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	$321
Lost Water Sales Revenues (thousand dollars)[6]	$676
Transfer Costs (thousand dollars)[7]	$369
Shortage Costs (thousand dollars)[8]	$212
Groundwater Pumping Costs (thousand dollars)[9]	$54
Excess Water Costs (thousand dollars)[10]	$228
Average Annual Changes in Water Supply Costs (thousand dollars)	**$1,509**

All costs in 2018 dollars

[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors

[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates

[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.

[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.

[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.

[6] Loss of revenue from retail water sales.

[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable

[8] Estimated consumer surplus loss to water shortages

[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.

[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-54. Bay-Delta Region M&I Water Supply related Regional Economic Effects under Alternative 4 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	-$795	-$2,099
Mining	0	-$58	-$257
Construction	0	-$6,947	-$17,409
Manufacturing	0	-$3,955	-$37,778
TIPU	0	-$18,640	-$77,356
Trade	-1	-$45,647	-$123,295
Service	-3	-$149,972	-$548,304
Government	-1	-$87,954	-$108,765
Total	**-6**	**-$313,969**	**-$915,263**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

San Francisco Bay Area Region

Alternative 4 would decrease water supplies to M&I water contractors in the San Francisco Bay Area Region on average by approximately 11,000 AFY compared to the No Action Alternative. With these decreases in CVP and SWP water supplies, San Francisco Region M&I contractors would need to invest in alternate water supply sources to meet 2030 water demands.

Table Q.2-55 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to increase by approximately $3.2 million under Alternative 4 compared to the No Action Alternative. The cost increase is mostly because of the increase in water transfers and increased reliance in groundwater. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 4, there would be an increase in water supply costs, and, consequently, water rates would be higher than the No Action Alternative. This would result in a decrease in disposable income and could result in less spending in the regional economy.

Table Q.2-56 summarizes the regional economic effects to employment, labor income, and revenue from increased water supply costs and decreased disposable income to CVP and SWP M&I contractors. A decrease in disposable income in the area would result a decrease in spending in the region. Decreases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-55. San Francisco Bay Area Region M&I Water Supply Costs under the Alternative 4 compared to the No Action Alternative

	Alternative 4 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	-11
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	-$402
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	-$65
Lost Water Sales Revenues (thousand dollars)[6]	$647

	Alternative 4 compared to No Action Alternative
Transfer Costs (thousand dollars)[7]	$2,789
Shortage Costs (thousand dollars)[8]	$218
Groundwater Pumping Costs (thousand dollars)[9]	$70
Excess Water Costs (thousand dollars)[10]	-$15
Average Annual Changes in Water Supply Costs (thousand dollars)	**$3,242**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-56. San Francisco Bay Area Region M&I Water Supply related Regional Economic Effects under Alternative 4 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	-$1,463	-$2,902
Mining	0	-$176	-$1,120
Construction	0	-$27,710	-$63,709
Manufacturing	0	-$15,783	-$86,143
TIPU	-1	-$66,122	-$217,557
Trade	-2	-$139,159	-$327,698
Service	-7	-$428,279	-$1,349,833
Government	-3	-$328,964	-$371,607
Total	**-13**	**-$1,007,656**	**-$2,420,570**

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Central Coast Region

Alternative 4 would decrease water supplies to M&I water contractors in the Central Coast Region on average by approximately 2,000 AFY compared to the No Action Alternative. With these decreases in CVP and SWP water supplies, Central Coast Region M&I contractors would need to invest in alternate water supply sources to meet 2030 water demands.

Table Q.2-57 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to increase by approximately $184 thousand under Alternative 4 compared to the No Action Alternative. The cost increase is mostly because of increased reliance in groundwater. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 4, there would be an increase in water supply costs, and, consequently, water rates would be higher than the No Action Alternative. This would result in a decrease in disposable income and could result in less spending in the regional economy.

Table Q.2-58 summarizes the regional economic effects to employment, labor income, and revenue from increased water supply costs and decreased disposable income to CVP and SWP M&I contractors. A decrease in disposable income in the area would result a decrease in spending in the region. Decreases in spending would result in induced impacts in the region and would primarily occur in the services sector.

Table Q.2-57. Central Coast Region M&I Water Supply Costs under the Alternative 4 compared to the No Action Alternative

	Alternative 4 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	-2
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	-$448
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	0
Annualized Alternate Supply Costs (thousand dollars)[4]	$0
Water Storage Costs (thousand dollars)[5]	$0
Lost Water Sales Revenues (thousand dollars)[6]	$0
Transfer Costs (thousand dollars)[7]	$0
Shortage Costs (thousand dollars)[8]	$0
Groundwater Pumping Costs (thousand dollars)[9]	$391
Excess Water Costs (thousand dollars)[10]	$241
Average Annual Changes in Water Supply Costs (thousand dollars)	**$184**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-58. Central Coast Region M&I Water Supply related Regional Economic Effects under Alternative 4 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	-$151	-$340
Mining	0	-$136	-$504
Construction	0	-$1,293	-$3,281
Manufacturing	0	-$160	-$1,877
TIPU	0	-$2,352	-$9,252
Trade	0	-$7,624	-$19,555
Service	-1	-$24,188	-$85,084
Government	0	-$14,583	-$18,023
Total	-1	-$50,486	-$137,916

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Southern California Region

Alternative 4 would decrease water supplies to M&I water contractors in the Southern California Region on average by approximately 91,000 AFY compared to the No Action Alternative. With these decreases in CVP and SWP water supplies, Southern California Region M&I contractors would need to invest in alternate water supply sources to meet 2030 water demands.

Table Q.2-59 summarizes the average annual water supply costs over the 81-year hydrologic period for M&I water supplies. Average annual water supply costs are expected to increase by approximately $16.8 million under Alternative 4 compared to the No Action Alternative. The cost increase is mostly because of investment in new supply projects, increases in water transfers and increased reliance on groundwater under Alternative 4. Typically, water supply cost increases are passed on to water customers through water rate increases. Under Alternative 4, there would be an increase in water supply costs, and, consequently, water rates would be higher than the No Action Alternative. This would result in a decrease in disposable income and could result in less spending in the regional economy.

Table Q.2-60 summarizes the regional economic effects to employment, labor income, and revenue from increased water supply costs and decreased disposable income to CVP and SWP M&I contractors. A decrease in disposable income in the area would result a decrease in spending in the region. Decreases in spending would result in induced impacts in the region and would primarily occur in the restaurant sector.

Table Q.2-59. Southern California Region M&I Water Supply Costs under the Alternative 4 compared to the No Action Alternative

	Alternative 4 compared to No Action Alternative
Average Annual CVP/SWP Deliveries (TAF)[1]	-91
Delivery Cost for CVP/SWP Deliveries (thousand dollars)[2]	-$13,506
Alternate Water Supply Deliveries (assumed new supply) (TAF)[3]	8
Annualized Alternate Supply Costs (thousand dollars)[4]	$3,870
Water Storage Costs (thousand dollars)[5]	$859
Lost Water Sales Revenues (thousand dollars)[6]	$5,412

	Alternative 4 compared to No Action Alternative
Transfer Costs (thousand dollars)[7]	$2,990
Shortage Costs (thousand dollars)[8]	$8,249
Groundwater Pumping Costs (thousand dollars)[9]	$8,564
Excess Water Costs (thousand dollars)[10]	-$159
Average Annual Changes in Water Supply Costs (thousand dollars)	**$16,278**

All costs in 2018 dollars
[1] CalSim II simulated CVP/SWP deliveries for North of Delta and South of Delta M&I contractors
[2] Cost to deliver CVP and SWP deliveries (line items 1 in table above) based on Reclamation CVP M&I rates and Bulletin 132-10 rates
[3] Alternate water supply deliveries including desalination, new groundwater development and some types of conservation, water transfer and/or imported water. See Table Q2.2-6 in Appendix Q2 for summary of alternate water supply source by M&I contractor.
[4] Cost to develop alternate water supplies. This cost typically only includes development cost and other marginal costs (such as delivery costs etc.) are not included in this cost.
[5] Storage Costs include costs to store water in local groundwater banks and storage reservoirs. Costs include put and take costs.
[6] Loss of revenue from retail water sales.
[7] Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
[8] Estimated consumer surplus loss to water shortages
[9] Cost savings from reduction in groundwater pumping between the action alternatives and the No Action Alternative. Negative refers to savings and positive refers to costs.
[10] Cost savings from contract water not used to meet demand or reduce groundwater pumping. Negative refers to savings and positive refers to costs.

Table Q.2-60. Southern California Region M&I Water Supply related Regional Economic Effects under Alternative 4 compared to the No Action Alternative

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	0	-$7,025	-$18,841
Mining	0	-$3,290	-$12,398
Construction	-1	-$60,961	-$160,358
Manufacturing	-1	-$83,855	-$579,827
TIPU	-3	-$237,425	-$902,290
Trade	-9	-$417,621	-$1,111,594
Service	-31	-$1,539,427	-$4,924,358
Government	-6	-$665,517	-$832,624
Total	-51	-$3,015,121	-$8,542,289

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Q.2.6.1.2 Potential agriculture-related changes to the regional economy

Trinity River Region

There are no agricultural lands irrigated with CVP and SWP water supplies in the Trinity River Region. Therefore, there would be no changes in irrigated lands under Alternative 4. Consequently, there would be no impacts to regional economy in the Trinity River Region under Alternative 4.

Sacramento River Region

Alternative 4 is expected to decrease average annual agricultural water supply deliveries by 4,000 AFY during average conditions and by 20,000 AFY during dry conditions. As summarized in Table Q.2-61, this decrease in CVP or SWP deliveries could increase groundwater usage in the Sacramento River Region under dry conditions. Consequently, operation costs associated with crop production would be higher and would result in decreased profitability to the growers. Reductions in irrigated acreage and agricultural revenue from decreases in deliveries are small under average conditions and would result in minimal changes to the regional economy. Under dry conditions, irrigated acreage is expected to reduce by approximately 2,000 acres due to reductions in water supply deliveries. This reduction in irrigated acreage would result in decrease in agricultural revenues for the growers as summarized in Table Q.2-61, Sacramento River Region Agricultural Water Supply Costs under the Alternative 4 compared to the No Action Alternative. Additionally, this would affect businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing. Table Q.2-62, Sacramento River Region Agricultural Water Supply Related Regional Economic Effects under Alternative 4 compared to the No Action Alternative under Dry Conditions summarizes the regional economic effects on employment, labor income, and revenue from increased CVP and SWP deliveries to agricultural contractors.

Table Q.2-61. Sacramento River Region Agricultural Water Supply Costs under the Alternative 4 compared to the No Action Alternative

	Alternative 4 compared to No Action Alternative
Average Conditions[1]	
Average Annual CVP/SWP Deliveries (TAF)	-4
Annual Groundwater Pumping (TAF)	0
Groundwater Pumping Cost (million dollars)	$0
Irrigated Acreage (thousand acres)	0
Agricultural Revenue (million dollars)	$0
Dry Conditions[2]	
Average Annual CVP/SWP Deliveries (TAF)	-20
Annual Groundwater Pumping (TAF)	7
Groundwater Pumping Cost (million dollars)	$1
Irrigated Acreage (thousand acres)	-2
Agricultural Revenue (million dollars)	-$3

All costs in 2018 dollars

Note: Average Conditions refers to an average of all year types in the 81-year simulation period. Dry Conditions refer to an average of dry years only, using Sacramento River Index.

Table Q.2-62. Sacramento River Region Agricultural Water Supply Related Regional Economic Effects under Alternative 4 compared to the No Action Alternative under Dry Conditions

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	-75	-$1,365,885	-$3,834,693
Mining	<1 job lost	-$672	-$5,663
Construction	<1 job lost	-$24,122	-$60,084
Manufacturing	<1 job lost	-$6,547	-$65,686
TIPU	<1 job lost	-$41,943	-$133,802
Trade	-2	-$81,458	-$252,928
Service	-7	-$342,447	-$1,114,679
Government	<1 job lost	-$23,937	-$71,485
Total	-86	-$1,887,010	-$5,539,020

All costs in 2018 dollars

San Joaquin River Region

Alternative 4 is expected to decrease average annual agricultural water supply deliveries by 57,000 AFY during average conditions and by 129,000 AFY during dry conditions in the San Joaquin River Region. Therefore, Alternative 4 would increase the occurrence of water supply shortages to agricultural contractors during all year types. Consequently, agricultural contractors would increase their reliance on groundwater supplies to meet their water demand. Table Q.2-63, San Joaquin River Region Agricultural Water Supply Costs under the Alternative 4 compared to the No Action Alternative summarizes the projected groundwater pumping volumes and groundwater pumping costs under Alternative 4 compared to the No Action Alternative. Overall, groundwater pumping volumes under Alternative 4 would be higher than under the No Action Alternative because of decreased surface water deliveries. Increased groundwater pumping would result in increased groundwater pumping costs. Consequently, operation costs associated with crop production would be higher and could result in decreased profitability to the growers.

As summarized in Table Q.2-63, the SWAP model estimates a decrease in irrigated acreage under Alternative 4 compared to the No Action Alternative. This decrease in irrigated acreage would result in decrease in agricultural revenues for the growers as summarized in Table Q.2-63. Additionally, this would affect businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing. Tables Q.2-64 and Q.2-65 summarize the regional economic effects on employment, labor income, and revenue from increased CVP and SWP deliveries to agricultural contractors.

Table Q.2-63. San Joaquin River Region Agricultural Water Supply Costs under the Alternative 4 compared to the No Action Alternative

	Alternative 4 compared to No Action Alternative
Average Conditions[1]	
Average Annual CVP/SWP Deliveries (TAF)	-57
Annual Groundwater Pumping (TAF)	26
Groundwater Pumping Cost (million dollars)	$6
Irrigated Acreage (thousand acres)	-6

	Alternative 4 compared to No Action Alternative
Agricultural Revenue (million dollars)	-$14
Dry Conditions[2]	
Average Annual CVP/SWP Deliveries (TAF)	-129
Annual Groundwater Pumping (TAF)	49
Groundwater Pumping Cost (million dollars)	$13
Irrigated Acreage (thousand acres)	-12
Agricultural Revenue (million dollars)	-$29

All costs in 2018 dollars
Average Conditions refers to an average of all year types in the 81-year simulation period
Dry Conditions refer to an average of dry years only, using Sacramento River Index.

Table Q.2-64. San Joaquin River Region Agricultural Water Supply Related Regional Economic Effects under Alternative 4 compared to the No Action Alternative under Average Conditions

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	-125	-$5,457,203	-$16,065,756
Mining	0	-$21,261	-$92,290
Construction	-1	-$81,820	-$222,810
Manufacturing	-1	-$70,665	-$790,231
TIPU	-3	-$227,152	-$638,960
Trade	-8	-$372,699	-$1,140,728
Service	-29	-$1,228,997	-$4,101,112
Government	-1	-$93,307	-$268,800
Total	-168	-$7,553,103	-$23,320,687

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Table Q.2-65. San Joaquin River Region Agricultural Water Supply Related Regional Economic Effects under Alternative 4 compared to the No Action Alternative under Dry Conditions

	Employment (in jobs)	Labor Income (in dollars)	Output (in dollars)
Agriculture	-271	-$11,769,901	-$34,431,640
Mining	-1	-$46,251	-$200,915
Construction	-3	-$173,038	-$471,301
Manufacturing	-2	-$151,205	-$1,698,570
TIPU	-7	-$487,588	-$1,372,900
Trade	-18	-$800,168	-$2,447,833
Service	-61	-$2,648,539	-$8,838,113
Government	-2	-$201,181	-$579,832
Total	-364	-$16,277,871	-$50,041,104

All costs in 2018 dollars
TIPU = Transportation, Information, Power, and Utilities

Bay-Delta Region

Alternative 4 is expected to decrease average annual agricultural water supply deliveries in the Bay-Delta Region. Impacts from decreased water supply to agricultural contractors in the Bay-Delta Region are evaluated under Sacramento and San Joaquin River Region analysis. The decrease in agricultural water supply in the region could result in a decrease in irrigated acreage and agricultural revenues in the region. This would have an adverse impact to the regional economy as it would impact businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing.

San Francisco Bay Area Region

Alternative 4 is expected to decrease average annual agricultural water supply deliveries in the San Francisco Bay Area Region by 2,000 AFY under average conditions and by 4,000 AFY under dry conditions. The decrease in agricultural water supply in the region could result in a decrease in irrigated acreage and agricultural revenues in the region. This would have an adverse impact to the regional economy as it would impact businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing.

Central Coast Region

There are no agricultural lands irrigated with CVP and SWP water supplies in the Central Coast Region. Therefore, there would be no changes in irrigated lands under Alternative 4. Consequently, there would no impacts to regional economy in the Central Coast Region under Alternative 4.

Southern California Region

Alternative 4 is expected to decrease average annual agricultural water supply deliveries in the Southern California Region by 300 AFY under average conditions and by 500 AFY under dry conditions. The decrease in agricultural water supply in the region could result in a decrease in irrigated acreage and agricultural revenues in the region. This would have an adverse impact to the regional economy as it would impact businesses and individuals who support farming activities, such as farm workers, fertilizer and chemical dealers, wholesale and agricultural service providers, truck transport, and others involved in crop production and processing

Q.2.6.1.3 Potential fisheries-related changes to the regional economy

The commercial and recreational (ocean sports) ocean salmon fishery along the SONCC are affected by the population of salmon that rely upon the Northern California rivers, including the Sacramento and San Joaquin rivers. Appendix O, *Aquatic Resources Technical Appendix* describes changes in CVP and SWP water operations would affect the flow patterns and water quality of the Sacramento and San Joaquin rivers, and the survivability of the salmon that use those rivers for habitat. Appendix O*, Aquatic Resources Technical Appendix* also describes that the population of salmon along the SONCC would be higher under all action alternatives compared to No Action Alternative. Increase in salmon population could potentially increase commercial and recreational ocean salmon harvest. Increase in commercial ocean salmon harvest would increase revenues received by fisherman. Ocean fisheries support industries such as fish processors, boat manufacturers, repair and maintenance would also see an increase in revenue. Overall, increased fisheries under Alternative 4 would be beneficial to the regional economy.

Q.2.6.2 *Program-Level effects*

Q.2.6.2.1 Potential changes to the regional economy

Alternative 4 includes water use efficiency components that could include construction actions, public outreach programs and operational changes to improve system efficiency. Construction activities associated with program action would temporarily increase construction-related employment and spending in the areas near the construction sites. These impacts would be beneficial to the regional economy and would result in a temporary increase in employment, labor income, and revenue.

Q.2.7 Mitigation Measures

No mitigation measures have been identified for the effects identified in this EIS.

Q.2.8 Summary of Impacts

Table Q.2-66 includes a summary of impacts, the magnitude and direction of those impacts, and potential mitigation measures for consideration.

Table Q.2-66. Impact Summary

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential M&I-related changes to the regional economy (Project-Level)	No Action	No Impacts	--
	1	**Trinity River Region:** No Impacts **Sacramento River Region:** Increase of <1 job, $28.8 thousand (K) in labor income, $83.6 K in revenue **San Joaquin River Region:** Increase of 2 jobs, $89.8 K in labor income, $0.2 million (M) in revenue **Bay-Delta Region:** Increase of 3 jobs, $0.2M in labor income, $0.5 M in revenue **San Francisco Bay Area Region:** Increase of 10 jobs, $0.8 M in labor income, $1.9 M in revenue **Central Coast Region:** Decrease of <1 job, $10.2 K in labor income, $27.9 K in revenue **Southern California Region:** Increase of 104 jobs, $6.2 M in labor income, $17.6 M in revenue	--

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	2	**Trinity River Region:** No Impacts **Sacramento River Region:** Increase of <1 job, $13.5 K in labor income, $39.6 K in revenue **San Joaquin River Region:** Increase of 16 jobs, $0.7 M in labor income, $2.3 M in revenue **Bay-Delta Region:** Increase of 5 jobs, $0.3 M in labor income, $0.9 M in revenue **San Francisco Bay Area Region:** Increase of 35 jobs, $2.7 M in labor income, $6.5 M in revenue **Central Coast Region:** Increase of 2 jobs, $0.1 M in labor income, $0.3 M in revenue **Southern California Region:** Increase of 232 jobs, $13.9 M in labor income, $39.4 M in revenue	--
	3	**Trinity River Region:** No Impacts **Sacramento River Region:** Increase of <1 job, $11.5 K in labor income, $33.3 K in revenue **San Joaquin River Region:** Increase of 16 jobs, $0.7 M in labor income, $2.3 M in revenue **Bay-Delta Region:** Increase of 5 jobs, $0.3 M in labor income, $0.9 M in revenue **San Francisco Bay Area Region:** Increase of 35 jobs, $2.7 M in labor income, $6.4 M in revenue **Central Coast Region:** Increase of 2 jobs, $0.1 M in labor income, $0.3 M in revenue **Southern California Region:** Increase of 232 jobs, $13.9 M in labor income, $39.2 M in revenue	--

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	4	**Trinity River Region:** No Impacts **Sacramento River Region:** Decrease of <1 job, $30.6 K in labor income, $88.8 K in revenue **San Joaquin River Region:** Decrease of 5 jobs, $0.2 M in labor income, $0.7 M in revenue **Bay-Delta Region:** Decrease of 6 jobs, $0.3 M in labor income, $0.9 M in revenue **San Francisco Bay Area Region:** Decrease of 13 jobs, $1.0 M in labor income, $2.4 M in revenue **Central Coast Region:** Decrease of 1 job, $50.4 K in labor income, $0.1 M in revenue **Southern California Region:** Decrease of 51 jobs, $3.0 M in labor income, $8.5 M in revenue	--
Potential agriculture-related changes to the regional economy (Project-Level)	No Action	No Impacts	--
	1	**Trinity River Region:** No Impacts **Sacramento River Region:** Minimal impacts to regional economy **San Joaquin River Region:** Increase of 136 jobs, $6.0 M in labor income, $16.6 M in revenue under Average Conditions Increase of 482 jobs, $24.8 M in labor income, $83.3 M in revenue under Dry Conditions **Bay Delta Region:** Beneficial to regional economy **San Francisco Bay Area Region:** Beneficial to regional economy **Central Coast Region:** No Impacts **Southern California Region:** Beneficial to regional economy	--

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	2	**Trinity River Region:** No Impacts **Sacramento River Region:** Minimal impacts to regional economy **San Joaquin River Region:** Increase of 184 jobs, $8.2 M in labor income, $23.7 M in revenue under Average Conditions Increase of 1,467 jobs, $66.1 M in labor income, $204.7 M in revenue under Dry Conditions **Bay Delta Region:** Beneficial to regional economy **San Francisco Bay Area Region:** Beneficial to regional economy **Central Coast Region:** No Impacts **Southern California Region:** Beneficial to regional economy	--
	3	**Trinity River Region:** No Impacts **Sacramento River Region:** Minimal impacts to regional economy **San Joaquin River Region:** Increase of 196 jobs, $8.7 M in labor income, $25.2 M in revenue under Average Conditions Increase of 1,461 jobs, $65.9 M in labor income, $204.0 M in revenue under Dry Conditions **Bay Delta Region:** Beneficial to regional economy **San Francisco Bay Area Region:** Beneficial to regional economy **Central Coast Region:** No Impacts **Southern California Region:** Beneficial to regional economy	--

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	4	**Trinity River Region:** No Impacts **Sacramento River Region:** Minimal impacts to regional economy under Average Conditions Decrease of 86 jobs, $1.9 M in labor income, $5.5 M in revenue under Dry Conditions **San Joaquin River Region:** Decrease of 168 jobs, $7.5 M in labor income, $23.3 M in revenue under Average Conditions Decrease of 364 jobs, $16.3 M in labor income, $50.0 M in revenue under Dry Conditions **Bay Delta Region:** Adverse impacts to regional economy **San Francisco Bay Area Region:** Adverse impacts to regional economy **Central Coast Region:** No Impacts **Southern California Region:** Adverse impacts to regional economy	--
Potential fisheries-related changes to the regional economy (Project-Level)	No Action	No Impacts	--
	1	Increased fisheries under Alternative 1 would be beneficial to the regional economy	--
	2 and 3	Decreased fisheries under Alternative 2 and 3 would be detrimental to the regional economy	--
	4	Increased fisheries under Alternative 4 would be beneficial to the regional economy	--
Potential changes to the regional economy (Program-Level)	No Action and 2	No Impacts	--
	1 and 3	Construction activities associated with program action would temporarily increase construction-related employment and spending in the areas near the construction sites. Habitat Restoration actions could remove agricultural lands or grazing lands out of production and could result in a decrease in agricultural employment and spending in the region. Tidal Restoration action could improve recreational fishing and day use opportunities in the long-term. This could result in increased recreational spending in the region.	--

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	4	Construction activities associated with water use efficiency actions would temporarily increase construction related employment and spending in the areas near the construction sites.	--

Q.2.9 Cumulative Effects

The No Action Alternative would not result in any changes to water operations and therefore additional effects on regional economics would be avoided by design. Thus, no cumulative effects on regional economics under the No Action Alternative were identified.

Potential M&I-related changes to the regional economy

Alternatives 1 through 3 would increase water supply deliveries to North of Delta and South of Delta M&I contractors, potentially helping water agencies meet their existing and future demands without alternate water supply projects. Alternative 4 would decrease M&I water supply deliveries to North of Delta and South of Delta M&I contractors. Implementation of Alternative 4 could increase the supply gap and require water agencies to invest in alternate water supply projects to meet their demands.

Appendix Y*, Cumulative Methodology* describes past, present, and reasonably foreseeable projects that may have effects on regional economics as well, as they would improve water supply and reliability. These cumulative projects include actions across California to develop new water storage capacity, new water conveyance infrastructure, new water recycling capacity and reoperation of existing water supply infrastructure - including surface water reservoirs and conveyance infrastructure. Cumulative projects also include ecosystem improvement and habitat restoration actions to improve conditions for special status species that could limit water supply deliveries to contractors.

Alternatives 1 through 3 would contribute to cumulatively beneficial impacts to the regional economy due to an overall increase in water supply that would reduce water rates to customers and increase disposable income and spending in the project area. Alternative 4 would decrease water supply and increase water rates to customers, which would contribute water supply shortages under the cumulative condition.

Collectively, implementation of these cumulative projects is expected to directly or indirectly improve water supply reliability to water contractors in California. The contribution of Alternative 1, 2 or 3 would be cumulatively beneficial. Alternative 4 would contribute to increased water rates under the cumulative condition.

Potential agriculture-related changes to the regional economy

Alternatives 1 through 3 would increase water supply deliveries to North of Delta and South of Delta agricultural contractors in all year types which may cause agricultural contractors to reduce their reliance on groundwater supplies, resulting in an overall lowering of groundwater pumping volumes and associated pumping costs. Operation costs associated with crop production would also be lower and would result in increased profitability to the growers and increased revenue to businesses and individuals who support farming activities. Alternative 4 would decrease water supply and would decrease agricultural production and revenue, as well as employment and labor income for growers and businesses and individuals who support farming activities.

Past, present, and reasonably foreseeable projects, described in Appendix Y, *Cumulative Methodology*, may have effects on regional economics as well, as they would improve water supply and reliability.

Alternatives 1 through 3 would contribute to cumulatively beneficial impacts to the regional economy due to an overall increase in water supply that would increase agricultural production and revenue in the project. Alternative 4 would decrease water supply and would decrease agricultural production and revenue, which would contribute to increased water rates under the cumulative condition.

Collectively, implementation of these cumulative projects is expected to directly or indirectly improve water supply reliability to agricultural water users in California. The contribution of Alternative 1, 2, or 3 would be cumulatively beneficial. Alternative 4 would contribute to increased water rates and is expected to reduce agricultural production under the cumulative condition.

Potential fisheries-related changes to the regional economy

Alternatives 1 and 4 would increase the population of salmon along the southern Oregon and northern California coast, potentially increasing commercial and recreational ocean salmon harvest and revenues received by fishermen. Alternatives 2 and 3 could lower the population of salmon along the southern Oregon and northern California coast, the reduction under Alternative 2 being higher than Alternative 3. This reduction could potentially decrease commercial and recreational ocean salmon harvest and result in a detrimental impact on fishermen and other ocean fisheries-supported industries.

Past and present human activities have substantially changed aquatic habitats in the Southern Oregon and northern California coast compared to historical conditions, resulting in cumulative adverse impacts on to the ocean salmon fishing industry. In addition to the ongoing activities, several probable future projects and programs may affect listed fishes and other aquatic biological resources in the Southern Oregon and northern California coast by effecting upstream salmon habitat. Some of the projects and programs listed in Appendix Y, *Cumulative Methodology,* may adversely affect special-status fishes and critical habitat but others are likely to be beneficial.

Alternatives 1 and 4 would contribute to cumulatively beneficial impacts to the regional economy due to an overall increase in salmon populations which would increase commercial and recreational ocean salmon harvest and associated revenues for fishermen and ocean fisheries-supported industries. Alternatives 2 and 3 would decrease salmon populations, which would contribute to the reduction in commercial and recreational ocean salmon harvest under the cumulative condition.

Collectively, implementation of these cumulative projects is expected to directly or indirectly improve water quality in the northern California rivers and the survivability of salmon that use those rivers for habitat. Alternatives 1 and 4's contribution would be cumulatively beneficial. Alternatives 2 and 3 would contribute to a decreased salmon population along the southern Oregon and northern California coast.

Program Level Effects - potential changes to the regional economy

Alternative 2 does not have any components considered at a program level. Thus, no cumulative program-level effects on regional economics under Alternative 2 were identified.

Alternatives 1 and 3 include several program actions that would require construction, which would temporarily increase construction-related employment and spending in the areas near the construction sites. Alternatives 1 and 3 also include habitat restoration projects that could remove agricultural lands or grazing lands out of production, which could reduce irrigated acreage and agricultural revenues that would negatively impact growers and businesses and individuals who support farming activities.

Alternative 4 includes construction actions associated with water use efficiency components that could temporarily increase construction-related employment and spending in the areas near the construction sites.

Construction activities associated with cumulative projects could be beneficial to regional economics due to the increase in employment, income, and output around the same period as the action alternatives.

Implementation of program actions under Alternatives 1, 3, and 4 would contribute to cumulatively beneficial impacts to the regional economy due to increased construction actions resulting in a temporary increase in employment, labor income, and revenue in the nearby areas.

Collectively, implementation of these cumulative projects is expected to directly or indirectly provide a temporary improvement to employment, labor income, and revenue in California. Alternatives 1, 3, and 4's contribution would be cumulatively beneficial.

Q.3 References

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Appendix Q - Attachment 1

Appendix Q1 IMpact Analysis for PLANning (IMPLAN) Model Documentation

This appendix documents the IMpact Analysis for PLANning (IMPLAN) model used to evaluate the regional economic impacts in the EIS.

Q1.1 IMPLAN Model

Regional economic impacts are concerned with the effects of changes in the economy of a region. The magnitudes of the economic impacts are determined by the interactions between linkages within the local/regional economy and the leakages from this economy to the larger economy. Economic linkages are the relationships between industries, businesses, factors of production (e.g., labor and capital), and government created by trade and other exchange, such as taxes, within and among regions. Economic linkages create multiplier effects in a regional economy as money is circulated by trade. The magnitudes of impacts resulting from economic linkages are limited by the amount of leakage that occurs within the region. Economic leakages are a measure of the income shares spent outside of the region. Thus, the more the economic leakage, the less the multiplier effect. Generally, the smaller the regional economy, the higher the economic leakage. For example, the economic leakages for a county are larger than those for the state, which are larger than those for the nation.

A number of regional economic analysis modeling systems (consisting of data as well as analytical software) are available for use in regional economic analysis, such as Regional Economic Models Inc. (REMI), Regional Industrial Multiplier System II (RIMS II), and IMPLAN.

IMPLAN is an input-output (I-O) database and modeling software used to estimate economic impacts of changes in final demand or spending associated with the project alternatives. An I-O analysis describes and analyzes the relationship among industries.

Q1.1.1 IMPLAN Development History

IMPLAN was originally developed by the U.S. Forest Service in cooperation with the Federal Emergency Management Agency and the U.S. Department of the Interior (DOI), Bureau of Land Management to assist in land and resource management planning. In 1984, the U.S. Forest Service partnered with the University of Minnesota to expand and update IMPLAN data products. The updated IMPLAN software remained with the U.S. Forest Service. Beginning in 1993 through 2013, development of the IMPLAN was under exclusive rights of the Minnesota Implan Group, Inc. (MIG, Inc.), located in Stillwater, Minnesota. MIG, Inc. licensed and distributed the software to users. In 2013, MIG Inc. was purchased by IMPLAN Group LLC, which relocated the offices to Huntersville, North Carolina.

Q1.1.2 IMPLAN Model Assumptions

The IMPLAN model is the most widely used I-O impact model system in the United States. IMPLAN analyzes the relationship among industries.

IMPLAN is a static model that estimates impacts for a snapshot in time when the impacts are expected to occur, based on the makeup of the economy at the time of the underlying IMPLAN data. IMPLAN measures the initial impact to the economy but does not consider long-term adjustments as labor and capital move into alternative uses. This approach is used to compare the alternatives. Realistically, the structure of the economy will adapt and change; therefore, the IMPLAN results can only be used to compare relative changes between alternatives and cannot be used to predict or forecast future employment, labor income, or output (sales).

Any given industry typically purchases goods and services from, and sells goods and services to, another industry within a given geographic area, which in turn, sells to or buys from other industries or supplies final consumers. Figure Q1-1, Economic Linkages in a Hypothetical Industry, shows the general flows of money between industries and consumers that is captured by IMPLAN.

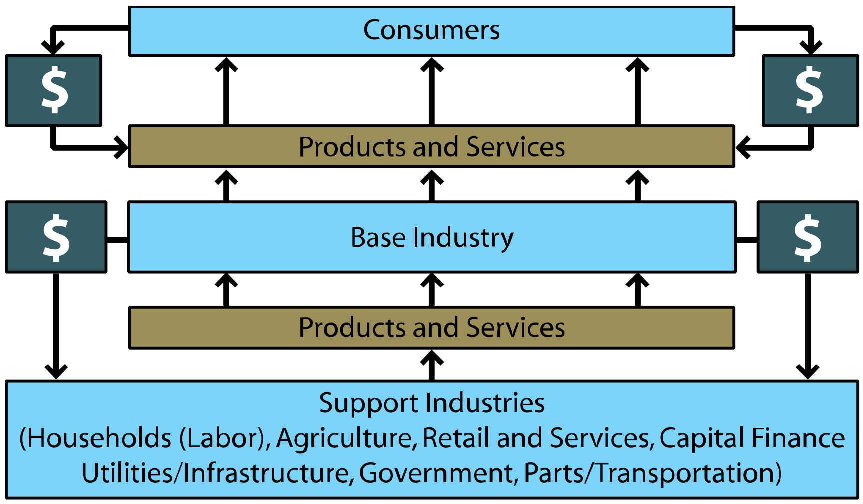

Figure Q1-1. Economic Linkages in a Hypothetical Industry

IMPLAN uses these inter-industry linkages and provides a tool to estimate the total economic effects within a region from a change in final demand to one economic sector. The industry linkages are estimated by economic multipliers (e.g., a multiplier of 2.0 indicates that each dollar of direct sale generates another dollar of secondary sales in the regional economy; a multiplier of 3.0 indicates that each dollar of direct sale generates an additional $2 of secondary sales in the regional economy, and so on). Total economic effects include:

- **Direct effects** – changes in final demand
- **Indirect effects** – changes in expenditures within the region in industries supplying goods and services
- **Induced effects** – changes in expenditures of household income

IMPLAN estimates impacts on an annual basis. If the project effects occurred over a shorter period of time, there would be fewer economic effects. This analysis presents estimates of impacts to value of output, labor income, and employment. The 2017 IMPLAN data sets were used for this analysis, since this was the most recent dataset available at the time when preparation of this EIS commenced.

Q1.1.2.1 IMPLAN Data

As discussed previously, the 2017 IMPLAN data set was used in this analysis. IMPLAN develops and releases data each year. IMPLAN data is developed from the system of national accounts for the United States based on data collected by the U.S. Department of Commerce's Bureau of Economic Analysis, the U.S. Department of Labor's Bureau of Labor Statistics, and other federal and state government agencies. The 2017 data set used in this analysis, uses the 15th comprehensive, or benchmark update of the National Income and Product Accounts (NIPAs) (IMPLAN 2018).

Data is collected for 536 distinct producing industry sectors of the national economy corresponding to the 2017 North American Industry Classification System (NAICS). Industry sectors are classified on the basis of the primary commodity or service produced. Corresponding data sets are also produced for each county in the United States, allowing analyses at the county level and for geographic aggregations such as clusters of contiguous counties, individual states, or groups of states. Initially, MIG Inc., and now the IMPLAN Group LLC, provide annual IMPLAN I-O datasets representing the state of the economy for any region. Since these data rely on the release of federal economic data, the release of the IMPLAN I-O dataset typically lags by a year or two.

Data provided for each industry sector include outputs and inputs from other sectors, value added, employment, wages and business taxes paid, imports and exports, final demand by households and government, capital investment, business inventories, marketing margins, and inflation factors (deflators). These data are provided both for the 536 producing sectors at the national level and for the corresponding sectors at the county level. Data on the technological mix of inputs and levels of transactions between producing sectors are taken from detailed input-output tables of the national economy. National and county level data are the basis for IMPLAN calculations of input-output tables and multipliers for local areas.

Q1.2 Regional IMPLAN Model Analysis

The regional economic analysis was conducted using results from the agricultural production and municipal and industrial (M&I) water use impact analyses. The incremental impact results, estimated by the Statewide Agricultural Production (SWAP) and CWEST economic models, were input into the regional IMPLAN models as the direct change caused by each of alternative as compared to the No Action Alternative and the Second Basis of Comparison. The IMPLAN models were then used to estimate the secondary (indirect and induced) regional employment, income, and output.

Q1.2.1 Modeling Objectives

IMPLAN modeling in this EIS was conducted to evaluate regional economic impacts of changes to M&I water supply costs (estimated using CWEST Model) and changes to irrigated agricultural revenue (estimated using SWAP Model). Modeling objectives included the evaluation of the following potential impacts:

- Effects on regional employment
- Effects on regional labor income
- Effects on regional total economic output

Q1.2.2 Study Areas

Models of the multi-county regions identified in the Background Information section of Appendix Q, *Regional Economics Technical Appendix*, were used to measure impacts in terms of total changes in employment, income and economic output in these regions.

SWAP and CWEST model outputs are not categorized by counties. SWAP results are provided by SWAP regions that could extend beyond the county boundaries. For example, SWAP Region V05 includes portions of Butte, Yuba, Placer and Sutter Counties. SWAP results were inputted into Sacramento Valley and San Joaquin Valley Region IMPLAN Model. Table Q1.2-1 below summarizes the IMPLAN model, Counties in the IMPLAN Model and the SWAP results inputted in the IMPLAN Model.

CWEST results are provided by M&I contractors that could extend across two or more counties. For example, Antelope Valley-East Kern Water Agency extends across Kern and Los Angeles counties. CWEST results were inputted into the IMPLAN Models based on the location of the water contractors. Table Q1.2-1, IMPLAN Models Regions, Counties and SWAP/CWEST Result Inputs, summarizes the IMPLAN model, counties in the IMPLAN model and CWEST results inputted in the IMPLAN model.

Table Q1.2-1. IMPLAN Models Regions, Counties and SWAP/CWEST Result Inputs

IMPLAN Model/Regions	Counties in IMPLAN Model	SWAP Results inputted in the IMPLAN Model	CWEST Results inputted in the IMPLAN Model
Trinity River Region	Trinity Humboldt Del Norte	–	–
Sacramento River Region	Butte Colusa El Dorado Glenn Nevada Placer Plumas Shasta Sutter Tehama Yuba	SWAP Region V01 SWAP Region V02 SWAP Region V03A/B SWAP Region V04 SWAP Region V05 SWAP Region V06[1] SWAP Region V07 SWAP Region V08	• Yuba City • Fixed City of Redding • Fixed City of Shasta Lake and Shasta CWA • City of Folsom • El Dorado ID • City of Roseville • Placer County WA
San Joaquin River Region	Stanislaus Madera Merced Fresno Tulare Kings Kern	SWAP Region V09[2] SWAP Region V10 SWAP Region V11 SWAP Region V12 SWAP Region V13 SWAP Region V14A/B SWAP Region V15A/B SWAP Region V16	• Kern County W.A. (Reaches 3, 9-13B) • City of Avenal • City of Coalinga • City of Huron • Fresno • Lindsay • Orange Cove • All other FK contractor
Delta Region	Contra Costa Sacramento San Joaquin Yolo	–	• CCWD • Solano County W.A. • Fixed City of West Sacramento • Stockton East • City of Tracy • San Juan W.D. • Sac County WA

IMPLAN Model/Regions	Counties in IMPLAN Model	SWAP Results inputted in the IMPLAN Model	CWEST Results inputted in the IMPLAN Model
San Francisco Bay Area Region	Alameda Santa Clara San Benito Napa	–	• Zone 7 Table A & A21 • ACWD Table A & A21 • Santa Clara table A & A21 • San Benito • Napa County F.C.&W.C.D.
Central Coast	San Luis Obispo Santa Barbara	–	• San Luis Obispo Co. F.C.&W.C.D. • Santa Barbara Co. F.C.&W.C.D.
Southern California	Ventura Los Angeles Orange San Diego Riverside San Bernardino	–	• MET • Castaic Lake WA • Antelope Valley-East Kern W.A.[3] • Palmdale & Little Rock Creek • Mojave W.A. • San Gorgonio • Desert W.A. • Coachella Valley W.D. • San Bernardino • Crestline-Lake Arrowhead W.A.

[1] SWAP Region V06 extends across Sutter, Sacramento, Yolo and Contra Costa Counties. This region was modeled in Sacramento Valley Region Model.
[2] SWAP Region V09 extends across San Joaquin and Contra Costa Counties. This region was modeled in San Joaquin Valley Region Model.
[3] Antelope Valley-East Kern W.A extends across Kern and Los Angeles Counties. This M&I contractors was modeled in the Southern California Region Model.
ACWD = Alameda County Water District
CCWD = Contra Costa Water District
CWA = county water agency
F.C.&W.D. = flood control and water conservation district
ID = irrigation district
IMPLAN = IMpact Analysis for PLANning
SWAP = Statewide Agricultural Production
WA = water agency
Zone 7 = Zone 7 Water Agency

Q1.2.3 Modeling and Assumptions

IMPLAN models of each region were used to estimate the secondary employment and income impacts associated with changes in irrigated agricultural production and M&I water costs. Each regional model follows county lines and incorporates, to the extent allowed by available data, the distinct sector characteristics of the region modeled.

The primary assumption attributable to IMPLAN concerns linkages among regions. Each of the IMPLAN models is a single-region model. Other than assumptions on imports, exports, and regional purchases, the models do not explicitly recognize inter-regional interdependencies among sectors. It is believed that the regions defined for the IMPLAN models are sufficiently large so that each is relatively self-sufficient as an economic entity.

Q1.2.3.1 M&I Water Costs Analysis

The long-term average year condition M&I cost estimates out of the CWEST model were used as input into the relevant IMPLAN sector within each of the regions. This analysis assumes that increased costs of water supply estimated from CWEST could be passed on to regional water users. This is a conservative assumption and water agencies may not pass on all cost increases to water customers and could find other ways to fund water supply cost increase. If water supply cost increases are not passed on to water customers, this would result in lower impacts to the regional economy.

Since M&I water supply cost estimates out of the CWEST model include changes in water supply costs for all M&I water customers including residential units, commercial buildings, large landscapes (parks, golf courses etc.) and industrial customers. M&I annual water supply costs estimates from the CWEST model was divided into effects to residential, commercial, and industrial customers using the split percentages in Table Q1.2-2 below. The split percentages in Table Q1.2-2, Urban Applied Water Breakdown by Residential/Commercial and Large Landscape, were developed based on 2010 Urban Applied Water Use as reported in the California Water Plan.

Table Q1.2-2. Urban Applied Water Breakdown by Residential/Commercial and Large Landscape

	Large Landscape	Commercial	Industrial	Residential
Sacramento River Region	9%	14%	11%	66%
San Joaquin River Region	7%	8%	15%	71%
Bay-Delta Region	8%	12%	16%	64%
Central Coast Region	9%	16%	6%	69%
San Francisco Bay Area Region	6%	20%	7%	67%
Southern California Region	11%	15%	3%	71%

Source: DWR 2010

As discussed previously, annual water supply cost changes to residential customers could be passed on to customers through a water rate change. This water rate change could result in a change in disposable income to household. These effects were modeled as an institution spending pattern to household in the IMPLAN models. Non-discretionary spending such as rent, childcare, health care etc. were removed from the spending pattern as changes to disposable income would not affect non-discretionary spending patterns.

Annual water supply costs changes to commercial customers could also be passed on to customers though rate changes. This could result in changed spending in the commercial sectors. These effects were modeled as an institutional spending pattern to State/Local Government non-education spending in the IMPLAN model.

Annual water supply cost change to industrial customers were not analyzed using IMPLAN.

Q1.2.3.2 Irrigated Agricultural Production Analysis

Incremental changes in agricultural production over the long-term condition (81-year simulation period analyzed in this EIS) were used as input into the relevant agricultural sector within each of the regions. Table Q1.2-3, Mapping SWAP Model Results to IMPLAN Sectors, shows the aggregated crop categories from the SWAP model and the IMPLAN sector to which each of these crop categories was assigned. These effects were modeled as industry changes in the specific IMPLAN sectors.

Table Q1.2-3 Mapping SWAP Model Results to IMPLAN Sectors

Crop Category	IMPLAN Sector
Grains	Sector 2 – Grain farming
Field Crops	Sector 10 – All other crop farming
Forage Crops	Sector 10 – All other crop farming
Vegetable, truck	Sector 3 – Vegetables and melon farming
Orchards and Vineyards	Sector 4 – Fruit farming

Q1.3 References

DWR 2010. Water Supply & Balance Data Interface, Lite ver. 9.1. Available here: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/WaterPortfolios/InterfaceTool/California-Water-Plan-Water-Supply-and-Balance-Tool.zip?la=en&hash=4EAE7C8C7F179FCB84FBE97370B795A94B2A7D2F

IMPLAN Group, LLC, IMPLAN System (data and software), 16740 Birkdale Commons Parkway, Suite 206, Huntersville, NC 28078 www.IMPLAN.com

IMPLAN 2018. 2018 Data Release Notes. Available here: https://implanhelp.zendesk.com/hc/en-us/articles/360011728033-2017-Data-Release-Notes

Appendix Q - Attachment 2

Appendix Q2 California Water Economics Spreadsheet Tool (CWEST) Model Documentation

This appendix documents the California Water Economics Spreadsheet Tool (CWEST) model used to support the impact analysis in the EIS. The CWEST version used for the EIS is the same version used in Final Environmental Impact Statement of the Coordinated Long-Term Operation of the Central Valley Project and State Water Project (USBR, 2015). The methodology and assumptions are provided.

Q2.1 CWEST Model Methodology

This section summarizes the CWEST development history, methodology, and coverage. It describes the overall analytical framework and the geographical extent of the economic evaluation of the alternatives. The EIS alternatives include several major components that will have significant effects on CVP and SWP operations and the quantity of delivered water to CVP and SWP M&I contractors. CWEST was developed to provide consistent and transparent analysis of economic benefits of CVP and SWP M&I water supplies for CVP contractors and SWP Table Q2.1-1 contract holders under 2030 conditions using publicly available information. Most demand data and data on local supply levels are from 2010 Urban Water Management Plans (UWMPs).

CWEST is an economic simulation and optimization tool that represents each individual CVP and SWP M&I contractor's decision making. It provides estimates of water supply costs for each contractor. The logic and methods are built on those used by other California M&I water economics tools. Similar to the existing California M&I water economics tools, CWEST minimizes the total costs of meeting annual M&I water demand subject to constraints. These costs include: conveyance and operations costs, costs of existing and new permanent supplies, transfer or other options costs, costs of local surface and groundwater operations, lost water sales revenues, and end-user shortage costs. The level of demand, quantity and type of local water supplies, and costs represent a 2030 development condition. The assumptions, sources of information, and description of the tool are discussed below.

Q2.1.1 CWEST Development History

CWEST was developed in response the requirements of the Final Environmental Impact Statement of the Coordinated Long-Term Operation of the Central Valley Project and State Water Project (USBR, 2015) quantitative analyses. CWEST provides a transparent and flexible tool that is applicable to many studies.

Q2.1.2 Modeling Objectives

The EIS modeling objectives accomplished with CWEST included the evaluation of the following potential impacts:

- Effects on CVP and SWP M&I contractor costs and revenues
- Effects on end users from experiencing shortage costs
- Annual quantities of transferred water to CVP and SWP M&I contractors

Q2.1.3 CWEST Methodology

CWEST is representation of how CVP and SWP M&I contractors will meet 2030 water demand levels at the lowest economic cost, subject to constraints. The model assumes that each CVP and SWP M&I contractor uses its contract delivery (modeled in CalSim II), local supplies, and imported water (if applicable) to meet annual demand. CWEST operates on an annual time step for the hydrologic period. The current application uses CVP and SWP delivery results modeled by CalSim II for the period 1922 to 2003, but CWEST can easily be adapted to other input data and period of record. In years where available supplies are lower than demand, the CVP and SWP M&I contractor will use local stored supplies, purchase or transfer water on a market, or short its customers - all of which result in an economic cost. If these shortage costs happen often throughout the modeled hydrologic period the CVP and SWP M&I contractor may choose to invest in additional fixed-yield supply. This tradeoff between incurring shortage costs and investing in additional fixed-yield supply is the central economic optimization in CWEST.

CWEST uses water supply costs that represent the specific situation and supply conditions for each CVP and SWP M&I contractor. Transfer and groundwater pumping costs vary by water year type or by the region. All of these shortage costs are based on linear cost functions except for the end-user shortage costs. This cost function for retail water is non-linear; therefore, CWEST uses Excel Solver® to find the optimal level of additional fixed-yield supply. At least one fixed-yield supply is included for every agency to choose when optimizing. Types of projects include stormwater, conservation, recycling, groundwater capacity, or desalination. The Metropolitan Water District of Southern California (MWDSC) can choose from five different fixed-yield project supply types, each with a unique increasing marginal cost function. The quantity of fixed-yield supply is a choice when optimizing and the cost for the new supply must be paid each year.

When annual supplies are in excess of demand, CWEST allows CVP and SWP M&I contractors to reduce groundwater pumping, put water into local or regional storage (if applicable), or turn back the water. Each CVP and SWP M&I contractor deals with excess water differently. Reduction in groundwater pumping results in a benefit based on the variable costs of groundwater pumping. Turning back water provides a cost savings based on the avoided conveyance charges. Fixed local supplies such as recycled water or desalination are not reduced in response to annual supply in excess of demand.

Q2.1.4 CWEST Coverage

Individual CVP and SWP M&I contractors are grouped into areas. Table Q2.1-1 displays the CVP and SWP M&I contractors included in each area.

Table Q2.1-1. CVP and SWP M&I Contractors included in the EIS

Central Valley Region – Sacramento Valley	Central Valley Region – San Joaquin Valley	San Francisco Bay Area Region	Central Coast Region	Southern California Region
El Dorado Irrigation District	All other Friant-Kern M&I contractors (Arvin-Edison Water Storage District, Delano-Earlimart Irrigation District, Lindsay-Strathmore Irrigation District)	Alameda County FC&WCD, Zone 7	San Luis Obispo County FC&WCD	Antelope Valley-East Kern Water Agency
Folsom, City of	Avenal, City of	Alameda County Water District	Santa Barbara County FC&WCD	Castaic Lake Water Agency
Napa County Flood Control & Water Conservation District (FC&WCD)	Coalinga, City of	Contra Costa Water District		Coachella Valley Water District
Placer County Water Agency	Fresno, City of	San Benito County Water District, Zone 6		Crestline-Lake Arrowhead Water Agency
Redding, City of	Huron, City of	Santa Clara Valley Water District		Desert Water Agency
Roseville, City of	Kern County Water Agency			MWDSC
Sacramento County Water Agency	Lindsay, City of			Mojave Water Agency
San Juan Water District	Orange Cove, City of			Palmdale Water District & Littlerock Creek Irrigation District
Shasta Lake, City of, Shasta County Water Agency, Centerville CSD (CSD), Mountain Gate CSD, and Shasta CSD	Stockton East Water District			San Bernardino Valley Municipal Water District
Solano County Water Agency	Tracy, City of			San Gorgonio Pass Water Agency
West Sacramento, City of				
Yuba City, City of				

CSD = Community Services District
FC = Flood Control
MWDSC = Metropolitan Water District of Southern California
WCD = Water Conservation District

Certain CVP and SWP M&I contractors are not included in the EIS. Table Q2.1-2 displays those CVP and SWP M&I contractors and the reason they are not included. Placeholders for San Gabriel Valley Municipal Water District, East Bay Municipal Utilities District, and Ventura County Watershed Protection District are included in CWEST, but are not modeled for the EIS. If the reason for not including them in the EIS changes, their results can be reported.

Table Q2.1-2. CVP and SWP M&I Contractors excluded from EIS Analysis

CVP and SWP Contractor	Reason
Bella Vista Water District	Contractor not included at time of CWEST development because EIS had no effect from alternatives
Clear Creek CSD	Contractor not included at time of CWEST development because EIS had no effect from alternatives
East Bay Municipal Utilities District	Lack of public information on major water supplies (Mokelumne Aqueduct)
El Dorado County Water Agency	Contractor does not have conveyance at time of CWEST development
Sacramento, City of	Contractor not included at time of CWEST development because EIS had no effect from alternatives
San Gabriel Valley Municipal Water District	Contractor uses project water solely for regional groundwater recharge
Settlement Contractors, Black Butte, Colusa Basin Drain, Corning Canal, and Tehama-Colusa Canal contractors	Contractor not included at time of CWEST development because EIS had no effect from alternatives
Ventura County Watershed Protection District	Contractor not included at time of CWEST development because EIS had no effect from alternatives

CVP = Central Valley Project
CWEST = California Water Economics Spreadsheet Tool
EIS = Environmental Impact Statement
SWP = State Water Project

Q2.2 CWEST Assumptions

Each of the EIS alternatives were evaluated under the same set of local supply, demand, and cost assumptions for 2030 conditions. The only model input that varied across alternatives is the CalSim II CVP and SWP M&I contractor delivery data.

Q2.2.1 CVP and SWP M&I Contractor Demand and Supply

CVP and SWP M&I contractor demands developed for CWEST are sourced from publicly available data. The majority of 2030 demands are reported in each CVP and SWP M&I contractor's 2010 UWMP, with exceptions for those that did not create one. 2030 demand levels for CVP and SWP M&I contractors without published UMWPs are provided by the Central Valley Project Municipal and Industrial Water Shortage Policy Draft Environmental Impact Statement (CVP M&I WSP) (Reclamation 2015). The UWMP demands presented for 2030 are assumed to be compliant with the "20% by 2020" legislation. In some cases, additional conservation is presented as part of 2030 supply in the UWMP. If so, this is counted as a demand reduction, not as a new supply in CWEST. Table Q2.2-1 displays the 2030 contract quantities and demand levels included in the model.

Table Q2.2-1. CWEST Modeled Demands in 2030

CVP and SWP M&I Contractor	2030 CVP and SWP Contract Quantities (AF)	2030 Demands From UWMP (AF)
Alameda County FC&WCD, Zone 7	80,619	75,500
Alameda County Water District	42,000	71,800
All other Friant-Kern M&I contractors (Arvin-Edison Water Storage District, Delano-Earlimart Irrigation District, Lindsay-Strathmore Irrigation District)	2,926	6,000
Antelope Valley-East Kern Water Agency	141,400	96,558
Avenal, City of	3,500	3,500
Castaic Lake Water Agency	95,200	105,313
Coachella Valley Water District	133,100	212,000
Coalinga, City of	10,000	10,000
Contra Costa Water District	195,000	215,471
Crestline-Lake Arrowhead Water Agency	5,800	2,250
Desert Water Agency	54,000	69,400
El Dorado Irrigation District	7,550	57,039
Folsom, City of	34,000	36,259
Fresno, City of	60,000	201,100
Huron, City of	3,000	3,000
Kern County Water Agency	134,600	51,750
Lindsay, City of	2,500	2,689
MWDSC	2,185,600	4,455,000
Mojave Water Agency	75,800	192,969
Napa County FC&WCD	29,025	21,572
Orange Cove, City of	1,400	2,790
Palmdale Water District & Littlerock Creek Irrigation District	21,300	45,700
Placer County Water Agency	100,000	156,333
Redding, City of	27,140	27,852
Roseville, City of	62,000	49,334
Sacramento County Water Agency	81,438	77,535
San Benito County Water District, Zone 6	8,250	11,583
San Bernardino Valley Municipal Water District	102,600	305,447
San Gorgonio Pass Water Agency	17,300	66,420
San Juan Water District	82,200	57,265
San Luis Obispo County FC&WCD	8,447	8,150
Santa Barbara County FC&WCD	62,039	75,935
Santa Clara Valley Water District	219,400	409,370
Shasta Lake, City of, Shasta County Water Agency, Centerville CSD, Mountain Gate CSD, and Shasta CSD	10,672	10,942
Solano County Water Agency	47,756	82,250

CVP and SWP M&I Contractor	2030 CVP and SWP Contract Quantities (AF)	2030 Demands From UWMP (AF)
Stockton-East Water District	75,000	64,960
Tracy, City of	20,000	31,000
West Sacramento, City of	23,600	19,273
Yuba City, City of	9,600	29,041

AF = acre-feet
CSD = Community Service District
CVP = Central Valley Project
FC = Flood Control
MWDSC = Metropolitan Water District of Southern California
M&I = municipal and industrial
SWP- State Water Project
WCD = Water Conservation District

Q2.2.1.1 Development of 2030 CVP and SWP M&I Contractor Water Supplies

CWEST uses UWMP reported local supplies expected to be available in 2030. In some cases, UWMP supplies were adjusted for projects that may not be implemented by 2030. CWEST uses the 2030 UWMP "normal" year supplies to represent 2030 supplies in wet, above normal, and below normal years, and "multiple-year drought" supplies are used to represent 2030 supplies in dry and critical years. The Sacramento index is used for CVP and SWP M&I contractors in the Sacramento Valley and the San Francisco Bay Area Region. The San Joaquin index is used for CVP and SWP M&I contractors in the San Joaquin Valley, the Central Coast Region, and the Southern California Region. Local, non-project supply amounts are as summarized in Table Q2.2-2.

Table Q2.2-2. CWEST Assumed 2030 Non-Project Supplies

CVP and SWP M&I Contractor	Non-Project Supplies in Below Normal or Better Water Year Type	Non-Project Supplies in Dry or Critical Water Year Type
Alameda County FC&WCD, Zone 7	11,600	2,620
Alameda County Water District	50,800	35,600
All other Friant-Kern M&I contractors (Arvin-Edison Water Storage District, Delano-Earlimart Irrigation District, Lindsay-Strathmore Irrigation District) [1]	3,000	0
Antelope Valley-East Kern Water Agency	40,000	20,000
Avenal, City of [1]	0	0
Castaic Lake Water Agency	77,787	77,787
Coachella Valley Water District	238,840	238,850
Coalinga, City of [1]	0	0
Contra Costa Water District	64,000	51,600
Crestline-Lake Arrowhead Water Agency	481	481
Desert Water Agency	69,900	89,000
El Dorado Irrigation District	54,789	54,789
Folsom, City of	3,250	11,250
Fresno, City of	228,800	232,400
Huron, City of [1]	0	0

CVP and SWP M&I Contractor	Non-Project Supplies in Below Normal or Better Water Year Type	Non-Project Supplies in Dry or Critical Water Year Type
Kern County Water Agency	68,126	40,130
Lindsay, City of [1]	1,210	1,210
MWDSC	3,040,100	3,142,300
Mojave Water Agency	152,921	176,785
Napa County FC&WCD	19,082	21,565
Orange Cove, City of [1]	0	0
Palmdale Water District & Littlerock Creek Irrigation District	39,600	42,059
Placer County Water Agency	68,119	103,119
Redding, City of	13,424	13,424
Roseville, City of	3,397	3,397
Sacramento County Water Agency	74,898	74,898
San Benito County Water District, Zone 6	5,174	5,174
San Bernardino Valley Municipal Water District	314,225	314,225
San Gorgonio Pass Water Agency	43,952	43,952
San Juan Water District	0	0
San Luis Obispo County FC&WCD	8,288	8,288
Santa Barbara County FC&WCD	79,490	79,490
Santa Clara Valley Water District	246,830	179,980
Shasta Lake, City of, Shasta County Water Agency, Centerville CSD, Mountain Gate CSD, and Shasta CSD [1]	1,064	1,064
Solano County Water Agency	75,276	75,276
Stockton-East Water District	28,000	50,000
Tracy, City of	15,250	16,050
West Sacramento, City of	5,000	5,000
Yuba City, City of	22,748	22,748

[1] CVP and SWP M&I Contractor without 2010 UWMP and supply and 2030 supply conditions are from CVP M&I WSP (Reclamation 2015)
AF = acre-feet
CSD = Community Service District
CVP = Central Valley Project
FC = Flood Control
MWDSC = Metropolitan Water District of Southern California
M&I = municipal and industrial
SWP- State Water Project
WCD = Water Conservation District

Q2.2.1.2 CalSim II Linkage Information

CalSim II node identification for each CVP and SWP M&I contractor in the EIS analysis is displayed in Table Q2.2-3.

Table Q2.2-3. CWEST and CalSim II Linkage

CVP and SWP M&I Contractor	CalSim II Equivalent Nodes
Alameda County FC&WCD, Zone 7	D810_PCO + D810_PMI + D813_PCO + D813_PMI + D810_PIN
Alameda County Water District	D814_PCO + D814_PMI + D814_PIN
All other Friant-Kern M&I contractors (Arvin-Edison Water Storage District, Delano-Earlimart Irrigation District, Lindsay-Strathmore Irrigation District)	2.926*(D910_C1/60)
Antelope Valley-East Kern Water Agency	D877_PMI + D877_PCO + D877_PIN
Avenal, City of	D844_PMI*0.35
Castaic Lake Water Agency	D896_PMI + D896_PCO
Coachella Valley Water District	D883_PMI + D883_PCO + D883_PIN
Coalinga, City of	D844_PMI*0.5
Contra Costa Water District	D420
Crestline-Lake Arrowhead Water Agency	D25_PMI + D25_PCO
Desert Water Agency	D884_PMI + D884_PCO + D884_PIN
El Dorado Irrigation District	D8F_NP + D8F_PMI
Folsom, City of	D8B_NP + D8B_PMI
Fresno, City of	MAX(0.25*60, D910_C1*(60/64.802))
Huron, City of	D844_PMI*0.15
Kern County Water Agency	D851A_PMI
Lindsay, City of	2.5*(D910_C1/60)
MWDSC	D895_PMI + D895_PMI+ D895_PIN+ D899_PCO + D899_PCO + D899_PIN + D27_PMI +D27_PIN + D27_PCO +D885_PMI + D885_PCO + D885_PIN
Mojave Water Agency	D881_PMI + D881_PCO
Napa County FC&WCD	D403B_PMI + D403B_PCO + D403B_PIN
Orange Cove, City of	1.4*(D910_C1/60)
Palmdale Water District & Littlerock Creek Irrigation District	D878_PMI + D878_PCO
Placer County Water Agency	D8H_PMI+D300_NP
Redding, City of	D104_PSC*0.13779 + D104_PMI*0.5
Roseville, City of	D8G_NP + D8G_PMI
Sacramento County Water Agency	D168C+D167B
San Benito County Water District, Zone 6	0.065*D711_PMI+0.518*D710_PAG
San Bernardino Valley Municipal Water District	D886_PMI + D886_PCO
San Gorgonio Pass Water Agency	D888_PMI + D888_PCO
San Juan Water Agency	D8D_NP + D8E_NP + D8E_PMI
San Luis Obispo County FC&WCD	[MIN(D869_PMI + D869_PCO,8.447)]
Santa Barbara County FC&WCD	[((D870_PMI + D870_PCO) + ((D870_PMI + D870_PCO) - 8.4)) * (0.852 if WY is W,AN,BN, 0.522 if WY is D,C)]
Santa Clara Valley Water District	D710_PAG * 0.442 + D711_PMI * 0.935 + D815_PCO + D815_PMI +D815_PIN

CVP and SWP M&I Contractor	CalSim II Equivalent Nodes
Shasta Lake, City of, Shasta County Water Agency, Centerville CSD, Mountain Gate CSD, and Shasta CSD	D104_PMI*0.5 + D104_PMI*0.35
Solano County Water Agency	D403C_PMI + D403C_PCO
Stockton-East Water District	D520_SEWD_PMI
Tracy, City of	0.2*[South of Delta % PMI Delivery]
West Sacramento, City of	D165_PSC
Yuba City, City of	D204_PMI

CSD = Community Service District
CVP = Central Valley Project
FC = Flood Control
MWDSC = Metropolitan Water District of Southern California
M&I = municipal and industrial
SWP- State Water Project
WCD = Water Conservation District

Q2.2.1.3 Development of Storage Operations

CWEST includes storage operations for the CVP and SWP M&I contractors with published information on local storage operations, who participate in a regional groundwater bank, or who use significant local groundwater banking to store water. CVP and SWP M&I contractors that participate in Semitropic Water Storage District's (WSD) groundwater banking program have their capacity share included. Most of MWDSC's portfolio of local storage projects are modeled. See Table Q2.2-4 for the list of storage operations included in CWEST.

Table Q2.2-4. Storage Operations Assumptions

Contractor with Storage	Modeled Storage Capacities
Alameda County FC&WCD, Zone 7	78,000 AF Semitropic WSD Share[1] 126,000 AF Local Groundwater[2] 120,000 AF Cawelo Water District[2]
Alameda County Water District	150,000 AF Semitropic WSD Share[1]
MWDSC	1,600,000 AF Regional Groundwater Banks[3] 980,000 AF Local Surface Storage[4]
Santa Clara Valley Water District	350,000 AF Semitropic WSD Share[1] 530,000 AF Local Groundwater[5]
Stockton-East Water District	100,000 AF Local Groundwater[6]

[1] (Semitropic 2015)
[2] (ACWD 2011)
[3] Includes: Arvin Edison WSD, Semitropic WSD, Kern Delta Water District, Mojave Water Agency Storage Program, Conjunctive Use programs (MWDSC 2011)
[4] Includes: Castaic Lake, Diamond Valley, Lake Mathews, Lake Skinner, and Cyclic Storage (MWDSC 2011)
[5] (SCVWD 2011)
[6] Stockton-East UWMP (SEWD 2011)
AF = acre-feet
FC = Flood Control
MWDSC = Metropolitan Water District of Southern California
WCD = Water Conservation District

Q2.2.2 Water Costs

Water costs include delivery costs, groundwater pumping costs, additional fixed-yield supply costs, storage operations costs, and shortage costs. Shortage costs include retail revenue losses, transfer and annual option costs, and end-user shortage costs. Increases in M&I deliveries raise total delivery costs, but may decrease shortage costs. Real increases in water and energy costs are used to escalate costs to the 2030 levels needed for the EIS analysis.

Q2.2.2.1 Delivery costs and Water Prices

CVP and SWP M&I deliveries are assigned a delivery cost based on Reclamation CVP M&I (Reclamation 2009) rates and Bulletin 132-10 (DWR 2013), respectively. In years when supply is in excess of demand, even after reductions in groundwater pumping and puts into storage, the quantity of excess water is credited the delivery costs. This represents a CVP and SWP M&I contractor "turning back" water.

The delivery cost for SWP M&I contractors is the variable OMP&R component plus the Off-Aqueduct charge, which is also charged based on amount of deliveries (CCWA 2007). As an example, DWR calculates the Off-Aqueduct charges based on the requested deliveries submitted by the Authority on a calendar year basis. The resulting total is paid by the Authority in twelve equal payments throughout the calendar year. Additionally, in May of each year, DWR provides an amended Off-Aqueduct bill based on the actual water deliveries and power costs for the first six months of the year. The delivery cost of CVP water is the "O&M rate" (Reclamation 2009).

Real energy costs are expected to increase in real terms leading up to 2030. The California Energy Commission mid-demand scenario predicts that real electricity rates will increase 1.7 percent annually over the 2014 to 2024 period (CEC 2013). This rate of increase is applied to water delivery costs up to 2030. See Table Q2.2-5 for 2030 delivery costs for CVP and SWP M&I contractors.

Table Q2.2-5 also shows representative retail water prices for each CVP and SWP M&I contractor. MWDSC projects their water rates will have a 1.364 percent real rate of increase annually between 2014 and 2024. Other CVP and SWP M&I contractors have not made long-range projections of real retail prices, so CWEST applies MWDSC's real rate of increase to all CVP and SWP M&I contractor retail water prices to estimate 2030 levels. Retail water prices are used to estimate revenue losses to CVP and SWP M&I contractors from a shortage.

Table Q2.2-5. Conveyance and Retail Water Price Assumptions

CVP and SWP M&I Contractor	CVP and SWP Delivery costs in 2030 ($/AF)[1]	Retail Water Price in 2030 ($/AF)[2]
Alameda County FC&WCD, Zone 7	42	1,162
Alameda County Water District	30	1,528
All other Friant-Kern M&I contractors (Arvin-Edison Water Storage District, Delano-Earlimart Irrigation District, Lindsay-Strathmore Irrigation District)	16	228
Antelope Valley-East Kern Water Agency	145	580
Avenal, City of	16	1,130
Castaic Lake Water Agency	99	1,462
Coachella Valley Water District	$162	$472
Coalinga, City of	$24	$228

CVP and SWP M&I Contractor	CVP and SWP Delivery costs in 2030 ($/AF)[1]	Retail Water Price in 2030 ($/AF)[2]
Contra Costa Water District	$26	$1,577
Crestline-Lake Arrowhead Water Agency	$173	$402
Desert Water Agency	$139	$527
El Dorado Irrigation District	$16	$475
Folsom, City of	$16	$235
Fresno, City of	$16	$228
Huron, City of	$16	$228
Kern County Water Agency	$18	$290
Lindsay, City of	$16	$228
MWDSC	$122	$1,374
Mojave Water Agency	$232	$1,175
Napa County FC&WCD	$33	$1,921
Orange Cove, City of	$16	$228
Palmdale Water District & Littlerock Creek Irrigation District	$192	$580
Placer County Water Agency	$16	$594
Redding, City of	$16	$514
Roseville, City of	$16	$197
Sacramento County Water Agency	$25	$454
San Benito County Water District, Zone 6	$32	$890
San Bernardino Valley Municipal Water District	$154	$402
San Gorgonio Pass Water Agency	$323	$624
San Juan Water Agency	$16	$235
San Luis Obispo County FC&WCD	$156	$2,429
Santa Barbara County FC&WCD	$157	$1,719
Santa Clara Valley Water District	$27	$1,204
Shasta Lake, City of, Shasta County Water Agency, Centerville CSD, Mountain Gate CSD, and Shasta CSD	$16	$596
Solano County Water Agency	$21	$1,198
Stockton-East Water District	$15	$507
`Tracy, City of	$16	$582
West Sacramento, City of	$16	$454
Yuba City, City of	$0	$681

[1] (Reclamation 2009) and (DWR 2013) escalated from 2010 to 2030 in proportion to the change in real energy prices (CEC 2013)
[2] Published retail prices were chosen from representative locations (Black and Veatch 2006) and updated using MWDSC
AF = acre-feet
CSD = Community Service District
CVP = Central Valley Project
FC = Flood Control
MWDSC = Metropolitan Water District of Southern California
M&I = municipal and industrial
SWP- State Water Project
WCD = Water Conservation District

Q2.2.2.2 Additional Fixed-Yield Supply Costs

For each CVP and SWP M&I contractor, at least one fixed-yield supply is available to choose in optimization. Examples are reclamation water projects, desalination, new groundwater development, and some types of conservation. Fixed-yield supplies provide the same amount of water every year and the annualized cost for operations and capital is paid every year. The model selects a level of fixed-yield supply that minimizes total cost over the hydrologic period. Table Q2.2-6 shows the fixed-yield supply included for each CVP and SWP M&I contractor and its annualized cost except for those with multiple fixed-yield supplies to choose from.

A variety of data sources were used to obtain capital costs of representative projects including the UWMPs, IRWM grant applications, and other public information.

For some CVP and SWP M&I contractors in the Sacramento Valley, the model chooses an optimal increase in total groundwater pumping capacity when that is the additional fixed-yield supply to choose. The model currently uses information from four representative urban well developments in Sonoma County (SCWA 2010). The annualized cost of well development for four wells was $358 per AF. When a CVP and SWP M&I contractor chooses to increase their groundwater pumping capacity, the annual pumping cost is added to obtain a total cost per AF per year.

Table Q2.2-6. Information on Additional Fixed-Yield Supplies

CVP and SWP M&I Contractor	Additional Fixed-Yield Supply Costs ($/AF)[1]	Type or Name of Additional Fixed-Yield Supply
Alameda County FC&WCD, Zone 7	Variable - See Table Q2.2-8	Variable - See Table Q2.2-8
Alameda County Water District	Variable - See Table Q2.2-8	Variable - See Table Q2.2-8
All other Friant-Kern M&I contractors (Arvin-Edison Water Storage District, Delano-Earlimart Irrigation District, Lindsay-Strathmore Irrigation District)	$449	Develop Groundwater[1]
Antelope Valley-East Kern Water Agency	$568	Regional Aquifer Project[2]
Avenal, City of	$266	Transfer/ exchange[3]
Castaic Lake Water Agency	$400	None - Assumed $400
Coachella Valley Water District	$258	Recycle golf course water[4]
Coalinga, City of	$274	Transfer/ exchange[3]
Contra Costa Water District	$1,070	Bay Area Regional Desalination[5]
Crestline-Lake Arrowhead Water Agency	$423	Transfer/ exchange[3]
Desert Water Agency	$416	Additional Colorado River Aqueduct water[3]
El Dorado Irrigation District	$410	Develop Groundwater[1]
Folsom, City of	$365	Willow Hill Pipeline Rehabilitation Project[6]
Fresno, City of	$449	Develop Groundwater[1]
Huron, City of	$266	Transfer/ exchange[3]
Kern County Water Agency	$314	None- Assumed $314
Lindsay, City of	$449	Develop Groundwater[1]

CVP and SWP M&I Contractor	Additional Fixed-Yield Supply Costs ($/AF)[1]	Type or Name of Additional Fixed-Yield Supply
MWDSC	Variable - See Table A.10	Variable - See Table A.10
Mojave Water Agency	$482	Transfer/ exchange[3]
Napa County FC&WCD	$233	Transfer/ exchange[3]
Orange Cove, City of	$449	Develop Groundwater[1]
Palmdale Water District & Littlerock Creek Irrigation District	$615	Regional Aquifer Project[7]
Placer County Water Agency	$410	Develop Groundwater[1]
Redding, City of	$432	Develop Groundwater[1]
Roseville, City of	$502	Develop Groundwater[1]
Sacramento County Water Agency	$410	Develop Groundwater[1]
San Benito County Water District, Zone 6	$384	Transfer/ exchange[3]
San Bernardino Valley Municipal Water District	$366	Beaumont Avenue Recharge Facility[8]
San Gorgonio Pass Water Agency	$366	Beaumont Avenue Recharge Facility[8]
San Juan Water Agency	$138	Regional Indoor & Outdoor Efficiency[6]
San Luis Obispo County FC&WCD	$475	Raise Lopez Dam 3-5 feet[9]
Santa Barbara County FC&WCD	$804	Expand Conjunctive Use and Groundwater[1]
Santa Clara Valley Water District	$1,795	Bay Area Regional Desalination[5]
Shasta Lake, City of, Shasta County Water Agency, Centerville CSD, Mountain Gate CSD, and Shasta CSD	$216	Transfer/ exchange[3]
Solano County Water Agency	$221	Expand exchange w/ Mojave Water Agency[3]
Stockton-East Water District	$338	Delta Water Supply Project[10]
Tracy, City of	$266	Transfer/ exchange[3]
West Sacramento, City of	$410	Develop Groundwater[1]
Yuba City, City of	$432	Develop Groundwater[1]

[1] (SCWA 2010) for cost of well development plus pumping cost from Table A.13
[2] (AVEK 2011)
[3] Transfer cost from Table A.11 plus delivery cost from Table A.8
[4] (CVWD 2013)
[5] (BARDP 2011)
[6] (RWA 2011)
[7] (ESA 2014)
[8] (FCS 2013)
[9] (Zone 3 2009)
[10] (ESJGB 2014)
AF = acre-feet
CSD = Community Service District
CVP = Central Valley Project
FC = Flood Control
MWDSC = Metropolitan Water District of Southern California

M&I = municipal and industrial
SWP- State Water Project
WCD = Water Conservation District

Alameda County FC&WCD, Zone 7, Alameda County Water Agency, and MWDSC have multiple additional fixed-yield supplies modeled in CWEST. For MWDSC, five fixed yield options are provided; reclamation, desalination, groundwater recovery, conservation, and stormwater. Cost functions are included that express the average cost of supply as an increasing function of the amount used. Table Q2.2-7 displays the range of average cost for each supply type.

Table Q2.2-7. CVP and SWP M&I Contractors with Multiple Additional Fixed-Yield Supply Options

CVP and SWP M&I Contractor	Additional Fixed-Yield Supply Costs ($/AF) – Type or Name of Additional Fixed-Yield Supply – Maximum Quantity Available (AF)
Alameda County FC&WCD, Zone7	$20 - Arroyo Valle - Perfection of Existing Permit – 3,800[1] $30 - Reduction of Demineralization Losses - 260[1] $100 - Reduction of Unaccounted-for-Water – 1,300[1] $110 - Enhance Existing In-lieu Recharge – 500-830[1] $200 - Arroyo Las Positas Water Rights - 750[1] $200 - Arroyo Mocho Water Rights - 900[1] $285 - Confirm Byron-Bethany Irrigation District Yield – 3,000[1] $1,400 - Intertie Supply: Long-term Leases – 10,900[1] $1,500 - Recycled Water - Direct – 3,700[1] $1,600 - Groundwater Injection: Recycled Water – 2,800[1] $2,000 - Intertie Supply: Regional Desalination – 9,300[1] $2,400 - Recycled Water - Storage – 17,300[1]
Alameda County Water District	$410 – Conservation – 3,600[2] $500 – Expansion of Newark Facility – 5,100[2]
MWDSC	$500 to $1,500[3] – Groundwater Recovery – 92,000[4] $600 to $1,500[3] – Recycling - 360,000[4] $192 to $1,300[5] – Conservation – 346,000[4] $300 to $1,500[6] – Stormwater Capture – 75,000[4] $1,300 to $2,000[3] – Desalination - 84,000[4]

[1] (Zone 7 WA 2011)
[2] (ACWD 2014
[3] (MWDSC 2010)
[4] (LADWP 2011)
[5] (Mitchell 2005)
[6] (Geosyntec Consultants 2014)
AF = acre-feet
CSD = Community Service District
CVP = Central Valley Project
FC = Flood Control
MWDSC = Metropolitan Water District of Southern California
M&I = municipal and industrial
SWP- State Water Project
WCD = Water Conservation District

Q2.2.2.3 Transfer Costs and Annual Options

Annual options are supplies that can be made available to meet demands annually. The model allows for separate costs of these supplies in dry and critical years, and a separate cost in below normal or wetter years. In below normal or wetter years, these supplies are generally transfers or groundwater. In dry or critical years, these supplies are generally transfers; providers are not allowed to pump groundwater in excess of their UWMP levels.

Costs of water transfers are based on publications summarizing observed market prices (Hanak and Stryjewski 2012, Mann and Hatchett 2012, WestWater Research 2013). Transfer prices were created for multiple regions, based on historical transfers in the same area of origin. Colorado River transfer prices are included as a supply option for agencies receiving their SWP Table A water by exchange. Prices are based on planned prices for the water transfer between Imperial Irrigation District and San Diego County Water Authority. The dry/critical year price is calculated as the weighted average of historical dry and critical year prices, where the weights are the frequency of the two year types in the historic hydrology (18 dry years and 12 critical years). The GNP Implicit Price Deflator was used to bring historical transfer prices to equivalent years.

These prices are intended as representative for purposes of the analysis, and are not predictions. Also, the prices in Table Q2.2-8 are at the source (location of purchase), and do not include delivery costs or losses. A conveyance loss of 18 percent is assumed for cross-Delta transfers, Water delivery costs from Table Q2.2-5 are included for all transfers.

Table Q2.2-8. Assumed Water Transfer Prices in CWEST, 2030 Conditions[1]

	NOD Origin	SOD origin	NOD with Conveyance Loss	Colorado River Transfers
Below Normal or Wetter	$200	$250	$244	$416
Dry or Critical	$378	$480	$461	$416

[1] See A.2.2.3 Transfer Costs and Annual Options for source information
NOD = North of Delta
SOD = South of Delta

Q2.2.2.4 Storage Operations and Groundwater Costs

Q2.2.2.4.1 Storage Operations Costs

Storage operations are included for MWDSC, some CVP and SWP M&I contractors in the San Francisco Bay Area Region, and Stockton-East Water District. The San Francisco Bay Area Region includes some local groundwater storage and Semitropic Water Bank storage for SCVWD, Zone 7 and ACWD. Storage operation costs for MWDSC are based on information provided in its Water Surplus and Demand Management Plan (MWDSC, 2011). Semitropic WSD's published put and take costs for banking operations are used in CWEST in addition to the delivery cost (Semitropic 2014). Local groundwater storage operation costs used by San Francisco Bay Area Region CVP and SWP M&I contractors are based on the groundwater costs detailed in Table Q2.2-9. These put and take costs for local groundwater storage operations are also used for Stockton East Water District's modeled operations.

Q2.2.2.4.2 Groundwater costs

CWEST includes an estimate of cost savings for groundwater not pumped when excess CVP and SWP water is available. Data on groundwater costs are from CVP and SWP M&I contractor UWMPs where possible. When this information is not available in UWMPs, groundwater pumping costs are based on estimates of regional depth to groundwater and electricity price. Depths to groundwater are from DWR's Bulletin 118 - Groundwater Basin Maps and Descriptions (DWR, 2004). The amount of groundwater available in below normal or wetter, and dry or critical conditions, is based on individual CVP and SWP M&I contractor UWMPs.

Groundwater pumping costs were estimated for each EIS area based on a representative value from published information. CVP and SWP M&I contractors in the Southern California Region have a groundwater pumping cost based on an estimate published in a Groundwater Basin Assessment (MWDSC 2007). Representative groundwater pumping costs in the Central Coast Region are based on recent estimates from the City of Santa Barbara (City of Santa Barbara 2015). Groundwater pumping costs in the San Francisco Bay Area Region are based published estimates from San Benito County (SBCWD 2014). San Joaquin Valley groundwater pumping costs are based on published estimates from James Irrigation District and Fresno Irrigation District (KBWA 2013). Sacramento Valley had no readily available information on groundwater pumping estimates. Groundwater depth estimates and published estimates of groundwater pumping from the previous sources were used to interpolate groundwater pumping costs in the Sacramento Valley. This method was used to adjust groundwater pumping prices in other regions.

Additional costs associated with groundwater use include lower groundwater tables, subsidence, streamflow depletion, depreciation, and well replacement that should be included. In some locations, groundwater must be treated for water quality, adding additional cost. No consistent source of information is available to assess these other costs, so cost per AF is conservatively increased by ten percent to account for some of these costs. Real increases in energy costs were applied to groundwater pumping costs (CEC 2013). Table Q2.2-9 displays groundwater variable costs used in the model.

Table Q2.2-9. Groundwater Variable Pumping Costs

CVP and SWP M&I Contractor	Estimated Groundwater Pumping Cost in 2030 ($/AF)[1]
Alameda County FC&WCD, Zone 7	52
Alameda County Water District	52
All other Friant-Kern M&I contractors (Arvin-Edison Water Storage District, Delano-Earlimart Irrigation District, Lindsay-Strathmore Irrigation District)	91
Antelope Valley-East Kern Water Agency	171
Avenal, City of	91
Castaic Lake Water Agency	94
Coachella Valley Water District	171
Coalinga, City of	91
Contra Costa Water District	52
Crestline-Lake Arrowhead Water Agency	171
Desert Water Agency	171
El Dorado Irrigation District	52
Folsom, City of	52
Fresno, City of	91
Huron, City of	91
Kern County Water Agency	168
Lindsay, City of	91
MWDSC	94
Mojave Water Agency	171
Napa County FC&WCD	108
Orange Cove, City of	91

CVP and SWP M&I Contractor	Estimated Groundwater Pumping Cost in 2030 ($/AF)[1]
Palmdale Water District & Littlerock Creek Irrigation District	171
Placer County Water Agency	52
Redding, City of	74
Roseville, City of	52
Sacramento County Water Agency	52
San Benito County Water District, Zone 6	52
San Bernardino Valley Municipal Water District	171
San Gorgonio Pass Water Agency	171
San Juan Water Agency	52
San Luis Obispo County FC&WCD	298
Santa Barbara County FC&WCD	298
Santa Clara Valley Water District	52
Shasta Lake, City of, Shasta County Water Agency, Centerville CSD, Mountain Gate CSD, and Shasta CSD	74
Solano County Water Agency	108
Stockton-East Water District	91
Tracy, City of	91
West Sacramento, City of	52
Yuba City, City of	74

[1] See A.2.2.4 Storage Operations and Groundwater Costs – *Groundwater Costs* for source information
AF = acre-feet
CSD = Community Service District
CVP = Central Valley Project
FC = Flood Control
MWDSC = Metropolitan Water District of Southern California
M&I = municipal and industrial
SWP- State Water Project
WCD = Water Conservation District

Q2.2.2.5 Shortage Costs

Shortages in critical years are handled in an approach that represents common behavior of CVP and SWP M&I contractors. CWEST requires that a 5 percent end-use drought conservation shortage is implemented before any annual supply is purchased in critical year. Then, a provider can eliminate a shortfall using dry/critical year annual supply. Therefore, end-user shortages only occur during critical years.

Shortage costs are lost retail water revenue plus end-user shortage costs. Revenue losses are based on the water prices displayed in Table Q2.2-5. The model calculates shortage costs based on a constant elasticity of demand (CED) demand function. This form of shortage loss function is standard practice in California water economics studies and has documented descriptions (M. Cubed 2007). The 2030 demand levels in Table Q2.2-6 price defines one point on the demand function, and the slope is defined by the price elasticity.

The short-run demand price elasticity assumed for all providers is -0.1. This elasticity represents a demand elasticity appropriate for drought conditions. A variety of studies have found short-run price elasticities in the range of -0.1 to -0.3 (Thomas and Syme 1988, A&N Technical Services 1996). Urban price elasticity in California is generally believed to be even more inelastic because of demand hardening, meaning that many actions that people could use to reduce water use in response to shortage will already have been implemented by 2030.

This shortage cost function generates very high costs at high shortage levels, so CWEST can limit the marginal value of water from the CED function. The current cap is set at $7000 per acre-foot year (AFY) more than the provider's retail water price.

Q2.3 CWEST Results

CWEST generates results for each CVP and SWP M&I contractor, which can be aggregated into regions or a statewide total. Result tables descriptions and interpretations are included below in Table Q2.3-1.

Table Q2.3-1. Interpretation of Reported Results

Reported Results	Interpretation
Average Annual CVP and SWP Deliveries (TAF)	Average Annual CVP and SWP delivery quantity for the reported alternative
Delivery Cost ($1,000)	Delivery cost to deliver SWP/ CVP water
New Supply (TAF)	Additional 2030 fixed-yield supply above stated 2030 supplies. This is the cost-minimizing decision variable in the model.
Annualized New Supply Costs ($1,000)	Cost of optimal quantity of additional 2030 fixed-yield supply. Varies across contractors by type of new supply listed in their UWMPs as likely new supply (e.g., desalination, recycling, conservation)
Surface/GW Storage Costs ($1,000)	Cost of annual puts/takes into local surface storage, local groundwater storage, or regional groundwater banks (e.g., Semitropic WSD)
Lost Water Sales Revenues ($1,000)	Loss of retail water sales revenue due to shortage
Transfer Costs ($1,000)	Cost to purchase and deliver transfer water purchases on annual spot market, or other annual options if applicable
Shortage Costs ($1,000)	Estimated consumer surplus loss to water shortages
GW pumping savings ($1,000)	Savings from resulting reduction in groundwater pumping relative to UWMP levels
Excess Water Savings ($1,000)	Cost savings from contract water not used to meet demand or reduce groundwater pumping
Average Annual Cost ($1,000)	Lost water sales revenue plus change in delivery, new supply, storage, transfers, options, and groundwater costs

AF = acre-feet
CVP = Central Valley Project
SWP- State Water Project
TAF = thousand acre-feet
UWMP = Urban Water Management Plan
WSD = Water Storage District

Q2.4 References

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Appendix Q - Attachment 3

Appendix Q3 Statewide Agricultural Production (SWAP) Model Documentation

This appendix documents the Statewide Agricultural Production (SWAP) model used to support the impact analysis in the EIS. The SWAP model version 6.1 was used for the EIS, which is the most recently updated version available. Previous model versions have been used for similar impact analyses. For example, SWAP version 6 was used in Final Environmental Impact Statement of the Coordinated Long-Term Operation of the Central Valley Project and State Water Project (Reclamation 2015). The methodology and assumptions are provided, while more comprehensive SWAP model documentation can be found in the reference list.

Q3.1 SWAP Model Methodology

This section summarizes the SWAP model version, methodology, and coverage. It describes the overall analytical framework and contains descriptions of input data. The project alternatives include several major components that will have significant effects on CVP/SWP operations and the quantity of delivered water to agricultural contractors.

The SWAP model is a regional agricultural production and economic optimization model that simulates the decisions of farmers across 93 percent of agricultural land in California. It is the most current in a series of production models of California agriculture developed by researchers at the University of California at Davis under the direction of Professor Richard Howitt and Duncan MacEwan in collaboration with the California Department of Water Resources (DWR). The SWAP model has been subject to peer-review and technical details can be found in the publication "Calibrating Disaggregate Economic Models of Irrigated Production and Water Management" (Howitt et al. 2012).

Q3.1.1 SWAP Model Version

The SWAP model version 6.1 is the most recent publicly-available model version and was used to estimate the economic value of new water supply in the California Water Commission Water Storage Investment Program Technical Reference Document (CWC, 2016) to support the evaluation of Prop 1 applications. It is also being used in several ongoing studies of water projects and operations. This version is calibrated using 2010 crop acreage, 2010 water use, and 2011-2012 crop prices and costs. SWAP model version 6.1 developed for the Prop 1 application was used for the regional economics evaluation in this EIS. Following changes were made to the SWAP version 6.1 model specific to the analysis in this EIS:

1. Using fixes crop prices instead of the endogenous price model: Fixed crop prices were assumed across all regions and all alternatives. The fixed crop prices were escalated and calculated for appropriate population and demand The scale of change in agricultural deliveries across the EIS alternatives resulted in cropping pattern and production changes outside of the range of the crop demand elasticities. The fixed-price model allows for changes in large changes production without large changes in prices; without fixed prices, the changes in global prices are not affected by changes in production.

2. CALSIM deliveries: The model was run using CALSIM estimates agricultural deliveries. CALSIM modeling and assumptions are documented in Appendix F, Model Documentation. Following adjustments were made to CALSIM results specific to the regional economic analysis:
   a. Agricultural water supply deliveries in certain regions were adjusted to correct a CALSIM mis-characterization of decomposition water for rice acreage.
   b. Agricultural deliveries to certain SWAP regions were adjusted to improve the post-processing calculations of CALSIM output with the alternative assumptions.

Q3.1.2 Modeling Objectives

The EIS modeling objectives accomplished with the SWAP model included the evaluation of the following potential impacts:

- Effects on irrigated agricultural acreage
- Effects on total production value
- Effects on groundwater pumping and groundwater pumping costs

Q3.1.3 SWAP Model Methodology

The SWAP model assumes that growers select the crops, water supplies, and other inputs to maximize profit subject to resource constraints, technical production relationships, and market conditions. Growers face competitive markets, where no one grower can influence crop prices. The competitive market is simulated by maximizing the sum of consumer and producer surplus subject to the following characteristics of production, market conditions, and available resources:

- Constant Elasticity of Substitution (CES) production functions for every crop in every region. CES has 4 inputs: land, labor, water, and other supplies. CES production functions allow for limited substitution between inputs which allows the model to estimate both total input use and input use intensity. Parameters are calculated using a combination of prior information and the method of Positive Mathematical Programming (PMP) (Howitt 1995a, Howitt 1995b).
- Marginal land cost functions are estimated using PMP. Additional land brought into production is assumed to be of lower value and thus requires a higher cost to cultivate. The PMP functions capture this cost by using acreage response elasticities which relate change in acreage to changes in expected returns and other information.
- Groundwater pumping cost including depth to groundwater.
- Crop demand functions.
- Resource constraints on land, labor, water, and other input availability by region.
- Agronomic and economic constraints. For example, minimum regional silage production to meet dairy herd feeding requirements.

The model chooses the optimal values of land, water, labor, and other input use in addition to input use intensity, as described by the CES production surface, subject to these constraints and definitions. Profit is revenue minus costs where revenue is price times yield per acre times total acres. Costs are standard input costs plus the exponentially increasing land cost (PMP) function. Downward-sloping crop demand curves guarantee, all else constant, that as production increases crop price decreases (and vice-versa). Over time, crop demands may shift out driven by real income growth and population increases. External data and elasticities are used to estimate the magnitude of these shifts.

The SWAP model incorporates CVP/SWP agricultural water supplies, other local surface water supplies, and groundwater. As conditions change within a SWAP region (e.g., the quantity of available project water supply increases or the cost of groundwater pumping increases), the model optimizes production by adjusting the crop mix, water sources and quantities used, and other inputs. Land will be fallowed when it is the most cost-effective response to resource conditions.

The SWAP model is used to compare the long-run response of agriculture to potential changes in CVP/SWP agricultural water delivery, other surface or groundwater conditions, or other economic values or restrictions. Results from the CalSim II model are used as inputs into SWAP through a standardized data linkage tool.

The model self-calibrates using Positive Mathematical Programming (PMP) which has been used in models since the 1980's (Vaux and Howitt 1984) and was formalized in 1995 (Howitt 1995a). PMP allows the modeler to infer the marginal decisions of farmers while only being able to observe limited average production data. PMP captures this information through a non-linear cost or revenue function introduced to the model.

Q3.1.4 SWAP Model Coverage

The SWAP model has 27 base regions in the Central Valley. The model is also able to include agricultural areas of the Central Coast, the Colorado River region that includes Coachella, Palo Verde and the Imperial Valley and San Diego, Santa Ana and Ventura and the South Coast. Figure Q3-1 shows California agricultural regions evaluated in the EIS. Table Q3-1 details the major water users in each of the regions.

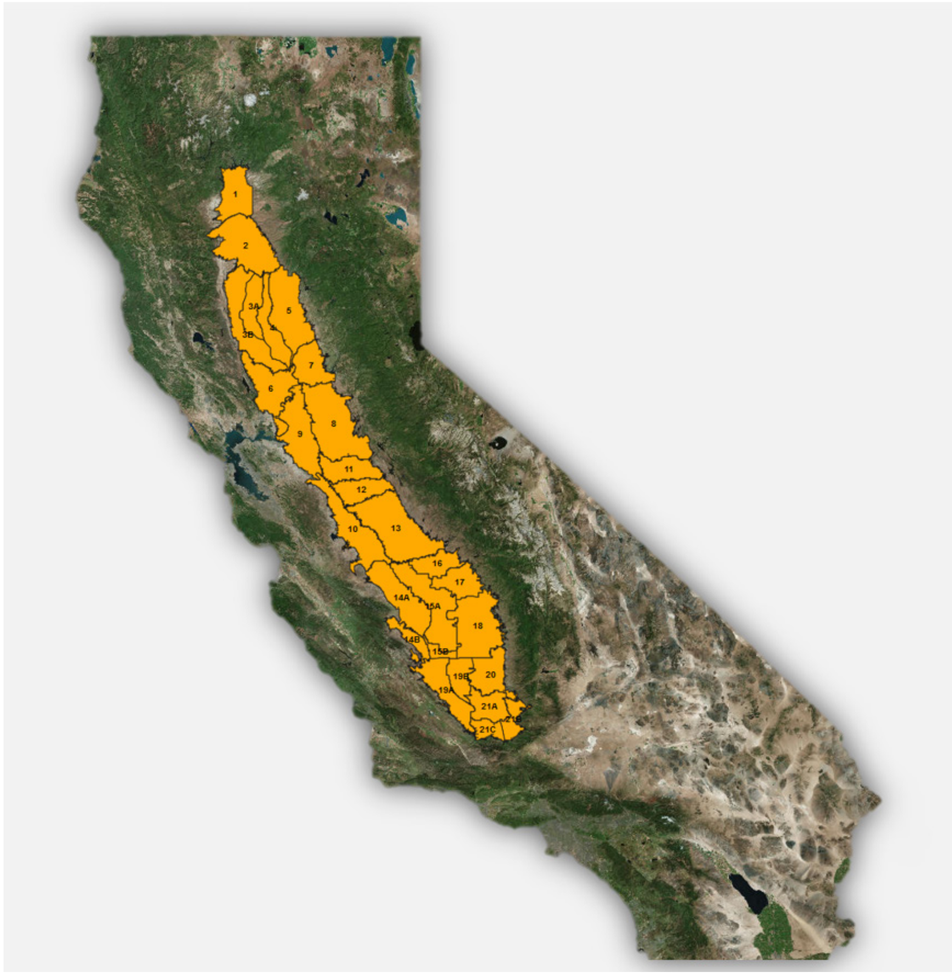

Figure Q3-1. SWAP Model Regions Evaluated in the EIS

Table Q3-1. SWAP Model Region Summary

SWAP Region	Major Surface Water Users
1	CVP Users: Anderson Cottonwood I.D., Clear Creek C.S.D., Bella Vista W.D., and miscellaneous Sacramento River water users.
2	CVP Users: Corning Canal, Kirkwood W.D., Tehama, and miscellaneous Sacramento River water users.
3a	CVP Users: Glenn Colusa I.D., Provident I.D., Princeton-Codora I.D., Maxwell I.D., and Colusa Basin Drain M.W.C.
3b	Tehama Colusa Canal Service Area. CVP Users: Orland-Artois W.D., most of Colusa County, Davis W.D., Dunnigan W.D., Glide W.D., Kanawha W.D., La Grande W.D., and Westside W.D..
4	CVP Users: Princeton-Codora-Glenn I.D., Colusa Irrigation Co., Meridian Farm W.C., Pelger Mutual W.C., Reclamation District 1004, Reclamation District 108, Roberts Ditch I.C., Sartain M.D., Sutter M.W.C., Swinford Tract I.C., Tisdale Irrigation and Drainage Co., and miscellaneous Sacramento River water users.
5	Most Feather River Region riparian and appropriative users.
6	Yolo and Solano Counties. CVP Users: Conaway Ranch and miscellaneous Sacramento River water users.

SWAP Region	Major Surface Water Users
7	Sacramento County north of American River. CVP Users: Natomas Central M.W.C., miscellaneous Sacramento River water users, Pleasant Grove-Verona W.M.C., and Placer County W.A..
8	Sacramento County south of American River and northern San Joaquin County.
9	Direct diverters within the Delta region. CVP Users: Banta Carbona I.D., West Side W.D., and Plainview.
10	Delta Mendota service area. CVP Users: Panoche W.D., Pacheco W.D., Del Puerto W.D., Hospital W.D., Sunflower W.D., West Stanislaus W.D., Mustang W.D., Orestimba W.D., Patterson W.D., Foothill W.D., San Luis W.D., Broadview, Eagle Field W.D., Mercy Springs W.D., San Joaquin River Exchange Contractors.
11	Stanislaus River water rights: Modesto I.D., Oakdale I.D., and South San Joaquin I.D.
12	Turlock I.D.
13	Merced I.D. CVP Users: Madera I.D., Chowchilla W.D., and Gravely Ford.
14a	CVP Users: Westlands W.D.
14b	Southwest corner of Kings County
15a	Tulare Lake Bed. CVP Users: Fresno Slough W.D., James I.D., Tranquillity I.D., Traction Ranch, Laguna W.D., and Reclamation District 1606.
15b	Dudley Ridge W.D. and Devils Den (Castaic Lake)
16	Eastern Fresno County. CVP Users: Friant-Kern Canal, Fresno I.D., Garfield W.D., and International W.D.
17	CVP Users: Friant-Kern Canal, Hills Valley I.D., Tri-Valley W.D., and Orange Cove.
18	CVP Users: Friant-Kern Canal, County of Fresno, Lower Tule River I.D., Pixley I.D., portion of Rag Gulch W.D., Ducor, County of Tulare, most of Delano-Earlimart I.D., Exeter I.D., Ivanhoe I.D., Lewis Creek W.D., Lindmore I.D., Lindsay-Strathmore I.D., Porterville I.D., Sausalito I.D., Stone Corral I.D., Tea Pot Dome W.D., Terra Bella I.D., and Tulare I.D.
19a	SWP Service Area, including Belridge W.S.D., Berrenda Mesa W.D..
19b	SWP Service Area, including Semitropic W.S.D
20	CVP Users: Friant-Kern Canal. Shafter-Wasco, and South San Joaquin I.D.
21a	CVP Users: Cross Valley Canal and Friant-Kern Canal
21b	Arvin Edison W.D.
21c	SWP service area: Wheeler Ridge-Maricopa W.S.D.
23-30	Central Coast, Desert, and Southern California (not evaluated in the EIS)

CVP = Central Valley Project
I.D. = Irrigation District
M.W.C. = Mutual Water Company
SWAP = Statewide Agricultural Production Model
SWP = State Water Project
W.D. = Water District

Crops are aggregated into 20 crop groups which are the same across all regions. Each crop group represents a number of individual crops, but many are dominated by a single crop. Irrigated acres represent acreage of all crops within the group, production costs and returns are represented by a single proxy crop for each group. Crop group definitions and the corresponding proxy crop are shown in Table A.2.

Table Q3-2. SWAP Model Crop Groups

SWAP Definition	Proxy Crop	Other Crops
Almonds and Pistachios	Almonds	Pistachios
Alfalfa	Alfalfa Hay	
Corn	Grain Corn	Corn Silage
Cotton	Pima Cotton	Upland Cotton
Cucurbits	Summer Squash	Melons, Cucumbers, Pumpkins
Dry Beans	Dry Beans	Lima Beans
Fresh Tomatoes	Fresh Tomatoes	
Grain	Wheat	Oats, Sorghum, Barley
Onions and Garlic	Dry Onions	Fresh Onions, Garlic
Other Deciduous	Walnuts	Peaches, Plums, Apples
Other Field	Sudan Grass Hay	Other Silage
Other Truck	Broccoli	Carrots, Peppers, Lettuce, Other Vegetables
Pasture	Irrigated Pasture	
Potatoes	White Potatoes	
Processing Tomatoes	Processing Tomatoes	
Rice	Rice	
Safflower	Safflower	
Sugar Beet	Sugar Beets	
Subtropical	Oranges	Lemons, Misc. Citrus, Olives
Vine	Wine Grapes	Table Grapes, Raisins

SWAP = Statewide Agricultural Production Model

Q3.2 SWAP Model Assumptions

This section is a non-technical overview of the SWAP model. It is important to note that SWAP, like any model, is a representation of a complex system and requires assumptions and simplifications to be made. All analyses using SWAP are explicit about the assumptions and provide sensitivity analysis where appropriate.

Q3.2.1 Calibration using PMP

The SWAP model self-calibrates using a three-step procedure based on Positive Mathematical Programming (PMP) (Howitt 1995a) and the assumption that farmers behave as profit-maximizing agents. In a traditional optimization model, profit-maximizing farmers would simply allocate all land, up until resource constraints become binding, to the most valuable crop(s). In other words, a traditional model would have a tendency for overspecialization in production activities relative to what is observed empirically. PMP incorporates information on the marginal production conditions that farmers face, allowing the model to exactly replicate a base year of observed input use and output. Marginal conditions may include inter-temporal effects of crop rotation, proximity to processing facilities, management skills, farm-level effects such as risk and input smoothing, and heterogeneity in soil and other physical capital. In the SWAP model, PMP is used to translate these unobservable marginal conditions, in addition to observed average conditions, into an exponential “PMP” cost function. This cost function allows the model to exactly replicate a base year of observed input use and output.

The SWAP model assumes additional land brought into production faces an increasing marginal cost of production. The most fertile land is cultivated first; additional land brought into production is of lower “quality” because of poorer soil quality, drainage or other water quality issues, or other factors that cause it to be more costly to farm. This is captured through an exponential land cost function (PMP cost function) for each crop and region. The exponential function is advantageous because it is always positive and strictly increasing, consistent with the hypothesis of increasing land costs. The PMP cost function is both region and crop specific, reflecting differences in production across crops and heterogeneity across regions. Functions are calibrated using information from acreage response elasticities and shadow values of calibration and resource constraints. The information is incorporated in such a way that the average cost data (known data) are unaffected.

Q3.2.2 Constant Elasticity of Substitution Production Function

Crop production in the SWAP model is represented by a Constant Elasticity of Substitution (CES) production function for each region and crop with positive acres. In general, a production function captures the relationship between inputs and output. For example, land, labor, water, and other inputs are combined to produce output of any crop. CES production functions in the SAWP model are specific to each region, thus regional input use is combined to determine regional production for each crop. The calibration routine in SWAP guarantees that both input use and output exactly match a base year of observed data.

The SWAP model considers four aggregate inputs to production for each crop and region: land, labor, water, and supplies. All units are converted into monetary terms, e.g. dollars of labor per acre instead of worker hours. Land is simply the number of acres of a crop in any region. Land costs represent basic land investment, cash overhead, and (when applicable) land rent. Labor costs represent both machinery labor and manual labor. Other supplies are a broad category that captures a range of inputs including fertilizer, pesticides, chemicals, custom, capital recovery, and interest on operating capital. Water costs and use per acre vary by crop and region.

The generalized CES production function allows for limited substitution among inputs (Beattie and Taylor 1985). This is consistent with observed farmer production practices (farmers are able to substitute among inputs in order to achieve the same level of production). For example, farmers may substitute labor for chemicals by reducing herbicide application and increasing manual weed control. Or, farmers can substitute labor for water by managing an existing irrigation system more intensively in order to reduce water use.

Q3.2.3 Crop Demand Functions

The SWAP model is specified with downward-sloping, California-specific crop demand functions. The demand curve represents consumer’s willingness-to-pay for a given level of crop production. All else constant, as production of a crop increases the price of that crop is expected to fall. The extent of the price decrease depends on the elasticity of demand or, equivalently, the price flexibility. The latter refers to the percentage change in crop price due to a percent change in production. The SWAP model is specified with linear demand functions.

The nature of the demand function for specific commodities can change over time due to tastes and preferences, population growth, changes in income, and other factors. The SWAP model incorporates linear shifts in the demand functions over time due to growth in population and changes in real income per capita. Changes in the demand elasticity itself, resulting from changing tastes and preferences, are not considered in the model.

Q3.2.4 Water Supply and Groundwater Pumping

Total available water for agriculture is specified on a regional basis in the SWAP model. Each region has six sources of supply, although not all sources are available in every region:

- CVP (including Friant-Kern Class I)
- CVP Settlement and Exchange
- Friant Kern Class 2
- SWP
- Local surface water
- Groundwater

State and Federal Project deliveries are estimated from DWR and Reclamation. Local surface water supplies are based on DWR estimates, reports of individual water suppliers, and, where necessary, drawn from earlier studies.

Costs for surface water supplies are compiled from information published by individual water supply agencies. There is no central data source for water prices in California. Agencies that prepared CVP water conservation plans or agricultural water management plans in most cases included water prices and related fees charged to growers. Other agencies publish and/or announce rates on an annual basis. Water prices used in SWAP are intended to be representative for each region, but vary in their level of detail.

Groundwater availability is specified by region-specific maximum pumping estimates. These are determined by consulting the individual districts records and information compiled by DWR. DWR analysts provided estimates of the actual pumping in the base year and the existing pumping capacity by region. The model determines the optimal level of groundwater pumping for each region, up to the capacity limit specified. In some studies using SWAP or CVPM, the model has been used interactively with a groundwater model to evaluate short-term and long-term effects on aquifer conditions and pumping lifts.

Pumping costs vary by region depending on depth to groundwater and power rates. The SWAP model includes a routine to calculate the total costs of groundwater. The total cost of groundwater is the sum of fixed, O&M, and energy costs. Energy costs are based on a blend of agricultural power rates provided by PG&E.

Q3.3 References

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Appendix R Land Use and Agricultural Resources Technical Appendix

This appendix documents the land use and agricultural resources technical analysis to support the impact analysis in the EIS.

R.1 Background Information

R.1.1 Overview of Land Use and Agricultural Resources

This section describes land use and agricultural resources conditions potentially affected by the implementation of the alternatives considered in this EIS.

The following description of the affected environment is presented at the county-level for agricultural and municipal and industrial land uses. In addition, an overview of agricultural resources is provided.

R.1.1.1 *Land Use*

An extensive range of land uses are within this study area. These include forestry, agriculture, water, urban (including industrial, commercial, and residential), rural residential, parks and recreation, and public open spaces.

R.1.1.2 *Agricultural Resources*

R.1.1.2.1 Crop Production Practices

Crop production practices vary by crop and locational differences such as soil, slope, local climate, and water source and reliability. Production practices discussed in this subsection include:

- Crop rotation and fallowing.
- Crop water use.
- Crop irrigation methods.
- Crop responses to water quality.
- Crop drainage methods.
- Crop adaptation to changes in water supply availability.

Crop Rotation and Fallowing

Crop rotation is the planned variation in the crops grown on a given field. Growers rotate annual crops and some forage crops to control plant pests, diseases, and weeds, and to improve soil structure, microbial diversity, and nutrient and mineral availability. Growers select a series of crops that are compatible for rotation that are planned to be grown in a field in a succession of years and plan their operations schedule and build their on-farm infrastructure (e.g., equipment, facilities, and staffing) to a scale that meets the production needs of those crop acreage mixes (Baldwin 2006).

Field fallowing is the practice of not planting a crop in a field for one or more growing seasons. Fallowing can be a planned part of the rotation, or may be a consequence of another event such as water supply shortage, flooding, land improvement, or poor crop prices. Rotations are not fixed, so changes in market conditions or federal farm programs can affect crop mix and the pattern and magnitude of fallowing.

Fallowed fields without cover crops can lose topsoil to surface drainage and wind erosion. Loss of topsoil to erosion reduces land productivity and can reduce nearby crop yields and marketability.

Crop Water Use

Crop irrigation water use depends on crop type, stage of crop growth, soil moisture profile from winter rains, soil moisture holding capacity (i.e., total amount of water in the soil potentially available to plants), management of plant pests and diseases, weather conditions (e.g., solar radiation, temperature, and humidity), and irrigation water use efficiency. Irrigation water use efficiency can be defined in different ways. The California Department of Water Resources (DWR) defines the agronomic water use fraction as the irrigation water beneficially used for necessary agronomic functions (e.g., transpiration, leaching, frost protection, germination) divided by the total applied water (DWR 2012). Applied irrigation water is transpired by plants (crops and weeds), percolates into the groundwater below the root zone (necessary salt leaching component or over-irrigation loss to groundwater), evaporates directly from water or soil surfaces, or runs off the field as surface drainage (Edinger-Marshall and Letey 1997).

Reuse of water from fields to irrigate other fields, often multiple times, occurs throughout California. As a result, relatively low field-level efficiency (agronomic water use fraction) can result in relatively high efficiency from a regional or basin perspective (DWR 2013).

Crop Irrigation

Agricultural irrigation needs vary by season. In the winter, rainfall refills the soil moisture profile that was depleted from the crop root zone the previous summer and fall. If soil moisture is not adequate for planting of annual crops, pre-irrigation water is applied. Pre-irrigation and early growing season irrigations generally occur in the time period of March through May. Peak agricultural irrigation water supply demand generally occurs from the late spring through late summer. Permanent crops are irrigated post-harvest to refill the root zone. Post-harvest irrigation of annual crop land is sometimes used to help break down crop residue and suppress some pests and diseases, especially in rice fields.

Irrigation methods vary by area, soil, crop type, and existing facilities. Annual row crops are often sprinkler irrigated for crop germination and furrow irrigated for the rest of the season. Permanent crops are typically irrigated with drip, sprinkler, furrow, border, or flood irrigation methods. Irrigated pasture and alfalfa are typically irrigated with sprinkler or flood irrigation methods. Rice is generally irrigated with flood irrigation. The following irrigation methods are used in the Central Valley:

- **Flood and Border Irrigation:** Water is released into a leveled field or block that is segmented into “checks” with a small berm to contain the water. Water applied to the check until it is flooded and the water seeps into the ground or some is allowed to drain off the lower elevation end of the field.
- **Furrow Irrigation:** Water is released into furrows at the higher side of the field and flows down to the lower end of the field. To provide adequate water to the low end of the field, surface irrigation

requires that a certain amount of water be spilled or drained off as tailwater. Recycling the tailwater to the head of the field or to an adjacent field can considerably increase overall efficiency. Furrow irrigation is used on annual row crops and on some vineyards.

- **Sprinkler Irrigation:** Sprinkler irrigation uses pressurized water through movable or solid set pipe to a sprinkler. Sprinklers lose some irrigation water to evaporation in the air before the water reaches the ground. Sprinklers also apply water to ground that does not have crop roots, and this applied water goes to surface evaporation, weed transpiration, or percolation to groundwater leaching. Sprinklers are often used during the germination stage of vegetables, and can also be used for frost control on orchards, especially citrus. Sprinkler irrigation can be used on most crops except those for which direct contact with the water drops could cause fruit cracking, fungal growth, or other issues.
- **Surface Drip and Micro-Sprinkler Irrigation:** Surface drip and micro-sprinkler irrigation also use pressurized water that is delivered through flexible tubes to drip emitters or micro-sprinkler heads. Surface drip irrigation generally applies water only to the crop root areas. Drip irrigation and micro-sprinklers are used on most orchards and vineyards.
- **Subsurface Drip Irrigation:** Subsurface drip irrigation is similar to the drip irrigation described above, but the tubing or drip tape is buried a few inches to several feet, depending on the crop. Subsurface drip irrigation generally applies water only to crop root areas and reduces surface evaporation. Subsurface drip is used on some row crops and vineyards.

Flood and furrow irrigated acreage has declined over time, especially for trees and vines, and been replaced by drip and micro-sprinkler irrigation (NCWA 2011). Crops that continue to rely upon flood irrigation, such as rice, have improved irrigation efficiency through laser leveling of the fields. The use of furrow and flood irrigation has declined in California from 67% of the total irrigated acreage in 1991 to 43% in 2010 (DWR 2013). During this same time period, the use of drip, micro-sprinkler, and subsurface drip irrigation increased from 16% of total irrigated acreage in 1991 to 42% in 2010.

Crop Response to Water Quality

Water quality of the surface water streams in the Central Valley is generally very suitable for agricultural production with low salinity, neutral acidity/alkalinity (i.e., pH), minerals, nutrients, and dissolved metal concentrations that are appropriate for agricultural uses. However, groundwater quality varies across California, as described in Appendix I, *Groundwater Technical Appendix*.

Agricultural production can be affected by high salinity, minerals, and boron in the irrigation water and the soils. In the Sacramento Valley, water temperature can reduce crop yields; cold water is a particular concern for rice production (Roel et al. 2005). Irrigation water can carry debris and biological contaminants that affect agricultural operations and the value of crop production.

High salinity concerns occur on agricultural lands receiving CVP and SWP water from the Bay-Delta. As described in Appendix G, *Water Quality Technical Appendix*, surface waters in the Bay-Delta and lower San Joaquin River water frequently are characterized by high salinity. These waters are used by agricultural water users in the Bay-Delta and CVP and SWP water users within and south of the Bay-Delta.

Evaporation and transpiration of irrigation water cause salts to accumulate in soils unless adequate leaching and drainage are provided (Reclamation 2006). High water tables with elevated concentrations of salts can draw the salinity vertically through the soil by capillary action into the plant root zone and cause damage to the plant. Excessive salinity in irrigation water and accumulated soil salinity can adversely affect soil structure, reduce water infiltration rates, reduce seed germination, increase seedling mortality, impede root growth, impede water uptake by the plant (from increased osmotic pressure), reduce plant growth rate, and reduce yields.

All irrigation water adds soluble salts to the soil, including sodium, calcium, magnesium, potassium, sulfate, and chlorides (Grattan 2002). Salinity is usually measured either in parts per million of total dissolved solids or by electrical conductivity (EC). Water salinity of irrigation water is measured as EC_w. Accumulated salts in the soil are measured as EC_e. The strength of the electrical conductivity depends upon the water temperature, types of salts, and salt concentrations.

High salinity can affect the amount of irrigation water applied for crop irrigation and necessary soil leaching component (washing soil salts out of the plant root zone) compared to the total quantity of irrigation water applied (Reclamation 2006). Irrigation in the San Joaquin Valley typically includes a salt leaching component. The leaching water generally conveys the salts into installed drains in the fields or into the groundwater. Therefore, in locations where adequate drainage does not exist, continued irrigation with high-salinity water has increased groundwater salinity.

Table R.1-1 presents EC_e and EC_w values for salinity tolerances of a range of crops grown in the Central Valley.

Table R.1-1. Salinity Tolerance of Selected Crops (as percent of maximum yield)

	Crop Tolerance Based on Soil Salinity (measured as EC_e)			Crop Tolerance Based on Water Salinity (measured as EC_w)		
Crops[1, 2]	**100%**	**50%**	**0%[3]**	**100%**	**50%**	**0%[3]**
Alfalfa	2.0	8.8	16	1.3	5.9	10
Almond[4]	1.5	4.1	6.8	1.0	2.8	4.5
Apricot[4]	1.6	3.7	5.8	1.1	2.5	3.8
Bean	1.0	3.6	6.3	0.7	2.4	4.2
Corn, sweet	1.7	5.9	10	1.1	3.9	6.7
Cucumber	2.5	6.3	10	1.7	4.2	6.8
Grape[5]	1.5	6.7	12	1.0	4.5	7.9
Peach	1.7	4.1	6.5	1.1	2.7	4.3
Rice (paddy)	3.0	7.2	11	2.0	4.8	7.6
Squash, Zucchini	4.7	10	15	3.1	6.7	10
Sudan Grass	2.8	14	26	1.9	9.6	17
Sugar Beet[5]	7.0	15	24	4.7	10	16
Tomato	2.5	7.6	13	1.7	5.0	8.4

Sources: Ayers and Westcot 1985; Grattan 2002; Maas and Hoffman 1977.

[1] These data should be used as a guide to relative tolerances among crops. Absolute tolerances will change based upon climate, soil conditions, and cultural practices. Plants will tolerate about 2 deciSiemens per meter (dS/m) higher soil salinity (EC_e) than indicated if soils have high gypsum, however the water salinity (EC_w) tolerances do not change.

[2] ECe is average root zone salinity as measured by electrical conductivity of the saturation extract of the soil, and EC_w is electrical conductivity of the irrigation water, both reported in dS/m) at 25°C. The data is based upon a relationship between soil salinity and water salinity of $EC_e = 1.5\ EC_w$ with a 15 to 20% leaching fraction and a 40-30-20-10% water use pattern for the upper to lower quarters of the root zone.

[3] The zero yield potential or maximum EC_e indicates the theoretical soil salinity (EC_e) at which crop growth ceases.

[4] Tolerance evaluations are based on tree growth and not on yield.
[5] For beets, which are more sensitive during germination, the EC_e should not exceed 3 dS/m in the seeding area for garden beets and sugar beets.

The most sensitive crops are affected when EC_e values exceed 1 deciSiemens per meter **(**dS/m), and include the following crops with threshold values: beans (1.0 dS/m); walnuts 1.1 dS/m), bulb onions (1.2 dS/m); grapes, peppers and almonds (1.5 dS/m); apricots (1.6 dS/m); corn and peaches (1.7 dS/m); alfalfa (2.0 dS/m); and cucumbers and tomatoes (2.5 dS/m).

In addition to an excess of salinity, depletion of boron is also a concern in some areas in California (Chang and Page 2000). Dry beans are one of the more boron-sensitive crops with a threshold value of 0.75 to 1.0 milligrams per liter (mg/L) in the soil water within the crop root zone (Ayers and Westcot 1985).

Crop Drainage Methods

Agricultural crop surface and subsurface drainage is important for the suitability of agricultural production (DWR 2013; Reclamation 2006; Presser and Schwarzbach 2008). Drainage of most agricultural fields occurs by a combination of surface drainage and subsurface drainage. Poor drainage can lead to crop loss or damage from lack of soil oxygen availability for plant roots, pest infestations (e.g., pathogenic root fungi, such as *phytophthora*), and salt accumulation in the root zone. High water tables, high salinity, and poor drainage can limit crop selection and limit the ability of farmers to use irrigation water to leach excess salts out of the crop root zone.

Surface water drainage from agricultural fields is collected in on-farm drainage ditches that are typically connected to larger drainage facilities. The drainage water either flows by gravity or is pumped into adjacent water bodies. Water quality issues related to disposal of surface water drainage can include high concentrations of sediment; nutrients from fertilizers; or residual organic carbon constituents from herbicides, pesticides, or nematicides. On-farm surface drainage systems sometimes include local methods to remove sediment or nutrients, such as the inclusion of vegetative strips to remove sediment and improve drain water quality (CALFED 2000). During the irrigation season, surface drainage water collected from irrigation can be recirculated for subsequent irrigation; however, this can lead to a long-term increase in soil salinity (DWR 2013).

Subsurface drainage is used to control groundwater depth to avoid or limit its encroachment into the root zone of crops (Panuska 2011). For example in the Bay-Delta, subsurface and surface drainage is used not only to control groundwater depths related to irrigation practices, but also to control groundwater that seeps into the soils from the surface water that surrounds the islands and tracts. Areas in the western and southern San Joaquin Valley are affected by shallow, saline groundwater that accumulates because of irrigation; and the shallow groundwater is underlain by soils with poor drainage (Strock et al. 2010; DWR 2013; Presser and Schwarzbach 2008; WWD 2013a, 2013b). Some areas of the northern San Joaquin Valley collect and discharge subsurface drainage to the San Joaquin River (Reclamation 2013). Areas in the central and southern San Joaquin Valley manage poor drainage conditions by careful and integrated management of crop patterns, land retirement, irrigation methods and application rates, and/or drainage water reuse and blending, (USGS 2008; WRCD and Center for Irrigation Technology 2004).

Crop Adaptation in Response to Changes in Water Supply Availability

Farmers and water suppliers can react to changes in water supply in a range of ways. Some farmers adapt to variability by maintaining a mix of crops that can be shifted or fallowed in response to water supply changes. Some farmers have groundwater wells that can be used to replace surface water in times of shortage. Short term responses can also include reducing irrigation water application below what is needed to maintain full crop yield (water stressing). Over the long term, irrigation systems and management can be changed to apply less water. Decisions that farmers make in response to changes in water supply affect other aspects of their operations, and affect the economy of the surrounding community. For example, crop mix and irrigation methods affect the kinds of tractors and other equipment used on the farm.

Some types of on-farm infrastructure also are specialized for the crops grown, such as grain driers and storage, hullers, fruit sorting and packing, fruit driers, cotton gins, and cold storage plants. Crop-specific equipment, infrastructure, and marketing agreements may prevent a grower from changing crops quickly due to changes in water supply availability.

Input suppliers, equipment dealers, the labor force, and processing facilities are also dependent on, and affected by, cropping decisions. As crop types change, the mix of these related economic activities also change. This can happen over a period of time, but is difficult to achieve in the short term.

Response to Variability in CVP and SWP Water Supplies

Water availability provided by the CVP and SWP varies each year based upon hydrologic conditions and regulatory requirements, as described in Appendix H, *Water Supply Technical Appendix*. The CVP and SWP water supply allocations are initially announced in the late winter. The allocations can be revised throughout the spring months as the hydrologic conditions become more certain. Growers often delay finalizing some of their crop decisions until water supply allocations are announced as late as April or May. Delays in finalizing crop decisions also can result in delays in finalizing crop financing and orders to suppliers (e.g., seed, fertilizer), and contracting with labor suppliers and crop processors. Responses to variations in water allocations depend on many factors, including feasibility of alternative water supplies (availability, suitability of water quality, cost); types of crops grown and need for changes in equipment, processing, and labor; and long-term crop supply contracts and obligations (WWD 2013a, 2013b). A study of changes that occurred during the 1986–1992 drought indicated that implementation of the changes will probably occur over a longer period of time and not necessarily during the water supply shortage, especially if groundwater or other surface water supplies can be obtained within the growing season (Dale and Dixon 1998).

The effects on the surrounding communities of the variability of CVP and SWP water supplies are discussed in Appendix Q, *Regional Economics Technical Appendix*, and Appendix T, *Environmental Justice Technical Appendix*.

Typical responses of a farmer or water supplier to increasing shortage of water supplies include the following actions:

- **Increase the use of groundwater**: Reduction in surface water supplies can induce substitution with groundwater using new or existing wells. Water supplies are used conjunctively in some areas with groundwater storage so that during surface water shortages, water historically used to recharge groundwater can be used for applied irrigation uses.
- **Use alternative/supplemental surface water supplies**: Alternative water supplies may include local exchanges or transfers of surface water, water transfers/purchases from more distant areas, and/or use of water stored in surface water reservoirs or groundwater banks. These all depend on the infrastructure to convey the water and the financial ability to pay for the alternatives water supplies.

- **Increased water use efficiency:** Reduced use of irrigation water may be achieved by on-farm system and irrigation management improvements, water reuse, water source blending, and delivery system improvements. Specific on-farm and delivery system improvements can include irrigation scheduling, field leveling, application system changes, and conveyance system loss reduction measures such as canal lining, spill reduction, and automation. Some of the changes require only management changes, such as irrigation scheduling, and can occur within the growing season. Other changes, such as conveyance system modifications, require capital investments and generally require several years to implement.
- **Field fallowing or changing to lower-water-use crops:** Fallowing, or temporary idling, reduces gross water use by the entire applied water amount, and reduces net water use by at least the evapotranspiration of the crop not planted. Typically fields with higher water use crops or lower value rotation crops would be the first fields to be fallowed. Farmers generally would avoid or minimize fallowing permanent crops or crops with long-term obligations (e.g., cannery contracts). A farmer receiving a partial allocation of water could decide to reduce irrigated acreage and transfer that acreage's water allocation to the remaining fields in production or sell the water to other water users. A smaller reduction in water use can be achieved by switching from a crop using more water to one using less water (Dale and Dixon 1998). Permanent crops, such as trees and vines, that are the least economically viable or that are approaching the end of their lifespan can be removed or abandoned, and the land fallowed until adequate water is available. In extreme dry periods, such as 2014 when there were no deliveries of CVP water to San Joaquin Valley water supply agencies with CVP water service contracts, permanent crops were removed because the plants would not survive the stress of no water or saline groundwater.
- **Stress Irrigation:** Farmers generally try to irrigate to achieve maximum economic yield. For some permanent crops, severe pruning could reduce water use, but could reduce yield over multiple years (AgAlert 2010).

R.1.1.2.2 Cropping Pattern Changes in Response to Water Supply Availability

Conversion of farm lands to other land uses has occurred historically and continues to occur. Agricultural lands have been converted to different crop patterns, urban areas, habitat restoration, off-farm infrastructure (e.g., utilities and transportation), and on-farm infrastructure (e.g., storage, maintenance, and processing facilities). Crop conversions occur in response to changes in water supply reliability, changes in market demand for specific crops, and decisions to convert lands to urban or infrastructure land uses.

One method used to indicate changes in California agricultural acreage is related to a loss of the value of production on "Important Farmland" and "Grazing Land" acreages, as reported by the California Department of Conservation since 1988 (CDOC 2004). The comparison of the acreage of lands within each category can be used to identify trends in agricultural land conversions. This information is provided in the following subsections for the years 2006 and 2016 for counties within the study area.

Another factor to be considered prior to crop conversion is the costs related to crop establishment. Costs of irrigated crop production include labor, purchased inputs (e.g., seed, fertilizer, chemicals), custom services, investment in growing stock, other capital (including machinery and structures), and other overhead costs.

Reliability of water supply can be especially important for maintaining substantial investments in growing stock of perennial and multi-year crops. Perennial crops include orchards and vineyards that may have useful lives of 25 years or more. Multiyear forage crops, such as alfalfa and irrigated pasture, also may be in production for years. Investment in growing stock may be expressed as the accumulated costs incurred during the period when the crop is planted and brought to bearing age, called the establishment period. Establishment costs for perennial crops can range up to $15,000 per acre in total costs (including cash outlays plus noncash and allocated overhead costs). The example establishment costs provided in Table R.1-2 are for the Central Valley, but are generally representative of establishment costs in other regions.

Table R.1-2. Typical Establishment Costs for Some Perennial Crops in the Central Valley

Example Crop	Establishment Period (years)	Assumed Life of Stand (years)	Accumulated Total Cost during Establishment ($ per acre)	University of California Cooperative Extension Cost of Production Study
Alfalfa Hay	1	4	555	Sacramento Valley, 2013
Almonds	4	25	10,520	San Joaquin Valley North, 2011
Irrigated Pasture	1	20	424	Sacramento Valley, 2003
Walnuts	5	25	14,695	San Joaquin Valley North, 2013
Wine Grapes	3	25	19,231	Cabernet Sauvignon, SJ Valley North, 2012

Sources: UCCE 2003, 2011, 2012a, 2012b, 2012c, 2013a, 2013b, 2013c
All costs are converted to 2018 dollar equivalent values using the Gross Domestic Product Implicit Price Deflator (USDOC 2019). Assumed stand life is the financial life used for the cost and budget analysis. Individual growers may decide to keep stands in production longer or to remove them sooner.

Farm expenditures are largely spent in the surrounding community in the form of input purchases, hired labor, rents paid to landlords, well drilling, and custom consulting services. Total labor in the agricultural production sector is discussed in relation to the regional economy in Appendix Q, *Regional Economics Technical Appendix*. Labor hours and input purchases vary substantially among crops, as shown in Table R.1-3.

Table R.1- 3. Land Rent, Labor Hours, and Custom Services for Example Crops in the Central Valley

Example Crop	Typical Rent ($ per acre)	Typical Annual Labor (hours per acre)	Custom Services Purchased ($ per acre)	University of California Cooperative Extension Cost of Production Study
Alfalfa Hay	295	2	382	Sacramento Valley, 2013
Almonds	793	32	860	San Joaquin Valley North, 2011
Corn, Grain	153	3	337	San Joaquin Valley South, 2012
Irrigated Pasture	65	3	165	Sacramento Valley, 2003
Rice	291	5	342	Sacramento Valley, 2012
Walnuts	717	8	1250	San Joaquin Valley North, 2013
Wheat	256	2	59	San Joaquin Valley South, 2013
Wine Grapes	658	71	525	Cabernet Sauvignon, SJ Valley North, 2012

Sources: UCCE 2003, 2011, 2012a, 2012b, 2012c, 2013a, 2013b, 2013c
All costs are converted to 2018 dollar equivalent values using the Gross Domestic Product Implicit Price Deflator (USDOC 2019).

R.1.1.2.3 Water Supply and Crop Acreage Relationships in the San Joaquin Valley

Most publicly available information on irrigated acreage and crop types is compiled at the county level, not the water district level. Water availability for CVP and SWP water is provided at a smaller geographic level, such as a water supply entity or several adjacent entities. Therefore, it is difficult to analyze the correlation of water supply availability, irrigated acreage, and crop types. However, the Westlands Water District does provide more detailed information related to water availability, irrigated acreage, and crop types in their publicly available reports, as summarized in this technical appendix. The purpose of this summary is to describe the relationships between cropping patterns, irrigation methods, and water supply availability. Due to the increased frequency of water supply reductions, especially in drier years, the amount of fallowed and nonharvested lands has increased as a percentage of total lands within Westlands Water District. The trend observed in Westlands Water District of using additional groundwater and crop idling land when CVP and SWP water supplies are reduced, and reducing groundwater use and increasing irrigated acreage when CVP and SWP become more available occurs throughout the San Joaquin Valley.

R.1.2 Trinity River Region

The Trinity River region includes the area in Trinity County along the Trinity River from Trinity Lake to the confluence with the Klamath River, and in Del Norte and Humboldt Counties along the lower Klamath River from the confluence with the Trinity River to the Pacific Ocean.

No municipal and industrial land or agricultural uses in the Trinity River area are served by CVP and SWP water supplies.

R.1.2.1 *Land Use*

R.1.2.1.1 Trinity County

Trinity County encompasses approximately 3,206 square miles in northwestern California. It is bounded on the north by Siskiyou County, on the east by Shasta and Tehama Counties, on the south by Mendocino County, and on the west by Humboldt County. About 76% of the land area is within a national forest (Shasta-Trinity, Six Rivers, and Mendocino) and in four wilderness areas (Yolla Bolly-Middle Eel Reserve, Trinity Alps, Chanchellula, and North Fork). Another 14% is zoned for timber use or held in agriculture land conservation contracts (Trinity County 2012).

The headwaters of the Trinity River are in the northeastern part of the county at an elevation of 6,200 feet in the southern Siskiyou Mountains. Trinity Reservoir and Lewiston Reservoir are located along the middle reach of the mainstem Trinity River. Downstream of Lewiston Dam, the river flows northwest to join the Klamath River in Humboldt County (Trinity County 2012).

Development of communities is relatively limited in Trinity County because much of the land is within national forests and tribal lands or is characterized by steep slopes. The largest communities in Trinity County include Lewiston, Weaverville, and Hayfork (Trinity County 2012).

Trinity County’s primary industries are tourism and timber and it is the sixth largest timber producer in the state, with substantial acreage in national forest and private holdings. There is one operating mill in the county. Recreational opportunities are also important in this area (Trinity County 2012).

The portion of Trinity County in the Trinity River region that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes areas in the vicinity of CVP facilities (Trinity

Reservoir and Lewiston Reservoir) and areas along the Trinity River between Trinity Reservoir and Lewiston Reservoir.

R.1.2.1.2 Humboldt County

Humboldt County encompasses approximately 3,570 square miles in northwestern California. It is bounded on the north by Del Norte County, on the east by Siskiyou and Trinity Counties, on the south by Mendocino County, and on the west by the Pacific Ocean. About 25% of the land area is within the Six Rivers National Forest, Trinity Alps Wilderness Area, Redwood National and State Parks, national wildlife refuges, or other public land. About 3% of the land area is within state park lands. The Yurok and Hoopa tribal lands represent about 5.6% of the land within Humboldt County boundaries (Humboldt County 2012).

Most of the population and developed areas are located in western Humboldt County along U.S. Highway 101 (Humboldt County 2012). Incorporated cities and residential lands in unincorporated portions of Humboldt County represent less than 1% of the county. Development of communities is relatively limited in Humboldt County because much of the land is within national forests and tribal lands, characterized by steep slopes, or within the coastal zone, where new, large scale developments are minimized. Timber and agricultural lands are located on over 60% of unincorporated areas of Humboldt County.

Humboldt County’s primary industries are lumber manufacturing, retail, and services (Humboldt County 2012). Humboldt County provides over 25% of the lumber in the state.

The portion of Humboldt County in the Trinity River region evaluated in this EIS is located along the Trinity and Klamath Rivers. Most of this area is located within the Hoopa Valley Indian Reservation and Yurok Indian Reservation. This portion of the county includes the communities of Willow Creek and Orleans within Humboldt County; Hoopa in the Hoopa Valley Indian Reservation; and the communities of Weitchpec, Cappell, Pecwan, and Johnson’s in the Yurok Tribe Indian Reservation (Humboldt County 2012).

R.1.2.1.3 Del Norte County

Del Norte County encompasses 1,070 square miles in northwestern California. It is bounded on the north by the State of Oregon, on the east by Siskiyou County, on the south by Humboldt County, and on the west by the Pacific Ocean. Del Norte County includes lands within national forests (Six Rivers and Rogue River-Siskiyou), Smith River National Recreation Area, Redwood National and State Parks, or other federally owned land. State lands include units of the Redwoods State Park and the Lake Earl Wildlife Area. The Yurok tribal lands are located along the lower Klamath River between the Del Norte and Humboldt county boundaries to the Pacific Ocean (Del Norte County 2003).

Del Norte County’s primary industries are retail and services (Del Norte County 2003).

The portion of Del Norte County in the Trinity River region evaluated in this EIS is located along the lower Klamath River. Most of this area is within the Yurok Indian Reservation. This portion of the county includes the communities of Requa and Klamath in the Yurok Tribe Indian Reservation (Del Norte County 2003).

R.1.2.1.4 Tribal Lands in Trinity River Region

Federally recognized tribes and tribal lands in the Trinity River region include the tribal lands of the Hoopa Valley Tribe, Yurok Tribe of the Yurok Reservation, Resighini Rancheria, and Karuk Tribe. Aquatic and wildlife resources associated with the Trinity and Klamath Rivers and the surrounding lands are very important to these tribes (NCRWQCB et al. 2009; Yurok Tribe 2005; Karuk Tribe 2010).

The Hoopa Valley Indian Reservation includes 93,702.73 acres (Hoopa Valley Tribe 2008). The Trinity River flows through the Hoopa Valley Indian Reservation.

The Yurok Indian Reservation includes about 55,890 acres within Tribal trust, Tribal fee, allotment, Tribal member fee, nonmember fee, federal, state, and county lands (Yurok Tribe 2012). The Yurok Tribe employs over 250 people in the government agency, as well as seasonal workers for fisheries, forestry, fire prevention, and other programs.

The Resighini Rancheria includes about 435 acres of land along the south bank of the lower Klamath River and extends from an inland area to the U.S. Highway 101 bridge along the western boundary of the Rancheria (Reclamation 2010). The Rancheria is surrounded by the Yurok Indian Reservation (Reclamation 2010; Resighini Rancheria 2014). The community includes tribal offices, a casino, campground, residences, agricultural lands, and open space.

The Karuk Ancestral Territory is located to the north of the Trinity River in the vicinity of Trinity County and east of the Trinity River in the vicinity of Humboldt County (Karuk Tribe 2010). The western boundary of the Karuk Ancestral Territory is relatively concurrent with the western boundary of the Six Rivers National Forest. Therefore, changes in the Trinity River flow or water quality that could be affected by the changes in CVP and/or SWP operations considered in the action alternatives in this EIS would not occur within the Karuk Ancestral Territory.

R.1.2.2 *Agricultural Resources*

Agriculture in the Trinity River region is primarily related to timber products and cattle ranching which generally do not rely upon irrigation. Small farms and vineyards located adjacent to or near the Trinity River rely primarily upon groundwater that is recharged by precipitation and infiltration from local streams. No lands in Trinity River region are irrigated with water supplies delivered through the CVP or SWP.

Total value of production and acreage by crop category in the counties that include portions of the Trinity River region are listed in Table R.1-5.

Table R.1-5. Average Annual Agricultural Acreage and Value of Production in Counties in the Trinity River Region from 2012 through 2016

	Orchards, Vineyards, and Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage[1]	54	102,652	N/A	199	N/A	102.905
Value[2]	$2.05	$9.63	$174.08	$64.66	$1.76	252

Sources: USDA-NASS 2012, 2013, 2014, 2015, 2016; U.S. Department of Commerce 2019.

1 Not all acreages and/or production values are reported for every crop in every county. Therefore the implied value of production per acre may be misleading for some crop categories.

2 Values in million dollars, 2018 basis.

R.1.3 Sacramento River Region

The Sacramento Valley includes Butte, Colusa, El Dorado, Glenn, Nevada, Placer, Plumas, Shasta, Sutter, Tehama, and Yuba Counties. The counties of Sacramento, Solano, and Yolo are discussed under Section R.1.5, *Bay-Delta Region*. Other counties in Sacramento Valley are not anticipated to be affected by changes in CVP and SWP operations: Alpine, Sierra, Lassen, and Amador Counties; therefore, they are not discussed here.

R.1.3.1 *Land Use*

R.1.3.1.1 Butte County

Butte County encompasses 1,680 square miles in Northern California. It is bounded on the north by Tehama County, on the east by Plumas County, on the west by Glenn and Colusa Counties, and on the south by Sutter and Yuba Counties. Butte County includes lands within national forests (Plumas and Lassen) and Sacramento National Wildlife Refuge (Butte County 2010). State lands in Butte County include Big Chico Creek and Butte Creek ecological preserves; Table Mountain Ecological Reserve; Gray Lodge, Sacramento River, and Oroville Wildlife Areas; SWP facilities at Lake Oroville and Thermalito Reservoir; and more than 750 miles of rivers and streams.

The county comprises three general topographical areas: valley region, foothills east of the valley, and mountain region east of the foothills. Each of these regions contains distinct environments with unique wildlife and natural resources.

The U.S. Forest Service manages 135,427 acres (12%) within Butte County, including portions of the Plumas and Lassen National Forests. The Bureau of Land Management owns and manages 16,832 acres (1.5%) in the county (Butte County 2010). Agriculture is the dominant land use within unincorporated Butte County, accounting for approximately 599,040 acres (60% of the county area) (Butte County 2010).

Butte County contains five incorporated municipalities: Biggs, Chico, Gridley, Oroville, and Paradise. Each has a general plan that guides development within its limits and larger planning area (Butte County 2010).

The portion of Butte County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes wildlife refuges, SWP facilities, CVP facilities, areas along the Feather River that use the surface waters (including agricultural lands), and CVP and SWP water service areas.

R.1.3.1.2 Colusa County

Colusa County encompasses approximately 1,132 square miles in Northern California. It is bounded on the north by Glenn County, on the east by Butte and Sutter Counties, on the west by Lake County, and on the south by Yolo County. Colusa County includes lands within the Mendocino National Forest, Sacramento National Wildlife Refuge complex (Colusa, Delevan, and Sacramento national wildlife refuges); East Park Reservoir; and other federally owned land (Colusa County 2011). State lands in Colusa County include Willow Creek-Lurline, North Central Valley, Colusa Bypass, and Sacramento River wildlife management areas.

Existing land uses in Colusa County are predominantly agricultural. Approximately 76% of the county's total land area is cropland or undeveloped rangeland. National forest and national wildlife refuge land makes up 12% of the county. Less than 1% is covered by urban and rural communities. Colusa and

Williams are the only incorporated cities in the county and they encompass about 2,574 acres (Colusa County 2011). Arbuckle is the largest unincorporated town of the county's unincorporated communities, which include Arbuckle, College City, Century Ranch, Grimes, Maxwell, Princeton, and Stonyford. Together, these established incorporated and unincorporated towns cover a total area in "urban" uses of about 5,451 acres (Colusa County 2011). The majority of land within the CVP water service area in Colusa County is designated for agricultural use (Colusa County 2011; Reclamation 2005b).

The portion of Colusa County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes wildlife refuges and CVP facilities, areas along the Sacramento River that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.3.1.3 El Dorado County

El Dorado County encompasses approximately 1,790 square miles in Northern California along the American River. It is bounded on the north by Placer County, on the east by California-Nevada boundaries, on the west by Sacramento County, and on the south by Amador and Alpine Counties. El Dorado County includes about 521,210 acres (45.5% of the total county), under federal ownership or trust, including lands within the El Dorado and Tahoe National Forests. About 9,751 acres (8.5% of the county), is under state jurisdiction (El Dorado County 2003).

The county includes two specific regions: the Lake Tahoe Basin and the western slopes of the Sierra Nevada (El Dorado County 2003). The CVP water service area provides water to a large portion of the communities and some agricultural areas along the western slope. El Dorado County includes two incorporated cities, Placerville and South Lake Tahoe, which cover 621 acres of land. Other major communities include El Dorado Hills, Cameron Park, Shingle Springs, Rescue, Diamond Springs, Camino, Coloma and Gold Hill, Cool and Pilot Hill, Georgetown and Garden Valley, Pollock Pines, Pleasant Valley, Latrobe, Somerset, and Mosquito. The rural land uses in the county include over 259,000 acres of private production forests, 153,472 acres of agricultural lands, and 35,282 acres within the waters of Folsom Lake and Lake Tahoe. The county's two largest crops are wine grapes and apples.

The portion of El Dorado County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP water facilities (Folsom Lake), areas along the American River that use the surface waters, and CVP water service areas.

R.1.3.1.4 Glenn County

Glenn County encompasses 1,317 square miles in Northern California. It is bounded on the north by Tehama County, on the east by Butte County, on the west by Lake and Mendocino Counties, and on the south by Colusa County. Glenn County includes lands within the Mendocino National Forest, Sacramento National Wildlife Refuge, and other federally owned land (Glenn County 1993).

Approximately two-thirds (583,974 acres) of this county are croplands and pasture. The two incorporated towns in the county are Willows, the county seat, and Orland (Reclamation 2004). Intensive agriculture provides a major segment of the county's economic base (Glenn County 1993; Reclamation 2005b).

The portion of Glenn County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes wildlife refuges, and CVP facilities, areas along the Sacramento River that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.3.1.5 Nevada County

Nevada County encompasses approximately 634,880 acres in Northern California. It is bounded on the north by Sierra County, on the northwest by Yuba County, and on the south by Placer County. Federally owned lands in Nevada County include 169,686 acres in the Tahoe National Forest; 2,574 acres in the Toiyabe National Forest; and approximately 11,000 acres administered by the Bureau of Land Management (Nevada County 1995). The State Lands Commission manages approximately 4,600 acres; State Parks administers 6,300 acres at several locations, including Malakoff Diggins State Historical Park and Empire Mine State Park; and the Department of Fish and Wildlife administers approximately 11,000 acres at the Spenceville Wildlife Management and Recreation Area.

Nevada County is predominantly rural (Nevada County 2012). Approximately 91% of the county is used for agriculture, timber, or open space. Most of the population lives in the three incorporated cities in the county (Grass Valley, Nevada City, and Truckee).

The portion of Nevada County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP water service areas.

R.1.3.1.6 Placer County

Placer County encompasses approximately 1,506 square miles in Northern California. It is bounded on the north by Nevada County, on the east by the California-Nevada boundary, on the west by Yuba and Sutter Counties, and on the south by Sacramento and El Dorado Counties. Placer County includes lands within the El Dorado and Tahoe National Forests and other federally owned land (Placer County 2011).

Placer County is predominantly rural. Most of the population lives in the area along Interstate (I-) 80 from Auburn to the Sutter and Sacramento county boundaries. Incorporated cities and towns include Roseville, Rocklin, Lincoln, Colfax, Loomis, and Auburn (Placer County 2011; Reclamation 2005c; SACOG 2007). Residential land uses range from rural residential areas to medium and high-density dwelling units in urbanized areas. Commercial land uses are primarily located in the urbanized portions of the county; although a large concentration of commercial development occurs outside existing urban areas along I-80. Non-urban land uses include agriculture, resource extraction (timber and mining), and public lands and open spaces. The largest amount of public lands within Placer County is located in the eastern half of the county, and is under the jurisdiction of the Bureau of Land Management, U.S. Forest Service, or the Bureau of Reclamation. The CVP water service area within Placer County primarily includes the communities and agricultural areas in the western portion of the county.

The portion of Placer County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP water facilities (Folsom Lake), areas along the American River that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.3.1.7 Plumas County

Plumas County encompasses approximately 2,610 square miles in Northern California. It is bounded on the north by Shasta County, on the east by Lassen County, on the west by Tehama and Butte Counties, and on the south by Sierra County. Plumas County includes lands within national forests (Plumas, Lassen, Toiyabe, and Tahoe), Lassen Volcanic National Park, or other federally owned land. State lands include Plumas-Eureka State Park (Plumas County 2012).

Prominent landscape features in Plumas County are the Sierra Valley, the Lake Almanor Basin, and the upper Feather River watershed, which features three SWP lakes (Antelope Lake, Lake Davis, and Frenchman Lake). The largest land uses in the county are agricultural and timber resource lands. Rural and semirural development is scattered throughout the county, with most growth concentrated in several designated planning areas. The county's only incorporated area is the city of Portola.

The most recent Plumas County General Plan was adopted in 1984. The county is in the process of updating its General Plan through 2030 (Plumas County 2012). Approximately 76% of the land in Plumas County is national forest land owned and managed by the U.S. Forest Service. The U.S. Forest Service prepared the *Plumas National Forest Land and Resource Management Plan* in 1988, to guide management and land use planning decisions in the forest. The plan provides a designation for areas based on established priorities for various resources, including wilderness, recreation, wildlife, timber, and visual resources (Plumas County 2012).

The portion of Plumas County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS is located at the SWP Antelope Lake, Lake Davis, and Frenchman Lake and along the Feather River downstream of Frenchman Lake.

R.1.3.1.8 Shasta County

Shasta County encompasses approximately 3,793 square miles in Northern California. It is bounded on the north by Siskiyou County, on the east by Lassen County, on the south by Tehama County, and on the west by Trinity County. Shasta County includes lands within national forests (Shasta-Trinity, Whiskeytown-Shasta-Trinity, and Lassen), Lassen Volcanic National Park, or other federally owned land. State lands include state forest and state parks (Shasta County 2004).

The *Shasta County General Plan* identifies four major categories of land use: urban, rural, agricultural, and timber (Shasta County 2004). Of Shasta County's 2,416,440 acres, 613,495 acres (25%) are designated as timber preserve zones pursuant to California's Forest Taxation Reform Act of 1976 (Shasta County 2004). Approximately 169,127 acres (7%), are designated as agricultural preserve lands.

Approximately 1.2% of the lands in the county are within incorporated areas (Shasta County 2004). Urban development is concentrated in the southern central portion of the county in the cities of Redding, Anderson, and Shasta Lake (Reclamation 2005a).

The portion of Shasta County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP facilities (Shasta Lake, Keswick Reservoir, and Whiskeytown Lake), areas along the Sacramento River and Clear Creek that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.3.1.9 Sutter County

Sutter County encompasses approximately 607 square miles in Northern California. It is bounded on the north by Butte County, on the east by Yuba and Placer Counties, on the west by Colusa and Yolo Counties, and on the south by Sacramento County. Sutter County includes lands within the Sutter National Wildlife Refuge. State lands in Sutter County include Butte Slough, Feather River, Gray Lodge, Sutter Bypass, and Butte Sink wildlife management areas; and Sutter Buttes State Park (Sutter County 2010).

Sutter County's *2030 General Plan* was updated in 2011. Approximately 98% of the land in the county is unincorporated, and approximately 98% of the unincorporated land is zoned for agricultural use (Reclamation 2004). The two incorporated cities within the county, Yuba City and Live Oak, encompass approximately 10,600 acres.

Existing land use in Sutter County is rural and dominated by agricultural areas. The county has substantial natural and recreational resources, and a relatively low population density. Existing land uses in Yuba City and Live Oak contain the bulk of the county's urban land uses, such as residences, commercial and industrial uses, parks, and public facilities (Sutter County 2010). The county includes several incorporated rural communities: Meridian, Sutter, Robbins, Rio Oso, Trowbridge, Nicolaus, East Nicolaus, and Pleasant Grove (Sutter County 2010).

The portion of Sutter County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes wildlife refuges, CVP facilities, areas along the Sacramento River that use the surface waters (including agricultural lands), and CVP and SWP water service areas.

R.1.3.1.10 Tehama County

Tehama County encompasses approximately 2,951 square miles in Northern California. It is bounded on the north by Shasta County, on the east by Plumas County, on the west by Trinity and Mendocino Counties, and on the south by Glenn and Butte Counties. Tehama County includes lands within national forests (Lassen, Mendocino, and Shasta-Trinity), Lassen Volcanic National Park, or other federally owned land (Tehama County 2008).

Tehama County is predominantly rural, with populations primarily concentrated in the incorporated cities of Corning, Red Bluff, and Tehama or along the major transportation corridors. The incorporated areas include less than 1% of the total land area in the county. The primary incorporated and unincorporated developed areas in the county are adjacent to major transportation centers, with most adjacent to I-5 and State Route 99. Clustered commercial land uses are located primarily along the major state and county roadways, most of which are near Red Bluff, Corning, and the unincorporated community of Los Molinos. Residential land uses in the developed portions of the county tend to be located behind or beyond the commercial and service uses adjacent to the major street network (Tehama County 2008).

Ranches, timber company holdings, and government land dominate the county. Much of the land use is resource-based, such as cropland, rangeland, pasture land, and timber land (Tehama County 2008). The majority of land within the CVP water service area in Tehama County is designated for agricultural use (Tehama County 2008; Reclamation 2005b).

The portion of Tehama County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP facilities, areas along the Sacramento River that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.3.1.11 Yuba County

Yuba County encompasses approximately 634 acres in Northern California. It is bounded on the north by Butte County, on the east by Sierra and Nevada Counties, on the west by Sutter County, and on the south by Placer County. Federally owned lands in Yuba County include Tahoe and Plumas National Forests, and the 22,944-acre Beale Air Force Base (Yuba County 2011). The Department of Fish and Wildlife administers the Spenceville Wildlife Area.

Yuba County is predominantly rural. Over 189,500 acres (46% of the county), are designated for agricultural land uses. Most of the population lives in the two incorporated cities in the county (Marysville and Wheatland) and the major unincorporated communities of Brown's Valley, Brownsville, Camptonville, Dobbins, Linda/Olivehurst, Log Cabin, Loma Rica, Oregon House, Rackerby, and River Highlands (Yuba County 2011).

The portion of Yuba County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes areas within Yuba County Water Agency facilities that provide water for environmental and water supply purposes within the Central Valley.

R.1.3.1.12 Tribal Lands in the Sacramento River Region

This section summarizes the tribal lands that could be affected by the changes in CVP and/or SWP operations and that are located within the county boundaries.

Tribal Lands within the Boundaries of Butte County

Federally recognized tribes and tribal lands within the boundaries of Butte County include the Tyme Maidu of Berry-Creek Rancheria on approximately 90 acres, and the Concow Maidu of Mooretown Rancheria on approximately 300 acres (Butte County 2010).

Tribal Lands within the Boundaries of Colusa County

Federally recognized tribes and tribal lands within the boundaries of Colusa County include the Cachil Dehe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria, and the Cortina Indian Rancheria of Wintun Indians of California (Colusa County 2011).

Tribal Lands within the Boundaries of El Dorado County

Federally recognized tribes and tribal lands within the boundaries of El Dorado County include the Shingle Springs Band of Miwok Indians.

Tribal Lands within the Boundaries of Glenn County

Federally recognized tribes and tribal lands within the boundaries of Glenn County include the Grindstone Indian Reservation near Elk Creek at the Grindstone Indian Rancheria of Wintun-Wailaki Indians of California, and lands of the Paskenta Band of Nomlaki Indians of California.

Tribal Lands within the Boundaries of Nevada County

Federally recognized tribes and tribal lands within the boundaries of Nevada County include tribal trust lands of the Shingle Springs Band of Miwok Indians.

Tribal Lands within the Boundaries of Placer County

Federally recognized tribes and tribal lands within the boundaries of Placer County include tribal trust lands of the United Auburn Indian Community of the Auburn Rancheria of California.

Tribal Lands within the Boundaries of Shasta County

Federally recognized tribes and tribal lands within the boundaries of Shasta County include the Pit River Tribe and the Redding Rancheria, which is a federal reservation of Wintun, Pit River, and Yana Indians near Redding.

Tribal Lands within the Boundaries of Tehama County

There are approximately 2,000 acres within the total acreage of Tehama County within tribal trust, including land near Corning owned by the Paskenta Band of Nomlaki Indians of California.

R.1.3.2 *Agricultural Resources*

Crops grown in the Sacramento River region include almonds, walnuts, and grapes; and rice, pasture, and grain. Crop establishment and production costs are generally similar to those shown in Tables R.1-2 and R.1-3. In total, the Sacramento River region contains about 4,000,000 acres planted, creating over three billion dollars per year in value of production. Table R.1-6 shows the acreage and production value of agricultural activity in the Sacramento River region, 2012–2016.

Table R.1-6. Average Annual Agricultural Acreage and Value of Production in Counties in the Sacramento River Region from 2012 through 2016

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage[1]	401,896	3,662,304	N/A	13,058	27,565	4,104,823
Value[2]	$2,006.54	$1,069.35	$378.15	$133.98	$127.38	$3,715

Sources: USDA-NASS 2012, 2013, 2014, 2015, 2016; U.S. Department of Commerce 2019

1 Not all acreages and/or production values are reported for every crop in every county. Therefore the implied value of production per acre may be misleading for some crop categories.

2 Values in million dollars, 2018 basis

Changes in farmland in the Sacramento River region counties are summarized in Table R.1-7. Overall, the Sacramento River region saw a decrease of approximately 31,000 acres in Important Farmland within the 10-year period 2006–2016.

Table R.1-7. Farmland Mapping and Monitoring Program Acreages in the Sacramento River Region in 2006 and 2016

		Important Farmland[2]			Grazing Land		
County	**Total[1]**	**2006**	**2016**	**Change**	**2006**	**2016**	**Change**
Butte	1.08	242,058	237,438	-4,620	407,678	400,165	-7,513
Colusa	0.72	325,670	320,560	-5,110	9,030	15,835	6,805
El Dorado	1.1	5,404	4,553	-851	195,957	195,201	-756
Glenn	0.84	267,021	264,816	-2,205	229,191	227,081	-2,110
Nevada	0.64	3,833	2,035	-1,798	117,930	133,508	15,578
Placer	0.96	36,337	30,312	-6,025	28,692	30,267	1,575
Plumas[3]	NI	NI	NI	NI	NI	NI	NI
Shasta	2.4	17,214	13,644	-3,570	409,616	414,181	4,565
Sutter	0.39	292,256	281,179	-11,077	51,516	54,460	2,944
Tehama	1.7	99,076	105,223	6,147	1,550,095	1,545,803	-4,292
Yuba	0.41	85,384	83,562	-1,822	142,729	140,185	-2,544

Sources: Butte County 2010; Colusa County 2011; CDOC 2006a, 2006b, 2006c, 2006d, 2006e, 2006f, 2006g, 2006h, 2006i, 2006j, 2016a, 2016b, 2016c, 2016d, 2016e, 2016f, 2016g, 2016h, 2016i, 2016j; El Dorado County 2003; Glenn County 1993; Nevada County 1995; Placer County 2011; Shasta County 2004; Sutter County 2010; Tehama County 2008; Yuba County 2011.

1 Total acreage of county in million acres

2 Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

3 NI = not inventoried

R.1.4 San Joaquin River Region

The San Joaquin Valley includes Fresno, Kern, Kings, Madera, Merced, Stanislaus, and Tulare Counties. San Joaquin County is discussed under Section R.1.5, *Bay-Delta Region*, for this appendix. Calaveras, Mariposa, and Tuolumne Counties are not anticipated to be affected by changes in CVP and SWP operations and are not discussed in this appendix.

R.1.4.1 *Land Use*

R.1.4.1.1 Fresno County

Fresno County encompasses approximately 6,000 square miles in central California. It is bounded on the north by Merced and Madera Counties, on the east by Mono and Inyo Counties, on the south by Kings and Tulare Counties, and on the west by San Benito and Monterey Counties. Fresno County includes lands within Millerton Lake, Pine Flat Lake, the Sierra and Sequoia national forests, Sequoia National Monument, and Kings Canyon National Park (Fresno County 2000). State lands within the county include the Millerton Lake State Recreation Area, San Joaquin River Parkway, and Mendota Wildlife Area.

Fresno County is California's sixth-largest county. Agricultural land uses cover over 48% of the county, and resource conservation lands (e.g., forests, parks, and timber preserves) cover approximately 45% of the county. The 15 incorporated cities and unincorporated communities cover approximately 5% of the county (Fresno County 2000). Development constraints within the county are primarily caused by lack of funding for infrastructure improvement, availability of water supplies, air quality regulations, and physical limitations, especially in the mountains and eastern foothills. The incorporated cities are Clovis, Coalinga, Firebaugh, Fowler, Fresno, Huron, Kerman, Kingsburg, Mendota, Orange Cove, Parlier-West Parlier, Reedley, Sanger, San Joaquin, and Selma (Fresno County 2000). Major unincorporated communities include Biola, Caruthers, Del Rey, Friant, Lanare, Laton, Riverdale, Shaver Lake, and Tranquility.

The portion of Fresno County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP water facilities (Millerton Lake and the Friant-Kern Canal), areas along the San Joaquin River that use the surface waters, and CVP water service areas (including agricultural lands).

R.1.4.1.2 Kern County

Kern County encompasses approximately 8,202 square miles in south central California. It is bounded on the north by Kings, Tulare, and Inyo Counties; on the east by San Bernardino County; on the south by Ventura and Los Angeles Counties; and on the west by San Luis Obispo County. Kern County includes lands within the Sequoia National Forest, Kern and Bitter Creek National Wildlife Refuges, Lake Isabella, China Lake Naval Air Weapons Station, and Edwards Air Force Base (Kern County 2004). State lands within the county include the Tule Elk State Reserve.

The county's geography includes mountainous regions, agricultural lands, and deserts. There are 11 incorporated cities in the county: Arvin, Bakersfield, California City, Delano, Maricopa, McFarland, Ridgecrest, Shafter, Taft, Tehachapi, and Wasco (Kern County 2010). The major unincorporated communities include Kernville, Lake Isabella, Inyokern, Mojave, Boron, Rosamond, Golden Hills, Stallion Springs, and Buttonwillow. Agricultural land uses are designated for approximately 85% of the unincorporated lands that are under the jurisdiction of the county (not including lands under the jurisdiction of the federal, state, tribes, or incorporated cities). Less than 6% of the unincorporated lands under county jurisdiction are designated for residential uses.

The portion of Kern County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP and SWP water service areas.

R.1.4.1.3 Kings County

Kings County encompasses approximately 1,280 square miles in south central California. It is bounded on the north by Fresno County, on the east by Tulare County, on the south by Kern County, and on the west by Monterey County. Kings County includes lands within Naval Air Station Lemoore (Kings County 2009).

Land use is predominantly agricultural, with more than 90% of the county designated for agricultural uses. Incorporated cities in Kings County are Avenal, Corcoran, Hanford, and Lemoore. Residential land uses in unincorporated areas and special districts cover less than 1% of the county's total acreage, in the communities of Armona, Home Garden, Kettleman City, and Stratford (Kings County 2009).

The portion of Kings County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP and SWP water service areas.

R.1.4.1.4 Madera County

Madera County encompasses approximately 2,147 square miles in central California. It is bounded on the north by Merced and Mariposa Counties, on the east by Mono County, and on the south and west by Fresno County. Madera County includes lands within the Sierra and Inyo National Forests (Madera County 1995). State lands within the county include the Millerton Lake State Recreation Area.

Land elevations in Madera County range from 180 feet to over 13,000 feet above mean sea level. Madera County can be divided generally into three regions: the San Joaquin Valley in the west, the foothills between the Madera Canal and the 3,500-foot elevation contour, and the mountains from the 3,500-foot contour to the crest of the Sierra Nevada. The county has two incorporated cities, Madera and Chowchilla (Madera County 1995). Major unincorporated communities in the county include North Fork, South Fork, O'Neals, Oakhurst, Coarsegold, Gunner Ranch, and Rio Mesa.

The portion Madera County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP water facilities (Millerton Lake and the Madera Canal), areas along the San Joaquin River that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.4.1.5 Merced County

Merced County encompasses approximately 1,977 square miles in central California. It is bounded on the north by Stanislaus County, on the east by Mariposa County, on the south by Fresno and Madera Counties, and on the west by Santa Clara and San Benito Counties. Merced County includes federally owned lands within the San Luis National Wildlife Refuge (Merced County 2013). State lands within the county include San Luis Reservoir State Recreation Area; Great Valley Grasslands State Park; and the Los Banos, North Grasslands, and Volta Wildlife Areas.

Merced County has six incorporated cities of Atwater, Dos Palos, Gustine, Livingston, Los Banos, and Merced. The major unincorporated communities include Delhi, Fox Hills, Franklin, Hilmar, LeGrand, Planada, Santa Nella, Laguna San Luis, and Winton (Merced County 2013). Unincorporated land within the county includes approximately 1.2 million acres (98.1% of the land in the county). Agriculture is the primary land use, totaling just over 1 million acres (81.2%). Public and quasi-public land is the next largest use with 131,582 acres or 10.6% of the unincorporated county. Commercial land uses represent 3,025 acres (0.2%), industrial uses represent 2,488 acres (0.2%), and mining represents 3,375 acres (0.3%). Incorporated cities account for 24,138 acres (1.9%) (Merced County 2012a, 2013). The Merced County Local Agency Formation Commission policies discourage annexation of prime agricultural land when substantial areas of non-prime agricultural land are already available. The policies also encourage development of vacant areas in cities before the annexation and development of outlying areas. Local Agency Formation Commission policies encourage city annexations that reflect a planned, logical, and orderly progression of urban expansion and promote efficient delivery of urban services (Merced County 2012b).

The portion of Merced County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes wildlife refuges, CVP and SWP water facilities (San Luis Reservoir, Delta-Mendota Canal, and San Luis Canal/California Aqueduct), areas along the San Joaquin River that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.4.1.6 Stanislaus County

Stanislaus County encompasses approximately 1,521 square miles in central California. It is bounded on the north by San Joaquin County, on the east by Calaveras and Tuolumne Counties, on the west by Santa Clara County, and on the south by Merced County. Stanislaus County includes lands within the San Joaquin River National Wildlife Refuge (Stanislaus Council of Governments 2007).

Land use in the county is primarily agricultural, with nearly 80% of the land zoned for general agriculture or in agricultural production (Stanislaus Council of Governments 2007). Over the past 40 years, some portions of the county have been changing from a rural agricultural region to semi-urbanized, especially along major highways and freeways. There are nine incorporated cities in the county: Ceres, Hughson, Modesto, Newman, Oakdale, Patterson, Riverbank, Turlock, and Waterford. Stanislaus County has adopted community plans for most of its unincorporated towns, including Crows Landing, Del Rio, Denair, Hickman, Keyes, Knights Ferry, La Grange, Westley, and Salida (Stanislaus County 2010, 2012).

The portion of Stanislaus County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes wildlife refuges, CVP water facilities (New Melones Reservoir, Delta-Mendota Canal, and San Luis Canal/California Aqueduct), areas along the Stanislaus and San Joaquin Rivers that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.4.1.7 Tulare County

Tulare County encompasses approximately 4,840 square miles in south central California. It is bounded on the north by Fresno County, on the east by Inyo County, on the south by Kern County, and on the west by Kings County. Tulare County includes federally owned lands within the Sequoia National Forest, Sequoia and Kings Canyon National Parks, Sequoia National Monument, several wilderness areas, Lake Kaweah, Lake Success, and Pixley National Wildlife Refuge (Tulare County 2010).

Agricultural land uses cover more than 2,150 square miles (approximately 44%) of the county. Lands classified as open space (i.e., national forests, monuments, and parks; wilderness areas; and county parks) make up 25% of the land use in the county. Less than 3% of the county lands are in the incorporated cities of Dinuba, Exeter, Farmersville, Lindsay, Porterville, Tulare, Visalia, and Woodlake (Tulare County 2010). Less than 2% of the county is designated for unincorporated residential areas, including the major communities of Alpaugh, Cutler, Ducor, Earlimart, East Oros, Goshen, Ivanhoe, Lemoncove, London, Oros, Pixley, Plainview, Poplar-Cotton Center, Richgrove, Springville, Strathmore, Terra Bella, Three Rivers, Tipton, Traver, and Woodville.

The portion of Tulare County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP water service areas.

R.1.4.1.8 Tribal Lands in the San Joaquin River Region

This section summarizes the tribal lands that could be affected by the changes in CVP and/or SWP operations and that are located within the county boundaries described above.

Tribal Lands within the Boundaries of Fresno County

Federally recognized tribes and tribal lands within the boundaries of Fresno County include the lands of the Big Sandy Rancheria of the Western Mono Indians of California and Table Mountain Rancheria of California.

Tribal Lands within the Boundaries of Kings County

Federally recognized tribes and tribal lands within the boundaries of Kings County includes the lands of the Santa Rosa Indian Community of Santa Rosa Rancheria near the town of Lemoore (SDSU 2013).

Tribal Lands within the Boundaries of Madera County

Federally recognized tribes and tribal lands within the boundaries of Madera County include the Picayune Rancheria of the Chuckchansi Indians of California near the community of Coarsegold and the Northfork Rancheria of the Mono Indians of California near Northfork (SDSU 2013).

Tribal Lands within the Boundaries of Tulare County

Federally recognized tribes and tribal lands within the boundaries of Tulare County includes the Tule River Indian Tribe of the Tule River Reservation of the Yokut Indians about 20 miles east of Porterville and covers 55,356 acres (SDSU 2013).

R.1.4.2 *Agricultural Resources*

Crops grown in the San Joaquin River region include almonds, alfalfa, silage, and wine grapes. Crop establishment and production costs are generally similar to those shown in Tables R.1-2 and R.1-3. In total, the San Joaquin River region contains about 6,900,000 acres planted, creating over thirty billion dollars per year in value of production. Table R.1-8 shows the acreage and production value of agricultural activity in the San Joaquin River region, 2012–2016.

Table R.1-8. Average Annual Agricultural Acreage and Value of Production in Counties in the San Joaquin River Region from 2012 through 2016

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage[1]	2,031.931	6,893,215	N/A	7,480	382.736	6,903,110
Value[2]	$14,977.79	$2,752.91	$10,107.68	$498.36	$2,232.94	$30,570

Sources: USDA-NASS 2012, 2013, 2014, 2015, 2016; U.S. Department of Commerce 2019

[1] Not all acreages and/or production values are reported for every crop in every county. Therefore the implied value of production per acre may be misleading for some crop categories.

[2] Values in million dollars, 2018 basis

Changes in farmland in the San Joaquin River region counties are summarized in Table R.1-9. Overall, the San Joaquin River region saw a decrease of approximately 280,000 acres in Important Farmland within the 10-year period 2006–2016.

Table R.1-9. Farmland Mapping and Monitoring Program Acreages in the San Joaquin River Region in 2006 and 2016

		Important Farmland[2]			Grazing Land		
County	**Total[1]**	**2006**	**2016**	**Change**	**2006**	**2016**	**Change**
Fresno	3.8	1,289,908	1,167,758	-122,150	827,114	822,697	-4,417
Kern	5.3	962,181	880,102	-82,079	1,792,928	1,849,266	56,338
Kings	0.82	585,616	468,855	-116,761	243,183	338,243	95,060
Madera	1.4	348,020	363,997	15,977	399,724	386,729	-12,995
Merced	1.3	529,764	538,687	8,923	569,828	552,632	-17,196
Stanislaus	0.94	361,974	399,349	37,375	441,435	404,405	-37,030
Tulare	3.1	724,139	700,182	-23,957	440,135	439,934	-201

Sources: CDOC 2006k, 2006l, 2006m, 2006n, 2006o, 2006p, 2006q, 2016k, 2016l, 2016m, 2016n, 2016o, 2016p, 2016q; Fresno County 2000; Kern County 2004; Kings County 2009; Madera County 1995; Merced County 2012; Stanislaus County 2010; Tulare County 2010.

[1] Total acreage of county in million acres

[2] Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

R.1.5 Bay-Delta Region

The Bay-Delta region in this analysis includes Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties. These counties include some of the leading agricultural areas in the state. In addition to agriculture, this area includes important transportation infrastructures including inland shipping ports (Port of West Sacramento and Port of Stockton); major employment centers (cities of Sacramento, West Sacramento, Fairfield, Stockton, and Concord); and water-based recreation activities (e.g., boating, fishing, and water skiing).

R.1.5.1 *Land Use*

R.1.5.1.1 Contra Costa County

Contra Costa County encompasses approximately 805 square miles in Northern California. It is bounded on the north by Solano and Sacramento Counties, on the east by San Joaquin County, on the south by Alameda County, and on the west by San Francisco Bay. Contra Costa County includes federally owned and state-owned lands throughout the county, including approximately 20,000 acres within Mount Diablo State Park (Contra Costa County 2005).

Over 40% of the county's land is in agricultural production, or about 200,370 acres. Residential land is the second largest use in the county, encompassing approximately 122,100 acres (25.4% of the county). Approximately 46,700 acres (9% of the land within the county), are within surface waters (Contra Costa County 2005).

Residential development is concentrated in existing cities and adjacent unincorporated communities. The Contra Costa County incorporated cities include Antioch, Brentwood, Clayton, Danville, El Cerrito, Hercules, Lafayette, Martinez, Moraga, Oakley, Orinda, Pinole, Pleasant Hill, Pittsburg, Richmond, San Pablo, San Ramon, and Walnut Creek. The major unincorporated areas in the county include Alamo, Bethel Island, Byron, Crockett, Discovery Bay, Kensington, Knightsen, North Richmond, Pacheco, Port Costa, and Rodeo (Contra Costa County 2005). Portions of the cities of Pittsburg, Antioch, Oakley, and Brentwood and eastern Contra Costa County are located within the Bay-Delta.

The portion of Contra Costa County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP facilities (including facilities associated with Rock Slough), areas along the Bay-Delta channels that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.5.1.2 Sacramento County

Sacramento County encompasses approximately 1,769 square miles in Northern California. It is bounded on the north by Sutter and Placer Counties, on the east by El Dorado and Amador Counties, on the south by Contra Costa and San Joaquin Counties, and on the west by Yolo and Solano Counties. Sacramento County includes federally owned lands within Folsom Lake and Lake Natoma.

Residential areas in Sacramento County primarily occur in northern and central Sacramento County. Sacramento County includes areas within the Bay-Delta, including the southwestern portion of the City of Sacramento, City of Isleton and the communities of Locke, Ryde, Courtland, Freeport, Hood, and Walnut Grove; and areas located to the east of the Delta (Sacramento County 2011). Sacramento County has seven incorporated cities located in about 56% of the county: Sacramento, Elk Grove, Citrus Heights, Folsom, Galt, Isleton, and Rancho Cordova. The County includes several unincorporated communities including Antelope, Arden-Arcade, Carmichael, Cordova, Elverta, Foothill Farms, Fair Oaks, Herold, Natomas, North Highlands, Orangevale, Rancho Murieta, Rio Linda, Sloughhouse, and Wilton.

The leading agricultural crops in Sacramento County include dairy, wine grapes, Bartlett pears, field corn, and turkeys (Sacramento County 2010). Agricultural acreage has declined as urban development has continued. Between 1989 and 2004, the portion of the county designated as agriculture declined from 40% to 34%. The southeastern portion of the county remains primarily rural with smaller communities, such as Herald (Sacramento County 2011).

The portion of Sacramento County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP facilities (Folsom Lake and Lake Natoma), areas along the American and Sacramento Rivers and Bay-Delta channels that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.5.1.3 San Joaquin County

San Joaquin County encompasses approximately 1,426 square miles in central California. It is bounded on the north by Sacramento County, on the east by Calaveras and Amador Counties, on the south by Stanislaus County, and on the west by Contra Costa and Alameda Counties. San Joaquin County includes about 6,000 acres of federally owned lands (San Joaquin County 2009).

San Joaquin County is currently in the process of updating its General Plan. Most of the county's land is in agricultural production. Agriculture, the predominant land use, covers 686,109 acres (75%) of the county. Residential land is the second largest use in the unincorporated lands, encompassing 40,410 acres (4.4% of the county). Residential development in the county is concentrated in existing cities and in adjacent unincorporated communities. San Joaquin County has seven incorporated cities: Stockton, Tracy, Manteca, Escalon, Ripon, Lodi, and Lathrop. Stockton and Tracy are the largest cities in the county. The major unincorporated areas in the county include French Camp, Linden, Lockeford, Morada, Mountain House, New Jerusalem, Thornton, and Woodbridge (San Joaquin County 2009). The incorporated cities account for 90,191 acres (approximately 10% of the county).

The portion of San Joaquin County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP and SWP facilities (including facilities associated with Rock Slough Pumping Plant, Jones Pumping Plant, Clifton Court, and Banks Pumping Plant), areas along the Bay-Delta channels that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.5.1.4 Solano County

Solano County encompasses approximately 910 square miles in Northern California. It is bounded on the north by Yolo County, on the east by Sutter and Sacramento Counties, on the south by Contra Costa County, and on the west by Napa County. Solano County includes federally owned lands within Travis Air Force Base (Solano County 2008). State lands include areas within Suisun Marsh and the Cache Slough area of Yolo Bypass.

Solano County’s General Plan was adopted in 2008. Approximately 81,678 acres of the county (14% of the total land area), lies within seven incorporated cities: Benicia, Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo. Urban development is generally concentrated within the incorporated cities or surrounding suburban communities. Travis Air Force Base is located on approximately 7,100 acres (1% of the land within the county). In 2006, agriculture accounted for 56.5% of the total land use in Solano County (Solano County 2008). The southern section of the Yolo Bypass, as described under the Yolo County subsection, is located within Solano County.

The portion of Solano County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes SWP facilities (North Bay Aqueduct intakes at Barker Slough), areas in the Yolo Bypass and along the Bay-Delta channels that use the surface waters (including agricultural lands), and CVP and SWP water service areas.

R.1.5.1.5 Yolo County

Yolo County encompasses approximately 1,021 square miles in Northern California. It is bounded on the north by Colusa County, on the east by Sutter and Sacramento Counties, on the south by Solano County, and on the west by Lake and Napa Counties. Yolo County includes federally owned lands in the Yolo Bypass and Cache Creek areas and state lands within the Yolo Bypass.

Residential areas in Yolo County primarily occur in the county’s four incorporated cities (Davis, West Sacramento, Winters, and Woodland) that comprise approximately 32,325 acres (5%) of county lands (Yolo County 2009). Yolo County includes areas within the Bay-Delta, including the City of West Sacramento and the community of Clarksburg. The unincorporated portion of the county encompasses 35 community areas, including Capay, Clarksburg, Dunnigan, Esparto, Guinda, Knights Landing, Madison, Monument Hills, Rumsey, Yolo, and Zamora.

Yolo County adopted its *2030 General Plan* in 2011. The general plan designates more than 92% of the county area for agricultural and open space uses. The major crops are tomatoes, alfalfa, wine grapes, rice, seed crops, almonds, organic production, walnuts, cattle, and wheat (Yolo County 2009).

The 59,000-acre Yolo Bypass is primarily located within Yolo County and includes a portion of the Sacramento River Flood Control Project, as described in Chapter 5, Surface Water Resources and Water Supplies (CALFED et al. 2001). The upper section of the Yolo Bypass is defined as the area between Fremont Weir and I-80 and is located within Yolo County. The lower section is defined as the area between I-80 and the southern boundary of Egbert Tract at the Sacramento River. The portion of the southern area located to the north of the upper Holland Tract and upper Liberty Island is within Yolo County. In the northern area, agricultural crops include rice, corn, and safflower with melons and tomatoes planted in years when the bypass is not inundated with flood waters. The southern bypass crops include corn, milo, safflower, beans, and sudan grass. Approximately 16,770 acres in the southern Yolo Bypass is within the Yolo Bypass Wildlife Area (Yolo County 2009).

The portion of Yolo County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes areas in the Yolo Bypass and along the Bay-Delta channels that use the surface waters (including agricultural lands), and CVP water service areas.

R.1.5.1.6 Tribal Lands in the Bay-Delta Region

This section summarizes the tribal lands that could be affected by the changes in CVP and/or SWP operations and that are located within the county boundaries described above.

Tribal Lands within the Boundaries of Sacramento County

Federally recognized tribes and tribal lands within the boundaries of Sacramento County include lands of the Wilton Miwok Indians of the Wilton Rancheria near Elk Grove (SACOG 2007).

Tribal Lands within the Boundaries of Yolo County

Federally recognized tribes and tribal lands within the boundaries of Yolo County include lands of the Yocha Dehe Wintun Nation (previously called the Rumsey Indian Rancheria of Wintun Indians of California) (Yolo County 2009).

R.1.5.2 *Agricultural Resources*

Crops grown in the Bay-Delta region include grapes, field crops, grain, alfalfa, and pasture. Crop establishment and production costs are generally similar to those shown in Tables R.1-2 and R.1-3. In total, the Bay-Delta region contains about 1,900,000 acres planted, creating more than four million dollars per year in value of production. Table R.1-10 shows the acreage and production value of agricultural activity in the Bay-Delta region, 2012–2016.

Table R.1-10. Average Annual Agricultural Acreage and Value of Production in Counties in the Bay-Delta Region from 2012 through 2016

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage[1]	376,418	1,431,337	N/A	13,977	127,195	1,948,927
Value[2]	$2,089.21	$714.65	$858.41	$215.80	$590.74	$4,469

Sources: USDA-NASS 2012, 2013, 2014, 2015, 2016; U.S. Department of Commerce 2019

[1] Not all acreages and/or production values are reported for every crop in every county. Therefore the implied value of production per acre may be misleading for some crop categories.

[2] Values in million dollars, 2018 basis

Changes in farmland in the Bay-Delta region counties are summarized in Table R.1-11. Overall, the Bay-Delta region saw a decrease of approximately 60,000 acres in Important Farmland within the 10-year period 2006–2016.

Table R.1-11. Farmland Mapping and Monitoring Program Acreages in the San Francisco Bay Area Region in 2006 and 2016

		Important Farmland[2]			Grazing Land		
County	**Total[1]**	**2006**	**2016**	**Change**	**2006**	**2016**	**Change**
Contra Costa	0.52	41,619	37,457	-4,162	168,662	157,701	-10,961
Sacramento	1.1	173,152	149,573	-23,579	156,977	153,174	-3,803
San Joaquin	0.91	560,113	546,172	-13,941	144,933	129,760	-15,173
Solano	0.58	157,736	147,863	-9,873	202,826	208,189	5,363
Yolo	0.65	325,079	316,182	-8,897	150,339	166,413	16,074

Sources: Contra Costa County 2005; CDOC 2006r, 2006s, 2006t, 2006u, 2006v, 2016r, 2016s, 2016t, 2016u, 2016v; Sacramento County 2010; San Joaquin County 2009; Yolo County 2009
[1] Total acreage of county in million acres
[2] Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

R.1.6 San Francisco Bay Area Region

The San Francisco Bay Area region includes portions of Alameda, Napa, San Benito, and Santa Clara Counties that are within the CVP and SWP service areas.

R.1.6.1 *Land Use*

R.1.6.1.1 Alameda County

Alameda County encompasses approximately 738 square miles in Northern California. It is bounded on the north by Contra Costa County, on the east by San Joaquin County, on the south by Santa Clara County, and on the west by San Francisco Bay. Alameda County includes federally owned and state-owned lands throughout the county (Alameda County 2009).

Western Alameda County and the portions of the Livermore-Amador Valley are heavily urbanized. The incorporated cities include Oakland, which is the county seat, Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Piedmont, Pleasant, San Leandro, and Union City. The unincorporated area of the county covers approximately 277,760 acres (59%) of the total land area; this includes the Castro Valley and Eden Area (Alameda County Community Development Agency 2010; Alameda County 2000, 2009). Large portions of the unincorporated areas located to the east of Castro Valley and within the Livermore-Amador Valley hills have agricultural lands and open spaces that are not served by the CVP or SWP water supplies.

The portion of Alameda County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP and SWP facilities (including the SWP South Bay Aqueduct), reservoirs that store CVP or SWP water, and CVP and SWP water service areas.

R.1.6.1.2 Napa County

Napa County encompasses approximately 793 square miles in Northern California. It is bounded on the north by Lake County, on the east by Yolo County, on the south by Solano County, and on the west by Sonoma County. Napa County has 62,865 acres of federally owned lands and 40,307 acres of state-owned lands throughout the county, including approximately 28,000 acres associated with Lake Berryessa and the State Cedar Rough Wilderness and Wildlife Area (Napa County 2007).

Approximately 479,000 acres (95%) of the county are unincorporated. The five incorporated cities are American Canyon, Calistoga, Napa, and St. Helena, and the town of Yountville. Land use in the county is predominantly agricultural (Napa County 2007, 2008).

The portion of Napa County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes SWP water service areas.

R.1.6.1.3 San Benito County

San Benito County encompasses approximately 1,386 square miles in central California. It is bounded on the north by Santa Clara County, on the east by Merced and Fresno Counties, and on the south and west by Monterey County. San Benito County includes federally owned and state-owned lands throughout the county, including approximately 26,000 acres within Pinnacles National Monument, over 105,403 acres owned by Bureau of Land Management, and over 8,800 acres associated with the Hollister Hills State Vehicular Recreation Area and San Juan Bautista State Historic Park (San Benito County 2010, 2013).

San Benito County has approximately 882,675 acres of unincorporated lands (nearly 99.5% of the total land area). The incorporated cities of Hollister and San Juan Bautista account for approximately 4,044 acres (0.5% of the county land area). Agriculture is the predominant land use, totaling 747,409 acres (84% of the county) (San Benito County 2010, 2013).

The portion of San Benito County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP and SWP facilities (including San Justo Reservoir and other facilities to convey water from San Luis Reservoir) and CVP water service areas.

R.1.6.1.4 Santa Clara County

Santa Clara County encompasses approximately 1,306 square miles in Northern California. It is bounded on the north by Alameda County, on the east by Stanislaus and Merced Counties, on the south by San Benito County, and on the west by San Mateo and Santa Cruz Counties. Santa Clara County includes federally owned and state-owned lands throughout the county, including approximately 87,000 acres within Henry W. Coe State Park (Santa Clara County 1994, 2012).

Approximately 83% of the county’s population resides in the 15 incorporated cities. The incorporated cities include Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, and Sunnyvale. The southern portion of the county near Gilroy and Morgan Hill is predominantly rural, with low-density residential developments scattered though the valley and foothill areas (Santa Clara County 1994, 2012).

The portion Santa Clara County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes CVP and SWP facilities (including the SWP South Bay Aqueduct and CVP facilities that convey water from San Luis Reservoir) and CVP and SWP water service areas.

R.1.6.1.5 Tribal Lands in the San Francisco Bay Area Region

No federally recognized tribal lands are in the San Francisco Bay Area region (BIA et al. 2011).

R.1.6.2 *Agricultural Resources*

Crops grown in the San Francisco Bay Area Region include berries, vegetables, orchards, nursery plants, and irrigated and non-irrigated pasture. Crop establishment and production costs are generally similar to those shown in Tables R.1-2 and R.1-3, except that land costs and rent may be substantially higher in this region. In total, the San Francisco Bay Area Region contains about 1 million acres planted, creating over one billion dollars per year in value of production. Table R.1-12 shows the acreage and production value of agricultural activity in the Sacramento River region, 2012–2016.

Table R.1-12. Average Annual Agricultural Acreage and Value of Production in Counties in the San Francisco Bay Area Region from 2012 through 2016

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage[1]	57,156.4	1,044,136	N/A	1,110	40,193	1,142,595
Value[2]	$738.53	$25.94	$52.59	$170.52	$340.19	$1,328

Sources: USDA-NASS 2012, 2013, 2014, 2015, 2016; U.S. Department of Commerce 2019.
[1] Not all acreages and/or production values are reported for every crop in every county. Therefore the implied value of production per acre may be misleading for some crop categories.
[2] Values in million dollars, 2018 basis

Changes in farmland in the San Francisco Bay Area Region counties are summarized in Table R.1-13. Overall, the San Francisco Bay Area Region saw a decrease of approximately 16,000 acres in Important Farmland within the 10-year period 2006–2016.

Table R.1-13. Farmland Mapping and Monitoring Program Acreages in the San Francisco Bay Area Region in 2006 and 2016

		Important Farmland[2]			Grazing Land		
County	**Total[1]**	**2006**	**2016**	**Change**	**2006**	**2016**	**Change**
Alameda	0.47	8,439	6,672	-1,767	244,947	240,986	-3,961
Napa	0.51	58,036	57,015	-1,021	179,299	179,202	-97
San Benito	0.89	42,118	36,352	-5,766	605,731	618,326	12,595
Santa Clara	0.84	27,678	20,409	-7,269	388,510	394,061	5,551

Sources: Alameda County 2000; CDOC 2006w, 2006x, 2006y, 2006z, 2016w, 2016x, 2016y, 2016z; Napa County 2007; San Benito County 2013; Santa Clara County 1994
[1] Total acreage of county in million acres
[2] Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

R.1.7 Central Coast Region

The Central Coast Region includes San Luis Obispo and Santa Barbara Counties served by the SWP.

R.1.7.1 *Land Use*

R.1.7.1.1 San Luis Obispo County

San Luis Obispo County encompasses approximately 3,594 square miles in central California, including over 200,000 acres of surface waters (San Luis Obispo County 2013). It is bounded on the north by Monterey County, on the east by Kern County, on the south by Santa Barbara County, and on the west by the Pacific Ocean. Federally owned land in San Luis Obispo County includes Los Padres National Forest, Carizzo Plain National Monument, several wilderness areas, and Guadalupe-Nipomo Dunes National Wildlife Refuge. State-owned lands include Hearst-San Simeon State Historical Monument, Montano de Oro State Park, and state beaches and marine conservation areas.

Land uses in the county are predominantly rural and agricultural with over 1,672,000 acres in agricultural and rural land uses (83% of the total county lands). Incorporated cities include Arroyo Grande, Atascadero, Grover Beach, Morro Bay, Paso Robles, Pismo Beach, and San Luis Obispo. Major unincorporated communities include Avila, California Valley, Creston Village, Edna Village, Heritage Ranch, Los Ranchos, Nipoma, Oak Shores, Oceano, San Miguel, Santa Margarita, and Templeton (San Luis Obispo County 2013).

The portion of San Luis Obispo County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes SWP facilities (including facilities associated with the Central Coast Water Authority) and SWP water service areas.

R.1.7.1.2 <u>Santa Barbara County</u>

Santa Barbara County encompasses approximately 2,744 square miles in central California. It is bounded on the north by San Luis Obispo, on the east by Ventura County, and on the south and west by the Pacific Ocean. Federally owned land in Santa Barbara County includes 629,120 acres in the Los Padres National Forest, 98,560 acres in the Vandenberg Air Force Base, Channel Islands National Park, and Guadalupe-Nipomo Dunes National Wildlife Refuge. The state-owned lands include the University of California at Santa Barbara, Sedgwick Reserve, La Purisima Mission State Park and other state parks, and Burton Mesa Ecological Reserve (Santa Barbara County 2009; SBCAG 2013).

Agricultural is the predominant land use in the county with over 1,440,000 acres (82% of the land) (Santa Barbara County 2009; SBCAG 2013). Santa Barbara County has eight incorporated cities: Buellton, Carpinteria, Goleta, Guadalupe, Lompoc, Santa Barbara, Santa Maria, and Solvang. Less than 3% of the county is within incorporated cities. The major unincorporated communities are Cuyuama, Los Alamos, Los Olivos, Mission Hills, Montecito, New Cayamu, Orcutt, Summerland, and Vandendberg Village.

The portion of Santa Barbara County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes SWP facilities (including facilities associated with the Central Coast Water Authority), recreation facilities at Cachuma Lake, which stores SWP water, and SWP water service areas.

R.1.7.2 *Tribal Lands in the Central Coast Region*

This section summarizes the tribal lands that could be affected by the changes in CVP and/or SWP operations and that are located within the county boundaries described above.

Tribal Lands within the Boundaries of Santa Barbara County

Federally recognized tribes and tribal lands within the boundaries of Santa Barbara County include the Santa Ynez Reservation, which is home to the Santa Ynez Band of Chumash Mission Indians of the Santa Ynez Reservation near Santa Barbara (SDSU 2013).

R.1.7.3 *Agricultural Resources*

Crops grown in this region include orchards and vineyards, berries, vegetables, and irrigated pasture. Crop establishment and production costs are generally similar to those shown in Tables R.1-2 and R.1-3, except that land costs and rent may be higher in this region. On average, the Central Coast region contains almost 1.8 million acres planted and over two billion dollars per year in value of production. Table R.1-14 shows the acreage and production value of agricultural activity in the Central Coast region, 2012–2016.

Table R.1-14. Central Coast Region Average Annual Agricultural Acreage and Value from 2012 through 2016

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage[1]	92,366	1,642,667	N/A	1,233	96,714	1,832,980
Value[2]	$1,178.43	$31.02	$124.85	$282.67	$701.52	$2,318

Sources: USDA-NASS 2012, 2013, 2014, 2015, 2016; U.S. Department of Commerce 2019
[1] Not all acreages and/or production values are reported for every crop in every county. Therefore the implied value of production per acre may be misleading for some crop categories.
[2] Values in million dollars, 2018 basis

Changes in farmland in the Central Coast region between 2000 and 2010 are summarized in Table R.1-15. Overall, the Central Coast region saw an increase of approximately 17,000 acres in Important Farmland within the 10-year period 2006–2016.

Table R.1-15. Farmland Mapping and Monitoring Program Acreages in the Central Coast Region in 2006 and 2016

		Important Farmland[2]			Grazing Land		
County	**Total[1]**	**2006**	**2016**	**Change**	**2006**	**2016**	**Change**
San Luis Obispo	2.3	95,857	109,060	13,203	742,004	1,189,168	447,164
Santa Barbara	1.8	113,903	117,497	3,594	584,449	579,054	-5,395

Sources: CDOC 2006aa, 2006ab, 2016aa, 2016ab; San Luis Obispo County 2013; Santa Barbara County 2009.
[1] Total acreage of county in million acres
[2] Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

R.1.8 Southern California Region

The Southern California region includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura Counties served by the SWP.

R.1.8.1 *Land Use*

R.1.8.1.1 Los Angeles County

Los Angeles County encompasses approximately 4,083 square miles in Southern California. It is bounded on the north by Kern County, on the east by San Bernardino County, on the south by Orange County, and on the west by Ventura County and the Pacific Ocean. Los Angeles County includes federally owned lands throughout the county, including nearly 650,000 acres in Los Padres and Angeles National Forests, portions of Edwards Air Force Base, over 29,000 acres of other federally owned open space (including wilderness areas), and approximately 50,893 acres of state-owned land, including Hungry Valley State Vehicular Recreation Area (Los Angeles County 2011).

More than half of Los Angeles County's 1,698,240 acres of unincorporated land area is designated a natural resources land use category. The next highest land use is rural, which accounts for 39% of the unincorporated areas, followed by residential, which accounts for 3% of the unincorporated areas. The remaining land area is in the county's 88 incorporated cities, the most populous of which is the City of Los Angeles (Los Angeles County 2012). The County has approximately 140 unincorporated areas (Los Angeles County 2013).

The portion of Los Angeles County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes SWP facilities and SWP water service areas.

R.1.8.1.2 Orange County

Orange County encompasses 948 square miles in Southern California. It is bounded on the north by Los Angeles County, on the east by San Bernardino and Riverside Counties, on the south by San Diego County, and on the west by the Pacific Ocean. Orange County includes federally owned lands, such as the Cleveland National Forest.

Orange County has 34 incorporated cities in Orange County. The unincorporated lands cover approximately 192,758 acres (Orange County 2005). Land zoned as open space forms the largest land use type in the county (143,313 acres).

The portion of Orange County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes SWP facilities and SWP water service areas.

R.1.8.1.3 Riverside County

Riverside County encompasses approximately 7,295 square miles in Southern California. It is bounded on the north by San Bernardino County, on the east by the state of Nevada, on the south by San Diego and Imperial Counties, and on the west by Orange County. Riverside County includes federally owned lands throughout the county, including March Air Reserve Base, Chocolate Mountains Naval Gunnery Range, Joshua Tree National Park, San Bernardino and Cleveland National Forests, numerous wilderness areas, and Coachella Valley National Wildlife Refuge. State-owned lands in Riverside County include San Jacinto and Santa Rosa Wildlife Areas and Mount San Jacinto State Park (RCIP 2000).

Residential land use accounts for approximately 184,000 acres, nearly 57% of which are within incorporated cities. Approximately 1,313,000 acres (28%) is open space, recreation land, agriculture, and wildland preservation (RCIP 2000).

Most of the population is concentrated in the 23 incorporated cities of Banning, Beaumont, Calimesa, Canyon Lake, Cathedral City, Coachella, Corona, Desert Hot Springs, Hemet, Indian Wells, Indio, Lake Elsinore, La Quinta, Moreno Valley, Murrieta, Norco, Palm Desert, Palm Springs, Perris, Rancho Mirage, Riverside, San Jacinto, and Temecula. The major unincorporated communities in the county are Banning Bench, Bermuda Dunes, Cabazon, Cherry Valley, Cleveland Ridge, Desert Center, Eagle Mountain, El Cerrito, Lakeview/Nuevo, Meadowbrook, Mecca, Menifee Valley, North Palm Springs, Ripley, Sun City, Temescal Canyon, Tenaja, Thermal, Thousand Palms, Warm Springs, and Wildomar.

The portion of Riverside County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes SWP facilities, reservoirs that store SWP water (including Diamond Valley Lake and Lake Skinner), and SWP water service areas.

R.1.8.1.4 San Bernardino County

San Bernardino County encompasses approximately 20,106 square miles in Southern California. It is bounded on the north by Inyo County, on the east by the state of Nevada, on the south by Riverside County, and on the west by Kern, Los Angeles, and Orange Counties. Most of the land in San Bernardino County is federally owned and state-owned lands: approximately 10,500,000 acres (81% of the county) (San Bernardino County 2007, 2012). The federally owned lands include 28 Bureau of Land Management wilderness areas (approximately 47% of the total county), San Bernardino and Angeles National Forests (676,666 and 655,387 acres, respectively), Mojave National Preserve, Joshua Tree and Death Valley National Parks, and four military bases (Edwards Air Force Base, Twentynine Palms Marine Corps Air Ground Combat Training Center, Fort Irwin, and China Lake Naval Weapons Center). State-owned lands include Silverwood Lake State Recreation Area at the SWP reservoir, Wildwood Canyon State Park, and Providence Mountain and Chino Hills State Recreation Areas.

San Bernardino County has 24 incorporated cities: Adelanto, Apple Valley, Barstow, Big Bear Lake, Chino, Chino Hills, Colton, Fontana, Grand Terrace, Hesperia, Highland, Loma Linda, Montclair, Needles, Ontario, Rancho Cucamonga, Redlands, Rialto, San Bernardino, Twentynine Palms, Upland, Victorville, Yucaipa, and Yucca Valley. Major unincorporated communities in the county are Amboy, Baker, Bear Valley, Bloomington, Crest Forest, Earp, Essex, Fontana suburbs, Goffs, Harvard, Havasu Lake, Helendale, Hilltop, Hinckley, Homestead Valley, Joshua Tree, Kelso, Kramer Junction, Lake Arrowhead, Landers, Lucerne Valley, Ludlow, Lytle Creek, Mentone, Moronga Valley, Muscoy, Newberry Springs, Nipton, Oak Glen, Oak Hills, Parker, Phelan/Pinon Hills, Pioneertown, Red Mountain, Rimrock, Silver Lake, Trona, Vidal, and Yerno.

The portion of San Bernardino County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes SWP water service areas.

R.1.8.1.5 San Diego County

San Diego County encompasses approximately 4,525 square miles in Southern California. It is bounded on the north by Orange and Riverside Counties, on the east by Imperial County, on the south by Mexico, and on the west by the Pacific Ocean. San Diego County includes federally owned land, including Camp Pendleton Marine Corps Base, Cleveland National Forest, and San Diego Bay and San Diego National Wildlife Refuges. State-owned lands in the county include Cuyamaca Rancho State Park, Anza-Borrego Desert State Park, Felipe Wildlife Area, and Ocotillo Wells State Vehicular Recreation Area (San Diego County 2011).

The incorporated cities include Carlsbad, Chula Vista, Coronado, Del Mar, El Cajon, Encinitas, Escondido, Imperial Beach, La Mesa, Lemon Grove, National City, Oceanside, Poway, San Marcos, Santee, Solano Beach, and Vista San Diego (San Diego County 2011). The unincorporated communities include Lakeside, Ramona, San Dieguito, Spring Valley, and Valle de Oro.

The portion of San Diego County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes SWP facilities, non-SWP reservoirs that store SWP water (including Dixon Lake, San Vicente, Lower Otay, and Sweetwater Reservoir), and CVP water service areas.

R.1.8.1.6 Ventura County

Ventura County encompasses approximately 1,873 square miles in Southern California. It is bounded on the north by Kern County, on the east and south by Los Angeles County, and on the west by Santa Barbara County and the Pacific Ocean. Ventura County includes federally owned and state-owned lands throughout the county, including 550,211 acres in Los Padres National Forest, Chumash and Sespe wilderness area, 4,331 acres at the Point Mugu Naval Air Station, 670 acres at the California State University Channel Islands, and over 410 acres in state beach parks (Ventura County 2013).

Ventura County has 10 incorporated cities: Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, Santa Paula, San Buenaventura, Simi Valley, and Thousand Oaks (Ventura County 2013). Major unincorporated communities within the county include Bell Canyon, Box Canyon, Camarillo Heights, Del Norte, El Rio, Hidden Valley, Lake Sherwood, Matilija Canyon, Montalvo, Oak Park, Ojai Valley, Piru, Saticoy, and Somis (Ventura County 2005).

The portion of Ventura County that could be affected by the changes in CVP and/or SWP operations evaluated in this EIS includes Lake Piru, which stores SWP water, and SWP water service areas.

R.1.8.2 *Tribal Lands in the Southern California Region*

This section summarizes the tribal lands that could be affected by the changes in CVP and/or SWP operations and that are located within the county boundaries described above.

Tribal Lands within the Boundaries of San Diego County

Federally recognized tribes and tribal lands within the boundaries of San Diego County include the following: lands of the Capitan Grande Band of Diegueno Mission Indians of California (Barona Reservation and Viejas Reservation), Cahuilla Band of Mission Indians of the Cahuilla Reservation, Campo Band of Diegueno Mission Indians of the Campo Indian Reservation, Ewiiaapaayp Band of Kumeyaay Indians, Inaja Band of Diegueno Mission Indians of the Inaja and Cosmit Reservation, Jamul Indian Village of California, La Jolla Band of Luiseno Indians, La Posta Band of Diegueno Mission Indians of the La Posta Indian Reservation, Los Coyotes Band of Cahuilla and Cupeno Indians, Manzanita Band of Diegueno Mission Indians of the Manzanita Reservation, Mesa Grade Band of Diegueno Mission Indians of the Mesa Grande Reservation, Pala Band of Luiseno Mission Indians of the Pala Reservation, Pauma Band of Luiseno Mission Indians of the Pauma and Yuima Reservation, Rincon Band of Luiseno Indians of the Rincon Reservation, San Pasqual Band of Diegueno Mission Indians of California, Iipay Nation of Santa Ysabel, and Sycuan Band of Kumeyaay Nation.

Tribal Lands within the Boundaries of Riverside County

Federally recognized tribes and tribal lands within the boundaries of Riverside County include the following: lands of the Agua Caliente Band of Cahuilla Indians of the Agua Caliente Reservation, Augustine Band of Cahuilla Indians, Cabazon Band of Mission Indians, Cahuilla Band of Mission Indians of the Cahuilla Reservation, Morango Band of Mission Indians, Pechanga Band of Luiseno Mission Indians of the Pechanga Reservation, Ramona Band of Cahuilla, Santa Rosa Band of Cahuilla Indians, Soboba Band of Luiseno Indians, Torres-Martinez Desert Cahuilla Indians, Twenty-Nine Palms Band of Mission Indians of California, and Colorado River Indian Tribes of the Colorado River Indian Reservation (RCIP 2000).

Tribal Lands within the Boundaries of San Bernardino County

Federally recognized tribes and tribal lands within the boundaries of San Bernardino County include the lands of the San Manual Band of Mission Indians and the Twenty-Nine Palms Band of Mission Indians of California (SDSU 2013). The Chemehuevi Indian Tribe of the Chemehuevi Reservation is also located in San Bernardino County near the Colorado River.

R.1.8.3 *Agricultural Resources*

Crops planted in the Southern California region include orchards, vineyards, and berries; field and forage, and vegetables. Crop establishment and production costs are generally similar to those shown in Tables R.1-2 and R.1-3, except that land costs and rent may be higher in parts of this region. In total, Southern California contains almost 2 million acres irrigated and generates over five billion dollars per year in value of production. Table R.1-16 shows the acreage and production value of agricultural activity in the Southern California region, 2012–2016.

Table R.1-16. Average Annual Agricultural Acreage and Value of Production in Counties in the Southern California Region from 2012 through 2016

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage[1]	132,358	1,880,727	N/A	14,293	84,254	2,111,632
Value[2]	$2,087.08	$219.50	$730.76	$1,772.32	$996.81	$5,806

Sources: USDA-NASS 2012, 2013, 2014, 2015, 2016; U.S. Department of Commerce 2019.
[1] Not all acreages and/or production values are reported for every crop in every county. Therefore the implied value of production per acre may be misleading for some crop categories.
[2] Values in million dollars, 2018 basis

Changes in farmland in the Southern California region between 2006 and 2016 are summarized in Table R.1-17. Overall, Southern California saw a decrease of approximately 65,000 acres in Important Farmland within the 10-year period 2006–2016.

Table R.1-17. Farmland Mapping and Monitoring Program Acreages in the Southern California Region in 2006 and 2016

		Important Farmland[2]			Grazing Land		
County	**Total[1]**	**2006**	**2016**	**Change**	**2006**	**2016**	**Change**
Los Angeles	2.6	34,658	24,345	-10,313	228,730	239,037	10,307
Orange	0.61	11,915	5,715	-6,200	35,656	37,114	1,458
Riverside	4.7	213,370	193,806	-19,564	111,695	110,203	-1,492
San Bernardino	12.9	28,134	19,831	-8,303	902,853	898,633	-4,220
San Diego	2.9	72,460	57,362	-15,098	106,680	127,183	20,503
Ventura	1.2	108,242	102,918	-5,324	199,004	197,859	-1,145

Sources: CDOC 2006ac, 2006ad, 2006ae, 2006af, 2006ag, 2006ah, 2016ac, 2016ad, 2016ae, 2016af, 2016ag, 2016ah; Los Angeles County 2011; Orange County 2005; RCIP 2000; San Bernardino County 2007; San Diego County 2011; Ventura County 2005.
[1] Total acreage of area inventoried in county in million acres; this may be less than the total acreage of the county
[2] Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

R.2 Evaluation of Alternatives

This section describes the technical background for the evaluation of environmental consequences associated with the action alternatives and the No Action Alternative.

R.2.1 Methods and Tools

Both the land use and agricultural resources analyses rely in part on modeling of water deliveries as projected by CalSim II. CalSim II is a generalized water resources modeling system for evaluating operational alternatives of large, complex river basins (DWR 2019a). Tables R.2-1 and R.2-2 show the change in CVP and SWP M&I and agricultural water deliveries (thousands of acre-feet) by region as modeled by CalSim II for Alternatives 1, 2, 3, and 4 for the average and dry/critical conditions, respectively.

Table R.2-1. CalSim II Water Deliveries Report by Region and Type, Average Year Averages (thousand acre feet/year)[1]

Regions Modeled	Water Delivery Type	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Sacramento River Region	M&I	7	5	4	-8
	Agriculture	24	24	22	-4
San Joaquin River Region	M&I	10	25	24	-6
	Agriculture	309	662	644	-57
San Francisco Bay Region	M&I	32	56	53	-17
	Agriculture	9	15	14	-2
Central Coast Region	M&I	4	12	12	-3
	Agriculture	–	–	–	–
Southern California Region	M&I	226	469	453	-71
	Agriculture	1	3	3	0

Notes:
[1] The totals do not include deliveries for CVP Settlement/Exchange or SWP Feather river Service Area

Table R.2-2. CalSim II Water Deliveries Report by Region and Type, Dry/Critical Year Averages (thousand acre feet/year)[1]

Regions Modeled	Water Delivery Type	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Sacramento River Region	M&I	5	2	2	-14
	Agriculture	26	16	13	-20
San Joaquin River Region	M&I	6	18	18	-8
	Agriculture	195	432	414	-129
San Francisco Bay Region	M&I	15	40	36	-29
	Agriculture	6	10	9	-4
Central Coast Region	M&I	2	9	8	-4
	Agriculture	--	--	--	--
Southern California Region	M&I	84	363	345	-137
	Agriculture	0	2	2	0

Notes:
[1] The totals do not include deliveries for CVP Settlement/Exchange or SWP Feather river Service Area

R.2.1.1 *Land Use*

Land uses in 2030 are assumed to be consistent with the future projections included in existing general plans. The general plans were developed assuming adequate water supplies to support the projected land uses. Changes in CVP and SWP operations under the No Action Alternative and Alternatives 1 through 3 could change the availability of CVP and SWP water supplies. If the CVP and SWP water supplies were reduced compared to the No Action Alternative to a level that would not support planned municipal and industrial (M&I) water demands, development of future land uses may not occur. Potential changes to agricultural land uses are described in Section R.2.1.2, *Agricultural Resources*.

Availability of CVP and SWP water supplies were analyzed using CalSim II model output (see Appendix H, *Water Supply Technical Appendix*). Most of the CVP and SWP M&I water users prepared urban water management plans (UWMPs) that project availability of water supplies to support land uses in 2030. That information was used with projected CVP and SWP water supply availability under each of the alternatives to determine if projected M&I water demands could be met in 2030 using the CWEST model, as described in Appendix Q, *Regional Economics Technical Appendix*. The CWEST model was used to evaluate M&I water demands of CVP and SWP water users in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions. For impacts outside the area modeled by CalSim II and CWEST as well as impacts from actions that were not modeled, impacts on land use were evaluated qualitatively.

It is assumed that under the No Action Alternative and Alternatives 1 through 3, existing programs to protect floodways would continue to be implemented, including federal and state requirements as implemented by the U.S. Army Corps of Engineers (USACE), Central Valley Flood Protection Board, and California Department of Water Resources (DWR). Within the Bay-Delta, the floodways are further regulated by the Delta Protection Commission and Delta Stewardship Council to preserve and protect the natural resources of the Bay-Delta; and prevent encroachment into Bay-Delta floodways, including the Delta Stewardship Council's recently adopted *Delta Plan* (Delta Stewardship Council 2013). These regulations would continue to be implemented in the No Action Alternative and Alternatives 1 through 3. Therefore, future development would be prevented from occurring within the Bay-Delta floodplains and floodways; and in the Sacramento, Feather, American, and San Joaquin river corridors upstream of the Bay-Delta. The potential changes in land use are analyzed qualitatively in this chapter.

The No Action Alternative and Alternatives 1 through 4 include the Coordinated Operation Agreement, CVP Water Contracts, SWP Water Contracts, Allocations and Forecasting, Agricultural Barriers, and the Suisun Marsh Preservation Agreement. Land uses in 2030 due to implementation of these programs would be consistent among all action alternatives. Therefore, this EIS does not analyze changes due to these programs.

R.2.1.2 *Agricultural Resources*

R.2.1.2.1 Changes in Irrigated Agricultural Acreage and Total Production Value

Changes in CVP and SWP operations under the action alternatives could change the extent of irrigated acreage and total production value over the long-term average condition and in dry and critical dry years compared to the No Action Alternative.

The impact analysis compares the typical changes that would occur between alternatives by 2030. The impact analysis does not represent changes in response to emergency flood or drought conditions.

For impacts within the area modeled, agricultural impacts were evaluated using both CalSim II and a regional agricultural production model developed for large-scale analysis of irrigation water supply and cost changes. The Statewide Agricultural Production (SWAP) model is a regional model of irrigated agricultural production and economics that simulates the decisions of producers (farmers) in 27 agricultural subregions in the Central Valley, as described in Appendix F, *Model Documentation*. The model selects the crops, water supplies, and other inputs that maximize profit subject to constraints on water and land, and subject to economic conditions regarding prices, yields, and costs. In each SWAP model run, results are presented as the change in irrigated acreage for a given flow scenario for the crop categories modeled. The SWAP model does not match precisely to the study area regions. The modeled results therefore begin with different areas of irrigated acreage for various crop categories than reported in the environmental setting. The actions modeled for each alternative are described in Appendix F, *Model Documentation*. Actions that were not modeled, such as the Shasta Dam raising, water transfers, and program actions, are analyzed qualitatively.

The SWAP model incorporates CVP and SWP water supplies, other local water supplies represented in the CalSim II model, and groundwater. As conditions change within a SWAP subregion (e.g., the quantity of available project water supply declines), the model optimizes production by adjusting the crop mix, water sources and quantities used, and other inputs. The model also fallows land when that appears to be the most cost-effective response to resource conditions.

SWAP was used to compare the long-run agricultural economic responses to potential changes in CVP and SWP irrigation water delivery and to changes in groundwater conditions associated with the alternatives. Results from the surface water analysis that used the CalSim II model, as described in Appendix H, *Water Supply Technical Appendix*, were provided as inputs into SWAP through a standardized data linkage procedure. Results from the groundwater analysis that used the Central Valley Hydrologic Model (CVHM model), as described in Appendix I, *Groundwater Technical Appendix*, were used to develop changes in pumping lift in SWAP. SWAP produces estimates of the change in value and costs of agricultural production.

The analysis only reduces groundwater withdrawals based upon an optimization of agricultural production costs. The analysis does not restrict groundwater withdrawals based upon groundwater overdraft or groundwater quality conditions. The Sustainable Groundwater Management Act requires preparation of groundwater sustainability plans (GSPs) by 2020 or 2022 for most of the groundwater basins in the Central Valley. The GSPs will identify methods to implement measures that will achieve sustainable groundwater operations by 2040 or 2042. The analysis in this chapter is focused on conditions that would occur through 2030. If local agencies fully implement GSPs prior to the regulatory deadline, increasing groundwater use would be less of an option for agricultural water users. However, to achieve sustainable conditions, some measures could require several years to design and construct new water supply facilities, and sustainable groundwater conditions are not required until 2040 or 2042. Therefore, it was assumed that Central Valley agriculture water users would not reduce groundwater use by 2030, and that groundwater use would change in response to changes in CVP and SWP water supplies. The Sustainable Groundwater Management Act (SGMA) could affect quantities of groundwater available for beneficial uses. Modeling in this analysis does not incorporate possible effects of SGMA implementation because the future effects are both uncertain and highly variable, depending on location conditions.

Some SWAP regions span multiple geographic regions as defined in this document. In this case, analysis considered the SWAP region to belong to the geographic region containing the largest proportion of the SWAP region.

For impacts outside the area modeled, specifically the Trinity River, San Francisco Bay Area, Central Coast, and Southern California regions, as well as impacts from actions that were not modeled in SWAP, impacts on agricultural resources were evaluated qualitatively and using the results of CalSim II modeling for M&I and agricultural water deliveries.

R.2.1.2.2 Effects Related to Cross-Delta Transfers

Historically, water transfer programs have been developed on an annual basis. The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfer transactions have increased over time as CVP and SWP water supply availability has decreased, especially during drier water years.

Parties seeking water transfers generally acquire water from sellers who have available surface water who can make the water available through releasing previously stored water, pump groundwater instead of using surface water (groundwater substitution), idle crops, or substitute crops that uses less water to reduce normal consumptive use of surface water.

Water transfers using CVP and SWP Bay-Delta pumping plants and south-of-Delta canals generally occur when there is unused capacity in these facilities. These conditions generally occur in drier water year types when the flows from upstream reservoirs plus unregulated flows are adequate to meet the Sacramento Valley water demands and the CVP and SWP export allocations. In non-wet years, the CVP and SWP water allocations would be less than full contract amounts; therefore, capacity may be available in the CVP and SWP conveyance facilities to move water from other sources.

Projecting future agricultural resources conditions related to water transfer activities is difficult because specific water transfer actions required to make the water available, convey the water, and/or use the water would change each year due to changing hydrological conditions, CVP and SWP water availability, specific local agency operations, and local cropping patterns. Reclamation recently prepared two long-term regional water transfer environmental documents which evaluated potential changes in agricultural resources conditions related to water transfer actions (Reclamation 2015, 2018a). Results from these analyses were used to inform the impact assessment of potential effects of water transfers under the action alternatives compared to the No Action Alternative and are incorporated here by reference.

R.2.2 No Action Alternative

Under the No Action Alternative, current CVP and SWP operations would continue. Flows and reservoir levels would remain as under current conditions. No additional habitat restoration or fish intervention actions are proposed, and thus no new construction is proposed.

R.2.2.1 *Land Use*

The No Action Alternative was modeled using CalSim II and CWEST, and the results are discussed here. Under the No Action Alternative, because current CVP and SWP operations would continue and no new construction is proposed, land uses in 2030 would occur in accordance with the general plans for counties and cities within the Central Valley, tribal lands, and regulations of state and regional agencies, including Central Valley Flood Protection Board, Delta Protection Commission, and Delta Stewardship Council.

Development along the river corridors in the Central Valley would continue to be limited by the state regulations to protect floodways. The Central Valley Flood Protection Board adopts floodway boundaries and approves uses within those floodways (DWR 2010, 2017). Various uses are permitted in the floodways: agriculture, canals, low dikes and berms, parks and parkways, golf courses, sand and gravel mining, structures that are not used for human habitation, and other facilities and activities that will not be substantially damaged by the base flood event and will not cause adverse hydraulic impacts that will raise the water surface in the floodway.

Within the Bay-Delta, future development also is subject to the requirements of the Delta Protection Commission and Delta Stewardship Council. The general plans within the Bay-Delta are required by state laws to be consistent with the Delta Protection Commission's *Land Use and Resource Management Plan for the Primary Zone of the Delta* (Delta Protection Commission 2010; Delta Stewardship Council 2017). This plan does not allow development within the Primary Zone of the Delta unless proponents can demonstrate that their projects would preserve and protect natural resources of the Bay-Delta, promote protection of remnants of riparian and aquatic habitat, not result in loss of wetlands or riparian habitat, not degrade water quality, not interfere with migratory birds or public access, not harm agricultural operations, and not degrade levees or expose the public to increased flood hazards. Farmers are encouraged to implement management practices to maximize habitat values for migratory birds and wildlife.

The Delta Plan, adopted by the Delta Stewardship Council in May 2013 and amended in 2018 (Delta Stewardship Council 2013), included a policy that protects floodways within the entire Bay-Delta that are not regulated by other federal or state agencies (23 California Code of Regulations Section 5014). This policy prevents encroachment into floodways that would impede the free flow of water in the floodway or jeopardize public safety.

Water supply, including CVP and SWP deliveries, in the action area regions was modeled by CWEST, as discussed in Appendix F, *Model Documentation*. Table R.2-3 shows the modeled water supply and costs under the No Action Alternative.

Table R.2-3. Water Supply and Costs under the No Action Alternative

	Trinity River	Sacramento River	San Joaquin River	Bay-Delta	San Francisco Bay Area	Central Coast	Southern California	Total
Average Annual CVP/SWP Deliveries (TAF)	0	235	228	419	266	41	1750	2939
Delivery Cost ($1,000)	$0	$4,118	$16,306	$10,304	$9,471	$7,394	$255,406	$303,000
New Supply (TAF)	0	0	1	0	8	0	86	94
Annualized New Supply Costs ($1,000)	$0	$0	$286	$0	$710	$0	$30,621	$31,616
Surface/ Groundwater Storage Costs ($1,000)	$0	$0	$0	$1,116	$1,882	$0	$10,018	$13,015
Lost Water Sales Revenues ($1,000)	$0	$225	$522	$2,051	$4,524	$0	$28,403	$35,725
Transfer Costs ($1,000)	$0	$500	$9,536	$2,286	$7,276	$0	$14,880	$34,479
Shortage Costs ($1,000)	$0	$75	$170	$685	$1,508	$0	$34,067	$36,507
Groundwater Pumping Savings ($1,000)	$0	-$1,472	-$20,191	-$3,496	-$415	-$9,201	-$61,010	-$95,785
Excess Water Savings ($1,000)	$0	-$447	-$3,726	-$1,948	-$1,291	-$3,207	-$1,975	-$12,593
Average Annual Cost ($1,000)	$0	$3,000	$2,904	$10,998	$23,665	-$5,013	$310,410	$345,964

TAF = thousand acre-feet

R.2.2.2 *Irrigated Agricultural Acreage and Total Production Value*

The No Action Alternative was modeled using CalSim II and SWAP, and the results are discussed here. Agricultural acreage and productivity conditions were modeled for the Sacramento River and San Joaquin River regions. As CalSim II modeling results show, flows and reservoir storage would increase in the Sacramento River and San Joaquin River regions. Note that counties in the Bay-Delta are reported under the Sacramento River and San Joaquin River regions because the relevant SWAP regions span the Bay-Delta region and the Sacramento and San Joaquin River regions.

Table R.2-4 shows the acreage planted in the average baseline condition under the No Action Alternative with respect to water availability, and Table R.2-5 shows productivity in the average baseline condition in millions of dollars (2018 basis). Table R.2-6 shows the acreage planted in the dry baseline condition under the No Action Alternative, and Table R.2-7 shows the productivity in the dry baseline condition in millions of dollars (2018 basis).

Table R.2-4. Crops in the SWAP Regions (acres) in the Average Condition under the No Action Alternative

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	710,988	63,015	240,346	144,658	636,755	1,795,761
San Joaquin River	981,750	825,639	721,371	607,052	1,667,071	4,802,883
Total Irrigated Acreage (Acres)	1,692,737	888,655	961,716	751,709	2,303,826	6,598,644

Table R.2-5. Crop Productivity in the SWAP Regions (millions of dollars) in the Average Condition under the No Action Alternative

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	1,260	85	327	1,140	4,557	7,369
San Joaquin River	1,357	1,465	1,508	4,537	13,454	22,320
Total Irrigated Acreage (Acres)	2,617	1,549	1,835	5,677	18,011	29,689

Table R.2-6. Crops in the SWAP Regions (acres) in the Dry Condition under the No Action Alternative

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	708,590	63,030	236,740	144,592	636,299	1,789,251
San Joaquin River	972,122	823,385	699,966	606,875	1,666,510	4,768,857
Total Irrigated Acreage (Acres)	1,680,712	886,415	936,706	751,467	2,302,808	6,558,108

Table R.2-7. Crop Productivity in the SWAP Regions (millions of dollars) in the Average Condition under the No Action Alternative

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	1,249	85	324	1,140	4,553	7,351
San Joaquin River	1,345	1,464	1,484	4,538	13,449	22,279
Total Irrigated Acreage (Acres)	2,594	1,548	1,808	5,678	18,003	29,630

As shown in Table R.2-4 (average condition) and Table R.2-6 (dry condition), SWAP analysis indicates that approximately 6.5 million acres of irrigated agricultural land are productive in the Sacramento River and San Joaquin River regions. The average year in the No Action Alternative has about 40,000 more acres planted than the dry year. As shown in Table R.2-5 (average condition) and Table R.2-7 (dry condition), crop productivity is approximately $29,000 million annually for these three regions as modeled by SWAP. The average year produces approximately $60 million more than the dry year.

Although the SWAP regions and study area regions do not match perfectly, the areas covered by SWAP cover much of the study area regions. Therefore, the values of crop acreages and productivity are taken as a proxy for all agriculture in these regions.

For these regions, because CVP and SWP operations would continue and no new construction is proposed, no changes to agricultural land are anticipated under the No Action Alternative.

In addition, for other regions not modeled by SWAP, because CVP and SWP operations would continue and no new construction is proposed, no changes to agricultural land are anticipated under the No Action Alternative.

R.2.2.3 *Cross-Delta Transfers*

Under the No Action Alternative, the timing of cross-Delta water transfers would be limited to July through September and annual volumetric limits would remain as under current conditions, in accordance with the 2008 USFWS Biological Opinion and 2009 NMFS Biological Opinion (USFWS 2008; NMFS 2009). No changes to water transfers are anticipated under the No Action Alternative.

R.2.3 Alternative 1

R.2.3.1 *Project-Level Effects*

Project-level action alternatives would change operations of the CVP and SWP, as described in Appendix F, *Model Documentation*. The changes to CVP and SWP operations would change river flows and reservoir levels, which in turn could, if flows and levels are decreased, affect the ability of local jurisdictions to fulfill plans described in their general plans, affect productivity of agricultural land to the extent that land is converted from agricultural to nonagricultural use, and change water transfer patterns.

Potential changes in land use

<u>Effects Modeled by CWEST</u>

As described in Appendix F, *Model Documentation* and in Tables R.2-1 and R.2-2, CVP and SWP water deliveries to M&I water users would be greater overall under Alternative 1 than under the No Action Alternative. The increased CVP and SWP water supply availability would allow water users to reduce other water supplies overall, including groundwater. It is anticipated that any additional water supplies would not result in changes in the general plan development plans without subsequent environmental documentation. Adequate water supplies would be available to support future municipal and industrial land uses projected in existing general plans under Alternative 1 and the No Action Alternative. Table R.2-8 shows the modeled changes in average annual CVP/SWP deliveries, delivery costs, new supply, annualized new supply costs, surface and groundwater storage costs, lost water sales revenues, transfer costs, shortage costs, groundwater pumping savings, excess water savings, and average annual cost by region for Alternative 1 as compared to the No Action Alternative.

Table R.2-8. Differences in Water Supply and Costs Between the No Action Alternative and Alternative 1

	Trinity River	Sacramento River	San Francisco Bay Area	San Joaquin River	Bay-Delta	Central Coast	Southern California	Total
Average Annual CVP/SWP Deliveries (TAF)	0	2	32	21	0	3	263	321
Delivery Cost ($1,000)	$0	$42	$1,156	$1,976	$29	$535	$38,019	$41,756
New Supply (TAF)	0	0	7	-1	0	0	-58	-52
Annualized New Supply Costs ($1,000)	$0	$0	$4,251	-$267	$0	$0	-$21,299	-$17,315
Surface/ Groundwater Storage Costs ($1,000)	$0	$0	$1,026	$0	$321	$0	-$393	$954
Lost Water Sales Revenues ($1,000)	$0	$0	-$2,339	-$4	-$92	$0	-$7,825	-$10,260
Transfer Costs ($1,000)	$0	-$108	-$5,793	-$307	-$1,001	$25	-$4,088	-$11,273
Shortage Costs ($1,000)	$0	$0	-$841	-$3	-$31	$0	-$8,984	-$9,859
Groundwater Pumping Savings ($1,000)	$0	-$34	-$570	-$74	$1	$40	-$19,126	-$19,763
Excess Water Savings ($1,000)	$0	-$27	-$89	-$1,812	$18	-$562	-$1,886	-$4,357
Average Annual Cost ($1,000)	$0	-$127	-$3,199	-$490	-$755	$37	-$25,583	-$30,116

TAF = thousand acre-feet

No municipal and industrial land uses in the Trinity River region are served by CVP and SWP water supplies. Therefore, the municipal and industrial land uses would be the same under Alternative 1 and the No Action Alternative in this region.

Table R.2-8 shows that the average annual cost would be less in all regions except for the Central Coast compared to the No Action Alternative. The increased average annual cost in the Central Coast is small spread over the entire region. Therefore, it is expected that local jurisdictions would afford to have adequate water to implement their general plans, and that land use in 2030 would not change under Alternative 1 compared to the No Action Alternative.

In addition to project actions that were modeled, Alternative 1 includes project actions that were not modeled. These are described by region below and their effects are compared to those of the No Action Alternative.

<u>Effects Not Modeled by CWEST</u>

<u>Sacramento River Region</u>

The Rice Decomposition Smoothing project action would not change overall water deliveries but instead would change the timing of deliveries. Therefore, the action would not result in local jurisdictions being unable to implement general plans because of lack of water. No changes in land use are likely to result, as compared to the No Action Alternative.

The Spring Management of Spawning Locations project action would involve coordination between Reclamation and National Marine Fisheries Service (NMFS) as part of adaptive management to establish experiments to determine if keeping water colder earlier induces earlier spawning or if keeping April to May Sacramento River temperatures warmer induces later spawning and to refine the state of the science. This action would change timing of flows but would not result in an overall change in quantity of water deliveries. Therefore, the action would not result in local jurisdictions being unable to implement general plans because of lack of water. Changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

<u>San Joaquin River Region</u>

The Dissolved Oxygen Requirement project action is a water quality objective for spawning beneficial uses for water bypassed through or released from New Melones Reservoir. It requires that applicable dissolved oxygen standards be maintained through maintenance of cold water in the Stanislaus River. This action would result in more water being available downstream for beneficial uses than under the No Action Alternative. Therefore, the action would not result in local jurisdictions being unable to implement general plans because of lack of water. Changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

<u>Bay-Delta Region</u>

The Minimum Export Rate project action would ensure minimum flows not ensured under the No Action Alternative. This action would not result in reduced water deliveries for M&I uses. Therefore, the action would not result in local jurisdictions being unable to implement general plans because of lack of water. Changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

The Delta Cross Channel Operations project action could change flows to the Jones Pumping Plant in comparison to the No Action Alternative. In dry years, water quality could approach trigger levels. In this case, Reclamation and DWR would meet to determine what to do based on a risk assessment. Because there is a process for ensuring that water quality levels are adequate for M&I purposes, it is unlikely that this action would result in local jurisdictions being unable to implement general plans because of lack of water. Changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

The Clifton Court Aquatic Weed Removal project action under Alternative 1 would involve application of aquatic herbicides and algaecides and operation of the Clifton Court Forebay intake gates to control flow of the water in and out of the Clifton Court Forebay. Because this action does not include changes in flows, it is unlikely that this action would result in local jurisdictions being unable to implement general plans because of lack of water. Changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

As discussed under No Action Alternative, the Tracy Fish Collection Facility and the Skinner Fish Facility project actions involve fish screening and hauling salvaged fish by truck to release sites. None of these activities affect flow or reservoir levels or surrounding land. It is unlikely that this action would result in local jurisdictions being unable to implement general plans because of lack of water. Changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

The Suisun Marsh Salinity Control Gates Operation project action would involve operations of the Suisun Marsh Salinity Control Gates to meet required characteristics of Delta Smelt habitat in June through September in below-normal and above-normal Sacramento Valley Index year types. The increased flows would be managed adaptively. Modeling suggests that the action would be achievable in all but drought or wet years (DWR n.d.). Because the flows would be increased with respect to the No Action Alternative, no reduction in M&I water is anticipated, and changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

The Fall Delta Smelt Habitat project action would involve managing for Delta Smelt habitat in normal and wet years, when adequate water is available for such activities. This action is not part of the No Action Alternative. Because the action assumes adequate water is available for these activities, no reduction in M&I water is anticipated, and changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

In addition, Alternative 1 includes some elements in the Summer-Fall Delta Smelt Habitat action that could vary year-to-year. The action could include operations of the Suisun Marsh Salinity Control Gates in some years or a fall action to maintain the X2 position at 80 km in some above normal and wet years. Both of these actions would require water and affect CVP and SWP operations, but the frequency of these actions is not specifically defined. CalSim and CWEST modeling do not include these actions. Generally, potential effects and benefits of Alternative 1 with respect to this action could range between modeled results and the No Action Alternative, which includes a Fall X2 action. If the Summer-Fall Delta Smelt Habitat action includes operations of the Suisun Marsh Salinity Control Gates or a Fall X2 action, the water requirements in summer and fall could be greater than shown for Alternative 1. Alternative 1 indicates that average annual CVP/SWP deliveries would be greater than under the No Action Alternative (Table R.2-8). In years with summer or fall actions, the deliveries could be less than indicated in Alternative 1 modeling. However, other water supplies are available, e.g., groundwater pumping and water transfers, so changes in land use as a result of this action are unlikely.

The San Joaquin Basin Steelhead Telemetry Study project action would continue a telemetry study for the migration and survival of San Joaquin Origin Central Valley Steelhead. This action is not part of the No Action Alternative. This action would not change flows or reservoir levels. Therefore, no reduction in M&I water is anticipated, and changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

Potential changes in irrigated agricultural acreage and total production value

<u>Effects Modeled by SWAP</u>

<u>Sacramento River and San Joaquin River Regions as Modeled under SWAP</u>

The Sacramento River Seasonal Operations, Spring Pulse Flows, Shasta Cold Water Pool Management, Fall and Winter Redd FERC Project #2100-134, and Seasonal Operations of the American River project actions in the Sacramento River region; the San Joaquin River Restoration Program and Stanislaus

Stepped Release Plan project actions in the San Joaquin River region; and the Delta Seasonal Operations, Contra Costa Water District Rock Slough Operations, North Bay Aqueduct, and OMR Management project actions in the Bay-Delta were modeled under CalSim II. These actions were also modeled under SWAP and are discussed here.

Assumptions in the SWAP model do not account for any change in groundwater use under SGMA implementation, which requires that local public agencies and Groundwater Sustainability Agencies (GSAs) in high- and medium-priority basins develop and implement Groundwater Sustainability Plans (GSPs) or Alternatives to GSPs in order to map how groundwater basins will reach long term sustainability. However, because in-stream flows are expected to increase with Alternative 1, no reduction in groundwater is anticipated. The additional surface water supply is expected to reduce the reliance of those areas on groundwater, no reduction in groundwater is anticipated.

As CalSim II modeling results show (Appendix F, *Model Documentation*), flows and reservoir storage would increase in the Sacramento River, San Joaquin River, and Bay-Delta regions. In addition, deliveries for agricultural uses would increase (Tables R.2-1 and R.2-2). Note that counties in the Bay-Delta are reported under the Sacramento River and San Joaquin River regions because the relevant SWAP regions span the Bay-Delta region and the Sacramento River and San Joaquin River regions. These actions are discussed under the SWAP modeling discussion and are not discussed further.

Table R.2-9 below shows the difference in acreage planted in the average year condition with respect to water availability between the No Action Alternative and Alternative 1, and Table R.2-10 shows the difference in productivity in the average year condition in millions of dollars. Table R.2-11 shows the difference in acreage planted in the dry and critical year condition with respect to water availability between the No Action Alternative and Alternative 1, and Table R.2-12 shows productivity in the dry and critical year condition in millions of dollars.

Table R.2-9. Difference in Crops in the SWAP Regions (acres) in the Average Year Condition between the No Action Alternative and Alternative 1

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	1,147	397	444	68	713	2,770
Total Irrigated Acreage (Acres)	1,147	397	444	68	713	2,770

Table R.2-10. Difference in Crop Productivity in the SWAP Regions (millions of dollars) in the Average Year Condition between the No Action Alternative and Alternative 1

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	2	1	1	0	6	10
Total Irrigated Acreage (Acres)	2	1	1	0	6	10

Table R.2-11. Difference in Crops in the SWAP Regions (acres) in the Dry and Critical Year Condition between the No Action Alternative and Alternative 1

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	16,517	2,164	2,406	242	2,339	23,668
Total Irrigated Acreage (Acres)	16,517	2,164	2,406	242	2,339	23,668

Table R.2-12. Difference in Crop Productivity in the SWAP Regions (millions of dollars) in the Dry and Critical Year Condition between the No Action Alternative and Alternative 1

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	23	4	5	1	16	50
Total Irrigated Acreage (Acres)	23	4	5	1	16	50

As shown in Table R.2-9, SWAP modeling shows that in the average year condition, there would be approximately 2,770 more acres of irrigated farmland in the San Joaquin River region under Alternative 1 compared to the No Action Alternative. Acreage of irrigated farmland in the Sacramento River region would be the same as under the No Action Alternative. As shown in Table R.2-10, the San Joaquin River region would have an increased productivity of approximately $10 million. Agricultural productivity in the Sacramento River region would be the same as under the No Action Alternative. Crop acreage and productivity in the Sacramento River region would remain the same because deliveries to this region in the average year condition would not change under Alternative 1 compared to the No Action Alternative.

As shown in Table R.2-11, in the dry and critical year condition, there would be approximately 23,668 more acres of irrigated farmland in the San Joaquin River region under Alternative 1 compared to the No Action Alternative. Acreage of irrigated farmland in the Sacramento River region would be the same as under the No Action Alternative. As shown in Table R.2-12, the San Joaquin River regions would have an increased productivity of approximately $550 million. Agricultural productivity in the Sacramento River region would be the same as under the No Action Alternative. Crop acreage and productivity in the Sacramento River region would remain the same because deliveries to this region in the dry and critical year condition would not change under Alternative 1 compared to the No Action Alternative.

In both the average and dry/critical year conditions, overall crop acreage and crop productivity in the San Joaquin River region would be greater under Alternative 1 compared to the No Action Alternative and would remain the same in the Sacramento River region. Therefore, no conversion of agricultural land to nonagricultural is expected to occur in these regions.

In addition to project actions modeled under CalSim II and SWAP, Alternative 1 includes project actions that were not modeled. These are described by region in the following sections and their effects are compared to those of the No Action Alternative.

Effects Not Modeled by SWAP

Trinity River Region

The Trinity River region was not modeled under SWAP. Because there are no CVP/SWP agricultural water deliveries in this region, no conversion of agricultural land to nonagricultural use is anticipated.

Sacramento River Region

The Rice Decomposition Smoothing project action would not change overall water deliveries but instead would change the timing of deliveries with respect to the No Action Alternative. Because the water delivery timing change would not occur during the growing season but rather during the rice decomposition season, no conversion of agricultural land to nonagricultural use is likely to result, as compared to the No Action Alternative.

The Spring Management of Spawning Locations project action would involve coordination between Reclamation and NMFS as part of adaptive management to establish experiments to determine if keeping water colder earlier induces earlier spawning or if keeping April to May Sacramento River temperatures warmer induces later spawning and to refine the state of the science. Water temperatures below 69°F are known to impede rice development, particularly during the early stages of the growing season (Raney 1963). Specifically, water temperatures below 69°F retard rice germination and emergence from water in the flooded fields, prevent or delay heading, prevent filling of the grains, and delay maturity. Temperature management on the Sacramento River would differ from the NAA only in other uses of Shasta cold water pool for Winter-Run Chinook salmon survival. NAA temperature targets on the Sacramento River are established by WRO 90-5, which require a temperature of 56°F at Red Bluff Diversion Dam throughout the temperature season (Reclamation 2018b). Temperature management on Clear Creek would differ from the NAA only in that daily water temperature in below normal and wetter years would be temperatures 56°F or less from September 15 to October 31, whereas in the NAA, the target temperature is 56°F. Temperature management on the American River would differ from the NAA only in that if the target temperature at Watt Avenue Bridge of 65°F cannot be met because of limited cold water availability in Folsom Reservoir, then the target daily average water temperature at this site may be increased. This management regime differs from the temperature management regime under the NAA in only minor ways. Therefore, while low water temperature releases could affect rice production, the difference between the NAA and Alternative 1 would be small. It is unlikely that effects on rice fields would lead to permanent conversion of agricultural land to nonagricultural use.

San Joaquin River Region

The Dissolved Oxygen Requirement project action is a water quality objective for spawning beneficial uses for water bypassed through or released from New Melones Reservoir. It requires that applicable dissolved oxygen standards be maintained through maintenance of cold water in the Stanislaus River. This action would move the compliance location from Ripon to Orange Blossom Bridge but would not change amount of water available downstream for beneficial uses from the No Action Alternative. Therefore, agricultural productivity would not decline, as compared to the No Action Alternative, and no conversion of agricultural land to nonagricultural uses is anticipated.

Bay-Delta Region

The counties that constitute the Bay-Delta region do not correspond exactly to SWAP regions; rather, these counties span multiple SWAP regions. For this reason, the SWAP modeling analysis of the Bay-Delta region has been reported in the Sacramento River region and the San Joaquin River region in Tables R.2-9, R.2-10, R.2-11, and R.2-12 above.

The Minimum Export Rate project action would ensure minimum flows not ensured under the No Action Alternative. This action would not result in reduced water deliveries for agricultural purposes, as compared to the No Action Alternative. Therefore, no conversion of agricultural land to nonagricultural uses is anticipated.

The Delta Cross Channel Operations project action could change flows to the Jones Pumping Plant in comparison to the No Action Alternative. In dry years, water quality could approach trigger levels. In this case, Reclamation and DWR would meet to determine what to do based on a risk assessment. Because there is a process for ensuring that water quality levels are adequate for agricultural purposes, it is unlikely that this action would result in conversion of agricultural land to nonagricultural purposes.

The Clifton Court Aquatic Weed Removal project action under Alternative 1 would involve application of aquatic herbicides and algaecides and operation of the Clifton Court Forebay intake gates to control flow of the water in and out of the Clifton Court Forebay. Because this action does not include changes in flows or reservoir levels or construction on agricultural land, this action is unlikely to result in conversion of agricultural land to nonagricultural purposes.

As discussed under No Action Alternative, the Tracy Fish Collection Facility and the Skinner Fish Facility project actions involve fish screening and hauling salvaged fish by truck to release sites. In addition, Reclamation would install a carbon dioxide injection device to allow remote controlled anesthetization of predators in the secondary channels of the TFCF. Addition of the carbon dioxide injection device would not affect flow or reservoir levels or surrounding land. This action would not result in conversion of agricultural land to nonagricultural purposes.

The Suisun Marsh Salinity Control Gates Operation project action would involve operations of the Suisun Marsh Salinity Control Gates to meet required characteristics of Delta Smelt habitat in June through September in below-normal and above-normal Sacramento Valley Index year types. The increased flows would be managed adaptively. Modeling suggests that the action would be achievable in all but drought or wet years (DWR n.d.). Because agricultural water deliveries would be increased with respect to the No Action Alternative, no reduction in agricultural productivity is anticipated, as compared to the No Action Alternative, and no conversion of agricultural land to nonagricultural use would result.

The Fall Delta Smelt Habitat project action would involve managing for Delta Smelt habitat in normal and wet years, when adequate water is available for such activities. This action is not part of the No Action Alternative. Because the action assumes adequate water available for these activities, no reduction in agricultural productivity is anticipated, as compared to the No Action Alternative, and no conversion of agricultural land to nonagricultural use would result.

In addition, Alternative 1 includes some elements in the Summer-Fall Delta Smelt Habitat action that could vary year-to-year. The action could include operations of the Suisun Marsh Salinity Control Gates in some years or a fall action to maintain the X2 position at 80 km in some above normal and wet years. Both of these actions would require water and affect CVP and SWP operations, but the frequency of these actions is not specifically defined. CalSim and CWEST modeling do not include these actions. Generally, potential effects and benefits of Alternative 1 with respect to this action could range between modeled results and the No Action Alternative, which includes a Fall X2 action. If the Summer-Fall Delta Smelt Habitat action includes operations of the Suisun Marsh Salinity Control Gates or a Fall X2 action, the water requirements in summer and fall could be greater than shown for Alternative 1. Analysis for Alternative 1 indicates that agricultural crop acreage and productivity would be the same as or greater than under the No Action alternative (Tables R.2-9 through R-2.12). In years with summer or fall actions, crop acreage or productivity could be less than indicated in Alternative 1 modeling, including a reduction in crop acreage and productivity with respect to the No Action Alternative in the part of the Sacramento River region that would be affected by these actions. Mitigation Measure AG-1 could reduce effects by encouraging water agencies to diversify their water portfolios, thus increasing likelihood that water users would have adequate water in years with these actions.

The San Joaquin Basin Steelhead Telemetry Study project action would continue a telemetry study for the migration and survival of San Joaquin Origin Central Valley Steelhead. This action is not part of the No Action Alternative. This action would not change flows or reservoir levels or involve construction, as compared to the No Action Alternative. No conversion of agricultural land to nonagricultural uses is anticipated.

San Francisco Bay Area Region

This region was not modeled under SWAP. As shown by CalSim modeling (Tables R.2-1 and R.2-2), deliveries for agricultural uses would increase under the average and dry/critical conditions in this region, so no conversion of agricultural land to nonagricultural use is anticipated.

Central Coast Region

This region was not modeled under SWAP. Because there are no CVP/SWP agricultural water deliveries in this region (Tables R.2-1 and R.2-2), no conversion of agricultural land to nonagricultural use is anticipated.

Southern California Region

This region was not modeled under SWAP. As shown by CalSim modeling (Tables R.2-1 and R.2-2), deliveries for agricultural uses would increase under the average and dry/critical conditions in this region, so no conversion of agricultural land to nonagricultural use is anticipated.

Potential changes in land use related to cross-Delta transfers

Alternative 1 would allow the same volume of water transfers as the No Action Alternative to take place over a longer period of time (from July to November rather than July to September) than under the No Action Alternative, providing for more flexibility in timing of water transfers. Environmental analysis for water supply for the increased period of water transfers would be analyzed separately, apart from this document. Because the amount of water available in flows and reservoirs would change with respect to the No Action Alternative, modeling indicates that water transfers would also change. Table R.2-8 shows the projected changes in water transfer costs across the regions. Water transfer costs in all regions other than the Central Coast region would either remain the same or decrease. In the Central Coast, the increase in water transfer costs would be small when considered across the entire region. It is unlikely that changes in water transfers would result in changes in land use or conversion of agricultural land.

Further, because Alternative 1 would allow for a longer period of time when transfers can take place than under the No Action Alternative, growers who want to participate in a water transfer contract would have more flexibility in their operations in the home region. Therefore, it is likely, because the same volume of water would be allowed for transfers under Alternative 1 as under the No Action Alternative, that growers would be able to participate in cross-Delta transfers without choosing cropland idling as the method of making water available for transfer. Alternative 1 is unlikely to result in conversion of agricultural land to nonagricultural uses in the Sacramento River region as a result of cross-Delta water transfers.

Similarly, growers in the regions that receive transferred water (i.e., San Joaquin River, San Francisco Bay Area, Central Coast, and Southern California) would be able to rely on water transfers during the additional months, which would provide them more flexibility in their operations, potentially allowing for an elective change in crop planting or an improvement in irrigation, depending on the crop. Therefore, Alternative 1 is unlikely to result in conversion of agricultural land to nonagricultural uses in these regions as a result of cross-Delta water transfers.

R.2.3.2 *Program-Level Effects*

Potential changes in land use

Sacramento River Region

The Spawning and Rearing Habitat Restoration program action, which is not included under the No Action Alternative, would involve injecting 40 to 55 tons of gravel into the Sacramento River to create additional spawning habitat, and creating 40 to 60 acres of side channel habitat at approximately 10 sites to create additional rearing habitat by 2030. The creation of spawning habitat would not affect flows or reservoir levels. Because this action would not decrease water deliveries, local jurisdictions would not be hindered in their ability to implement their general plans, and no change in land use is anticipated.

The Small Screen Program program action in the Sacramento River region would continue to work within existing authorities to screen small diversions throughout CVP and SWP streams and the Bay-Delta. This action would not change flows or reservoir levels. Because this action would not decrease water deliveries, local jurisdictions would not be hindered in their ability to implement their general plans, and no change in land use is anticipated.

The Winter-Run Chinook Salmon Conservation Hatchery Production program action, which is not part of the No Action Alternative, would involve use of a different stock for augmenting conservation hatchery stock to improve genetic stock. This action would not affect flow or reservoir levels or agricultural land. Because this action would not decrease water deliveries, local jurisdictions would not be hindered in their ability to implement their general plans, and no change in land use is anticipated.

The Adult Rescue program action, which is not part of the No Action Alternative, would trap and haul adult salmonids and sturgeon from Yolo and Sutter Bypasses during droughts and after periods of bypass flooding and move them up the Sacramento River to spawning grounds. The program action would involve placement of temporary juvenile collection weirs at key feasible locations, downstream of spawning areas in the Sacramento River, and transport of collected fish to a safe release location(s) in the Bay-Delta upstream of Chipps Island. These actions would not affect flow or reservoir levels or agricultural land. Because this action would not decrease water deliveries, local jurisdictions would not be hindered in their ability to implement their general plans, and no change in land use is anticipated.

The Trap and Haul program action, which is not part of the No Action Alternative, would capture and transport juvenile Chinook Salmon and Steelhead in the Sacramento River watershed in drought years when low flows and resulting high water temperatures are unsuitable for volitional downstream migration and survival. Reclamation would place temporary juvenile collection weirs at key feasible locations, downstream of spawning areas in the Sacramento River. This action would not involve changes in flows or use of agricultural land. Because this action would not decrease water deliveries, local jurisdictions would not be hindered in their ability to implement their general plans, and no change in land use is anticipated.

The Spawning and Rearing Habitat Named Projects program action, which is not part of the No Action Alternative, would increase woody material and gravel augmentation and floodplain work along the American River. Flow and reservoir levels would not change. Because this action would not decrease water deliveries, local jurisdictions would not be hindered in their ability to implement their general plans, and no change in land use is anticipated.

The Drought Temperature Management program action, which is not part of the No Action Alternative, would evaluate and implement alternative shutter configurations at Folsom Dam to allow temperature flexibility as part of adaptive management. While flows could change, they would be increased in some conditions but not decreased. Sufficient water would be available for local jurisdictions to implement their general plans. No change in land use is anticipated.

San Joaquin River Region

The Lower San Joaquin River Habitat program action would implement the San Joaquin River Restoration Program, as described in the No Action Alternative. In addition, this action would implement rearing habitat restoration on the lower San Joaquin River not included in the No Action Alternative. This would involve a large-scale floodplain habitat restoration effort in the lower San Joaquin River. This action would not change flows, although it would involve connecting a floodplain to its river. Because the action would not change water deliveries, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated.

The Spawning and Rearing Habitat Restoration program action, which is not part of the No Action Alternative, would place 4,500 tons of gravel annually in the Stanislaus River for spawning habitat. It would also construct an additional 50 acres of rearing habitat adjacent to the Stanislaus River by 2030. Further, it would study approaches to temperature management for listed species. Placement of gravel would not change flow levels or affect agricultural land directly. Temperature management studies, while they would involve studies of flow regime, would not substantially affect flows. Therefore, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated.

Bay-Delta Region

The Removing Predator Hot Spots program action, which is not part of the No Action Alternative, would not involve changes in flows or construction on agricultural land but rather would involve minimizing lighting at fish screens and bridges and possibly removing abandoned structures. Because the action would not change flows, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated.

The Small Screen Program action, which is not part of the No Action Alternative, could involve construction on agricultural land. The action does not involve changes in flows. Because the action would not change water deliveries, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated.

The Sacramento Deepwater Ship Channel program action, which is not part of the No Action Alternative, would involve repairing and/or replacing the West Sacramento lock system to hydraulically reconnect the ship channel with the mainstem of the Sacramento River. The action would not involve changes in flows or reservoir levels. Because the action would not change water deliveries, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated.

The North Delta Food Subsidies/Colusa Basin Drain Study program action would increase food entering the north Delta through flushing nutrients from the Colusa Basin into the Yolo Bypass and north Delta. DWR, Reclamation, and water users would work with partners to flush agricultural drainage (i.e., nutrients) from the Colusa Basin Drain through Knight's Landing Ridge Cut and Tule Canal to Cache Slough, improving the aquatic food web in the north Delta for fish species. Reclamation would work with DWR and partners to augment flow in the Yolo Bypass in July and/or September by closing Knights Landing Outfall Gates and routing water from Colusa Basin into Yolo Bypass to promote fish food production. This action would involve increasing flows into the Bay-Delta. Because the action would not reduce water deliveries, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated.

The Tracy Fish Facility Improvements program action, which is not part of the No Action Alternative, would involve (1) incorporating additional fish exclusion barrier technology into the primary fish removal barriers, (2) incorporating additional debris removal systems at each trash removal barrier, screen, and fish barrier, (3) constructing additional channels to distribute the fish collection and debris removal among redundant paths through the facility, (4) constructing additional fish handling systems and holding tanks to improve system reliability, and (5) incorporating remote operation into the design and construction of the facility. Construction activities, depending on where they are located, could involve use of agricultural land. This action would not involve changes in water deliveries, and therefore local jurisdictions would continue to have adequate water for implementing their general plans. No change in land use is anticipated.

The Skinner Fish Facility Improvements program action, which is not part of the No Action Alternative, would involve (1) electroshocking and relocating predators, (2) controlling aquatic weeds, (3) developing a fishing incentives or reward program for catching predators, and (4) operational changes when listed species are present. None of these activities would involve reduction of water deliveries. Therefore, local jurisdictions would continue to have adequate water for implementing their general plans. No change in land use is anticipated.

The Delta Fish Species Conservation Hatchery program action, which is not part of the No Action Alternative, would involve construction and operation of a conservation hatchery for Delta Smelt. Depending on where this facility is sited, it could cause use of agricultural land. This action would not involve changes in water deliveries, and therefore local jurisdictions would continue to have adequate water for implementing their general plans. No change in land use is anticipated.

The Reintroduction Efforts from Fish Conservation and Culture Laboratory program action would supplement populations of Delta Smelt, focusing on capturing existing genetic diversity. The action would not affect water deliveries, and therefore local jurisdictions would continue to have adequate water for implementing their general plans. No change in land use is anticipated.

Potential changes in irrigated agricultural acreage and total production value

Sacramento River Region

The Spawning and Rearing Habitat Restoration program action, which is not included under the No Action Alternative, would involve injecting 40 to 55 tons of gravel into the Sacramento River to create additional spawning habitat, and creating 40 to 60 acres of side channel habitat at approximately 10 sites to create additional rearing habitat by 2030. While the creation of spawning habitat would not affect flows, reservoir levels, or agricultural land, creation of the side channel habitat could result in use of agricultural land, depending on where the habitat is sited. As a result, agricultural land could be converted to nonagricultural uses. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land.

The Small Screen Program programmatic action in the Sacramento River region would continue to work within existing authorities to screen small diversions throughout CVP and SWP streams and the Bay-Delta. This action would not change flows or reservoir levels. However, a small amount of land may be needed to construct these screens, and some of this land may be agricultural. It is possible that a small amount of agricultural land could be converted to nonagricultural uses compared to the No Action Alternative. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land.

The Winter-Run Chinook Salmon Conservation Hatchery Production program action, which is not part of the No Action Alternative, would involve use of a different stock for augmenting conservation hatchery stock to improve genetic stock. This action would not affect flow or reservoir levels or agricultural land. Accordingly, no land would be converted from agricultural to nonagricultural uses.

The Adult Rescue program action, which is not part of the No Action Alternative, would trap and haul adult salmonids and sturgeon from Yolo and Sutter Bypasses during droughts and after periods of bypass flooding and move them up the Sacramento River to spawning grounds. The Adult Rescue program action would involve placement of temporary juvenile collection weirs at key feasible locations, downstream of spawning areas in the Sacramento River, and transport of collected fish to a safe release location(s) in the Bay-Delta upstream of Chipps Island. These actions would not affect flow or reservoir levels or agricultural land. Accordingly, no land would be converted from agricultural to nonagricultural use.

The Trap and Haul program action, which is not part of the No Action Alternative, would capture and transport juvenile Chinook Salmon and Steelhead in the Sacramento River watershed in drought years when low flows and resulting high water temperatures are unsuitable for volitional downstream migration and survival. Reclamation would place temporary juvenile collection weirs at key feasible locations, downstream of spawning areas in the Sacramento River. This action would not involve changes in flows or use of agricultural land. Therefore, no change in agricultural productivity compared to the No Action Alternative is anticipated, and no land would be converted from agricultural to nonagricultural use.

The Spawning and Rearing Habitat Named Projects program action, which is not part of the No Action Alternative, would increase woody material and gravel augmentation and floodplain work along the American River. While flow and reservoir levels would not change, the floodplain work, depending on location, could affect agricultural land. Therefore, agricultural land could be converted to nonagricultural uses.

The Drought Temperature Management program action, which is not part of the No Action Alternative, would evaluate and implement alternative shutter configurations at Folsom Dam to allow temperature flexibility as part of adaptive management. While flows could change, they would be increased in some conditions but not decreased. Sufficient water would be available for agricultural use. No conversion of agricultural land to nonagricultural use is anticipated.

San Joaquin River Region

The Lower San Joaquin River Habitat program action would implement the San Joaquin River Restoration Program, as described in the No Action Alternative. In addition, this action would implement rearing habitat restoration on the lower San Joaquin River not included in the No Action Alternative. This would involve a large-scale floodplain habitat restoration effort in the lower San Joaquin River. This action could remove agricultural land from agricultural use for restoration purposes, thus resulting in conversion of agricultural land to nonagricultural use. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land.

The Spawning and Rearing Habitat Restoration program action, which is not part of the No Action Alternative, would place 4,500 tons of gravel annually in the Stanislaus River for spawning habitat. It would also construct an additional 50 acres of rearing habitat adjacent to the Stanislaus River by 2030. Further, it would study approaches to temperature management for listed species. Placement of gravel would not change flow levels or affect agricultural land directly. Temperature management studies, while they would involve studies of flow regime, would not substantially affect flows and therefore would not affect agricultural land. However, construction of rearing habitat, depending on placement, could remove agricultural land from agricultural use. Therefore, there is a possibility that this program action could convert agricultural land to a nonagricultural use. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land.

Bay-Delta Region

The Removing Predator Hot Spots program action, which is not part of the No Action Alternative, would not involve changes in flows or construction on agricultural land but rather would involve minimizing lighting at fish screens and bridges and possibly removing abandoned structures. No effects on agricultural productivity are anticipated and accordingly, no conversion of agricultural land would result.

The Small Screen Program action, which is not part of the No Action Alternative, could involve construction on agricultural land. However, any such construction would be evaluated under a separate environmental analysis. The screening action in itself would not result in conversion of agricultural land.

The Sacramento Deepwater Ship Channel program action, which is not part of the No Action Alternative, would involve repairing and/or replacing the West Sacramento lock system to hydraulically reconnect the ship channel with the mainstem of the Sacramento River. The action would not involve changes in flows or reservoir levels or construction on agricultural land. The action would not result in conversion of agricultural land.

The North Delta Food Subsidies/Colusa Basin Drain Study program action, which is not part of the No Action Alternative, would increase food entering the north Delta through flushing nutrients from the Colusa Basin into the Yolo Bypass and north Delta. DWR, Reclamation, and water users would work with partners to flush agricultural drainage (i.e., nutrients) from the Colusa Basin Drain through Knight's Landing Ridge Cut and Tule Canal to Cache Slough, improving the aquatic food web in the north Delta for fish species. Reclamation would work with DWR and partners to augment flow in the Yolo Bypass in July and/or September by closing Knights Landing Outfall Gates and routing water from Colusa Basin into Yolo Bypass to promote fish food production. This action would involve increasing flows into the Bay-Delta. Therefore, no reduction to agricultural productivity is anticipated, and no conversion of agricultural land to nonagricultural use would result.

The Tracy Fish Facility Improvements program action, which is not part of the No Action Alternative, would involve (1) incorporating additional fish exclusion barrier technology into the primary fish removal barriers, (2) incorporating additional debris removal systems at each trash removal barrier, screen, and fish barrier, (3) constructing additional channels to distribute the fish collection and debris removal among redundant paths through the facility, (4) constructing additional fish handling systems and holding tanks to improve system reliability, and (5) incorporating remote operation into the design and construction of the facility. Construction activities, depending on where they are located, could involve use of agricultural land. In this case, the action would result in conversion of agricultural land. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land.

The Skinner Fish Facility Improvements program action, which is not part of the No Action Alternative, would involve (1) electroshocking and relocating predators, (2) controlling aquatic weeds, (3) developing a fishing incentives or reward program for catching predators, and (4) operational changes when listed species are present. None of these activities would involve reduction of flow or use of agricultural land. Therefore, no reduction in agricultural productivity is anticipated, and no conversion of agricultural land to nonagricultural use would result.

The Delta Fish Species Conservation Hatchery program action, which is not part of the No Action Alternative, would involve construction and operation of a conservation hatchery for Delta Smelt. Depending on where this facility is sited, it could cause use of agricultural land. If this is the case, this action would result in conversion of agricultural land to nonagricultural purposes. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land.

The Reintroduction Efforts from Fish Conservation and Culture Laboratory program action would supplement populations of Delta Smelt, focusing on capturing existing genetic diversity. The action would not affect flows or use agricultural land, so no change in agricultural productivity is anticipated. No conversion of agricultural land to nonagricultural use would result.

Potential changes in land use related to cross-Delta transfers.

While program actions could affect the amount of water available for beneficial purposes for water transfers, any effect on water transfers would be indirect, and assessment of the magnitude of any subsequent change would be speculative.

R.2.4 Alternative 2

Project-level action alternatives would change operations of the CVP and SWP, as described in Appendix F, *Model Documentation*. The changes to CVP and SWP operations would change river flows and reservoir levels, which in turn could, if flows and levels are decreased, affect the ability of local jurisdictions to fulfill plans described in their general plans, affect productivity of agricultural land to the extent that land is converted from agricultural to nonagricultural use, and change water transfer patterns.

R.2.4.1 *Project-Level Effects*

Potential changes in land use

Effects Modeled by CWEST

As described in Appendix F, *Model Documentation* and in Tables R.2-1 and R.2-2, CVP and SWP water deliveries to M&I water users would be greater overall under Alternative 1 than under the No Action Alternative. The increased CVP and SWP water supply availability would allow water users to reduce other water supplies overall, including groundwater. It is anticipated that any additional water supplies would not result in changes in the general plan development plans without subsequent environmental documentation. Adequate water supplies would be available to support future municipal and industrial land uses projected in existing general plans under Alternative 1 and the No Action Alternative. Table R.2-13shows the modeled changes in average annual CVP/SWP deliveries, delivery costs, new supply, annualized new supply costs, surface and groundwater storage costs, lost water sales revenues, transfer costs, shortage costs, groundwater pumping savings, excess water savings, and average annual cost by region for Alternative 2 as compared to the No Action Alternative.

Table R.2-13. Differences in Water Supply and Costs Between the No Action Alternative and Alternative 2

	Trinity River	Sacramento River	San Francisco Bay Area	San Joaquin River	Bay-Delta	Central Coast	Southern California	Total
Average Annual CVP/SWP Deliveries (TAF)	0	2	54	50	10	12	518	647
Delivery Cost ($1,000)	$0	$43	$1,960	$4,706	$146	$2,258	$74,165	$83,278
New Supply (TAF)	0	0	-3	-1	0	0	-73	-76
Annualized New Supply Costs ($1,000)	$0	$0	-$526	-$286	$0	$0	-$25,145	-$25,957
Surface/ Groundwater Storage Costs ($1,000)	$0	$0	$252	$0	-$523	$0	-$3,483	-$3,755
Lost Water Sales Revenues ($1,000)	$0	$0	-$2,891	-$38	-$284	$0	-$22,967	-$26,180
Transfer Costs ($1,000)	$0	-$44	-$6,000	-$3,667	-$485	$0	-$13,813	-$24,010
Shortage Costs ($1,000)	$0	$0	-$965	-$14	-$95	$0	-$28,004	-$29,077
Groundwater Pumping Savings ($1,000)	$0	-$28	-$411	-$1,248	$50	-$884	-$39,856	-$42,376
Excess Water Savings ($1,000)	$0	-$31	-$449	-$3,465	-$147	-$1,791	-$5,951	-$11,833
Average Annual Cost ($1,000)	$0	-$60	-$9,029	-$4,012	-$1,338	-$417	-$65,054	-$79,909

TAF = thousand acre-feet

No municipal and industrial land uses in the Trinity River region are served by CVP and SWP water supplies. Therefore, the municipal and industrial land uses would be the same under Alternative 2 and the No Action Alternative in the Trinity River region.

Table R.2-13 shows that the average annual cost would be the same or less in all regions compared to the No Action Alternative. Therefore, it is expected that local jurisdictions would afford to have adequate water to implement their general plans, and that land use in 2030 would not change under Alternative 2 compared to the No Action Alternative in all regions.

In addition to project actions that were modeled, Alternative 1 includes project actions that were not modeled. These are described by region below and their effects are compared to those of the No Action Alternative.

Effects Not Modeled by CWEST

San Joaquin River Region

Alternative 2 would operate New Melones Reservoir in the same way as described in the No Action Alternative. No changes in use are anticipated

Potential changes in irrigated agricultural acreage and total production value

Effects Modeled by SWAP

Sacramento River and San Joaquin River Regions as Modeled under SWAP

As CalSim II modeling results show (Appendix F, *Model Documentation*), flows and reservoir storage would increase in the Sacramento River, San Joaquin River, and Bay-Delta regions. In addition, deliveries for agricultural uses would increase (Tables R.2-1 and R.2-2). Note that counties in the Bay-Delta region are reported under the Sacramento River and San Joaquin River regions because the relevant SWAP regions span the Bay-Delta region and the Sacramento River and San Joaquin River regions.

Assumptions in the SWAP model do not account for any change in groundwater use under SGMA implementation, which requires that local public agencies and Groundwater Sustainability Agencies (GSAs) in high- and medium-priority basins develop and implement Groundwater Sustainability Plans (GSPs) or Alternatives to GSPs in order to map how groundwater basins will reach long term sustainability. However, because in-stream flows are expected to increase with Alternative 2, no reduction in groundwater is anticipated. The additional surface water supply is expected to reduce the reliance of those areas on groundwater, no reduction in groundwater is anticipated.

Table R.2-14 shows the difference in acreage planted in the average year condition with respect to water availability between the No Action Alternative and Alternative 2, and Table R.2-15 shows the difference in productivity in the average year condition in millions of dollars. Table R.2-16 shows the difference in acreage planted in the dry and critical year condition with respect to water availability between the No Action Alternative and Alternative 2, and Table R.2-17 shows productivity in the dry and critical year condition in millions of dollars.

Table R.2-14. Difference in Crops in the SWAP Regions (acres) in the Average Year Condition between the No Action Alternative and Alternative 2

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	2,487	483	604	76	891	4,541
Total Irrigated Acreage (Acres)	2,487	483	604	76	891	4,541

Table R.2-15. Difference in Crop Productivity in the SWAP Regions (millions of dollars) in the Average Year Condition between the No Action Alternative and Alternative 2

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	4	1	2	1	7	14
Total Irrigated Acreage (Acres)	4	1	2	1	7	14

Table R.2-16. Difference in Crops in the SWAP Regions (acres) in the Dry and Critical Year Condition between the No Action Alternative and Alternative 2

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	36,158	5,392	7,275	752	6,570	56,147
Total Irrigated Acreage (Acres)	36,158	5,392	7,275	752	6,570	56,147

Table R.2-17. Difference in Crop Productivity in the SWAP Regions (millions of dollars) in the Dry and Critical Year Condition between the No Action Alternative and Alternative 2

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	50	9	13	4	46	121
Total Irrigated Acreage (Acres)	50	9	13	4	46	121

As shown in Table R.2-14, SWAP modeling shows that in the average year condition, there would be approximately 4,541 more acres of irrigated farmland in the San Joaquin River region under Alternative 2 compared to the No Action Alternative. Acreage of irrigated farmland in the Sacramento River region would be the same as under the No Action Alternative. As shown in Table R.2-15, the San Joaquin River region would have an increased productivity of approximately $14 million. Agricultural productivity in the Sacramento River region would be the same as under the No Action Alternative. Crop acreage and productivity in the Sacramento River region would remain the same because deliveries to this region in the average year condition would not change under Alternative 2 compared to the No Action Alternative.

As shown in Table R.2-16, in the dry and critical year condition, there would be approximately 56,147 more acres of irrigated farmland in the San Joaquin River region under Alternative 2 compared to the No Action Alternative. Acreage of irrigated farmland in the Sacramento River region would be the same as under the No Action Alternative. As shown in Table R.2-17, the San Joaquin River region would have an increased productivity of approximately $121 million. Agricultural productivity in the Sacramento River region would be the same as under the No Action Alternative. Crop acreage and productivity in the

Sacramento River region would remain the same because deliveries to this region in the average year condition would not change under Alternative 2 compared to the No Action Alternative.

In both the average and dry/critical year conditions, overall crop acreage and crop productivity in the San Joaquin River region would be greater under Alternative 2 compared to the No Action Alternative and would remain the same in the Sacramento River region. Therefore, no Therefore, no conversion of agricultural land to nonagricultural is expected to occur in these regions

In addition to project actions modeled under CalSim II and SWAP, Alternative 2 includes project actions that were not modeled. These are described in the following sections and their effects are compared to those of the No Action Alternative.

Effects Not Modeled by SWAP

Trinity River Region

This region was not modeled under SWAP. Because there are no CVP/SWP agricultural water deliveries in this region, no conversion of agricultural land to nonagricultural use is anticipated.

San Joaquin River Region

Alternative 2 would operate New Melones Reservoir in the same way as described in the No Action Alternative. No conversion of agricultural land to nonagricultural use is anticipated

Bay-Delta Region

The counties that constitute the Bay-Delta region do not correspond exactly to SWAP regions; rather, these counties span multiple SWAP regions. For this reason, the SWAP modeling analysis of the Bay-Delta region has been reported in the Sacramento River region and the San Joaquin River region in Tables R.2-14— through R.2-17 above.

San Francisco Bay Area Region

This region was not modeled under SWAP. As shown by CalSim modeling (Tables R.2-1 and R.2-2), deliveries for agricultural uses would increase under the average and dry/critical conditions in this region, so no conversion of agricultural land to nonagricultural use is anticipated.

Central Coast Region

This region was not modeled under SWAP. Because there are no CVP/SWP agricultural water deliveries in this region (Tables R.2-1 and R.2-2), no conversion of agricultural land to nonagricultural use is anticipated.

Southern California Region

This region was not modeled under SWAP. As shown by CalSim modeling (Tables R.2-1 and R.2-2), deliveries for agricultural uses would increase under the average and dry/critical conditions in this region, so no conversion of agricultural land to nonagricultural use is anticipated.

Potential changes in land use related to cross-Delta transfers.

Alternative 2 would allow the same volume of water transfer to take place during the same time period as the No Action Alternative. However, because the amount of water available in flows and reservoirs would change with respect to the No Action Alternative, modeling indicates that water transfers would also change. Table R.2--13 shows the projected changes in water transfer costs across the regions. Water transfer costs in all regions would either remain the same or decrease compared to the No Action Alternative. In addition, it is unlikely that changes in water transfers would result in changes in land use or conversion of agricultural land.

R.2.4.2 *Program-Level Effects*

No program actions are proposed for Alternative 2.

R.2.5 Alternative 3

Project-level action alternatives would change operations of the CVP and SWP, as described in Appendix F, *Model Documentation*. The changes to CVP and SWP operations would change river flows and reservoir levels, which in turn could, if flows and levels are decreased, affect the ability of local jurisdictions to fulfill plans described in their general plans, affect productivity of agricultural land to the extent that land is converted from agricultural to nonagricultural use, and change water transfer patterns.

R.2.5.1 *Project-Level Effects*

Potential changes in land use

Effects Modeled by CWEST

As described in Appendix F, *Model Documentation* and in Tables R.2-1 and R.2-2, CVP and SWP water deliveries to M&I water users would be greater overall under Alternative 3 than under the No Action Alternative. The increased CVP and SWP water supply availability would allow water users to reduce other water supplies overall, including groundwater. It is anticipated that any additional water supplies would not result in changes in the general plan development plans without subsequent environmental documentation. Adequate water supplies would be available to support future municipal and industrial land uses projected in existing general plans under Alternative 3 and the No Action Alternative. Table R.2-18 shows the modeled changes in average annual CVP/SWP deliveries, delivery costs, new supply, annualized new supply costs, surface and groundwater storage costs, lost water sales revenues, transfer costs, shortage costs, groundwater pumping savings, excess water savings, and average annual cost by region for Alternative 3 as compared to the No Action Alternative.

Table R.2-18. Differences in Water Supply and Costs Between the No Action Alternative and Alternative 3

	Trinity River	Sacramento River	San Francisco Bay Area	San Joaquin River	Bay-Delta	Central Coast	Southern California	Total
Average Annual CVP/SWP Deliveries (TAF)	0	2	54	49	10	12	498	625
Delivery Cost ($1,000)	$0	$37	$1,971	$4,591	$140	$2,232	$71,746	$8
New Supply (TAF)	0	0	-3	-1	0	0	-66	-70
Annualized New Supply Costs ($1,000)	$0	$0	-$526	-$286	$0	$0	-$23,394	-$24,206
Surface/ Groundwater Storage Costs ($1,000)	$0	$0	$252	$0	-$523	$0	-$3,303	-$3,574
Lost Water Sales Revenues ($1,000)	$0	$0	-$2,891	-$41	-$284	$0	-$22,940	-$26,156
Transfer Costs ($1,000)	$0	-$35	-$6,000	-$3,491	-$510	$0	-$14,203	-$24,238
Shortage Costs ($1,000)	$0	$0	-$965	-$14	-$95	$0	-$28,016	-$29,090
Groundwater Pumping Savings ($1,000)	$0	-$26	-$411	-$1,286	$51	-$844	-$39,343	-$41,858
Excess Water Savings ($1,000)	$0	-$27	-$459	-$3,352	-$140	-$1,786	-$5,330	-$11,094
Average Annual Cost ($1,000)	$0	-$50	-$9,029	-$3,878	-$1,361	-$398	-$64,782	-$79,500

TAF = thousand acre-feet

No municipal and industrial land uses in the Trinity River region are served by CVP and SWP water supplies. Therefore, the municipal and industrial land uses would be the same under Alternative 3 and the No Action Alternative in this region.

Table R.2-18 shows that the average annual cost would be less in all regions compared to the No Action Alternative. Therefore, it is expected that local jurisdictions would afford to have adequate water to implement their general plans, and that land use through 2030 would not change under Alternative 3 compared to the No Action Alternative in all regions.

In addition to project actions that were modeled, Alternative 1 includes project actions that were not modeled. These are described by region below and their effects are compared to those of the No Action Alternative.

Effects Not Modeled by CWEST

Bay-Delta Region

The Clifton Court Aquatic Weed Removal project action under Alternative 1 would involve application of aquatic herbicides and algaecides and operation of the Clifton Court Forebay intake gates to control flow of the water in and out of the Clifton Court Forebay. Because this action does not include changes in flows, it is unlikely that this action would result in local jurisdictions being unable to implement general plans because of lack of water. Changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

As discussed under No Action Alternative, the Tracy Fish Collection Facility and the Skinner Fish Facility project actions involve fish screening and hauling salvaged fish by truck to release sites. None of these activities affect flow or reservoir levels. These actions, as under the No Action Alternative, would not result in land use changes, as compared to the No Action Alternative.

The San Joaquin Basin Steelhead Telemetry Study project action would continue a telemetry study for the migration and survival of San Joaquin Origin Central Valley Steelhead. This action is not part of the No Action Alternative. This action would not change flows or reservoir levels. Therefore, no reduction in M&I water is anticipated, and changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

Potential changes in irrigated agricultural acreage and total production value

Effects Modeled by SWAP

Sacramento River and San Joaquin River Regions as Modeled under SWAP

As CalSim II modeling results show (Appendix F, *Model Documentation*), flows and reservoir storage would increase in the Sacramento River, San Joaquin River, and Bay-Delta regions. In addition, deliveries for agricultural uses would increase (Tables R.2-1 and R.2-2). Note that counties in the Bay-Delta Region are reported below under the Sacramento River and San Joaquin River regions because the relevant SWAP regions span the Bay-Delta region and the Sacramento and San Joaquin River regions.

Assumptions in the SWAP model do not account for any change in groundwater use under SGMA implementation, which requires that local public agencies and Groundwater Sustainability Agencies (GSAs) in high- and medium-priority basins develop and implement Groundwater Sustainability Plans (GSPs) or Alternatives to GSPs in order to map how groundwater basins will reach long term sustainability. However, because in-stream flows are expected to increase with Alternative 3, no reduction in groundwater is anticipated. The additional surface water supply is expected to reduce the reliance of those areas on groundwater, no reduction in groundwater is anticipated.

Table R.2-19 shows the difference in acreage planted in the average year condition with respect to water availability between the No Action Alternative and Alternative 3, and Table R.2-20 shows the difference in productivity in the average year condition in millions of dollars. Table R.2-21 shows the difference in acreage planted in the dry/critical year condition with respect to water availability between the No Action Alternative and Alternative 2, and Table R.2-22 shows productivity in the dry/critical year condition in millions of dollars.

Table R.2-19. Difference in Crops in the SWAP Regions (acres) in the Average Year Condition between the No Action Alternative and Alternative 3

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	2,674	507	652	78	946	2,674
Total Irrigated Acreage (Acres)	2,674	507	652	78	946	2,674

Table R.2-20. Difference in Crop Productivity in the SWAP Regions (millions of dollars) in the Average Year Condition between the No Action Alternative and Alternative 3

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	4	1	2	1	8	15
Total Irrigated Acreage (Acres)	4	1	2	1	8	15

Table R.2-21. Difference in Crops in the SWAP Regions (acres) in the Dry/Critical Year Condition between the No Action Alternative and Alternative 3

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	36,112	5,373	7,246	752	6,556	56,039
Total Irrigated Acreage (Acres)	36,112	5,373	7,246	752	6,556	56,039

Table R.2-22. Difference in Crop Productivity in the SWAP Regions (millions of dollars) in the Dry/Critical Year Condition between the No Action Alternative and Alternative 3

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	50	8	13	4	45	121
Total Irrigated Acreage (Acres)	50	8	13	4	45	121

As shown in Table R.2-19, SWAP modeling shows that in the average year condition, there would be of approximately 2,674 more acres of irrigated farmland in the San Joaquin River region under Alternative 3 compared to the No Action Alternative. Acreage of irrigated farmland in the Sacramento River region would be the same as under the No Action Alternative. As shown in Table R.2-20, the San Joaquin River region would have an increased productivity of approximately $15 million. Agricultural productivity in the Sacramento River region would be the same as under the No Action Alternative. Crop acreage and productivity in the Sacramento River region would remain the same because deliveries to this region in the average year condition would not change under Alternative 3 compared to the No Action Alternative.

As shown in Table R.2-21, In the dry and critical year condition, there would be of approximately 56,039 more acres of irrigated farmland in the San Joaquin River region under Alternative 3 compared to the No Action Alternative. Acreage of irrigated farmland in the Sacramento River region would be the same as under the No Action Alternative. As shown in Table R.2-22, the San Joaquin River region would have an increased productivity of approximately $121 million. Agricultural productivity in the Sacramento River region would be the same as under the No Action Alternative. Crop acreage and productivity in the Sacramento River region would remain the same because deliveries to this region in the dry and critical year condition would not change under Alternative 3 compared to the No Action Alternative.

In both the average and dry/critical year conditions, overall crop acreage and crop productivity in the San Joaquin River region would be greater under Alternative 3 compared to the No Action Alternative and would remain the same in the Sacramento River region. Therefore, no conversion of agricultural land to nonagricultural is expected to occur in these regions.

In addition to project actions modeled under CalSim II and SWAP, Alternative 3 includes project actions that were not modeled. These are described in the following sections and their effects are compared to those of the No Action Alternative.

Effects Not Modeled by SWAP

Trinity River Region

This region was not modeled under SWAP. Because there are no CVP/SWP agricultural water deliveries in this region, no conversion of agricultural land to nonagricultural use is anticipated.

Bay-Delta Region

The counties that constitute the Bay-Delta region do not correspond exactly to SWAP regions; rather, these counties span multiple SWAP regions. For this reason, the SWAP modeling analysis of the Bay-Delta region has been reported in the Sacramento River region and the San Joaquin River region in Tables R.2—19 through R.2-22 above.

The Clifton Court Aquatic Weed Removal project action under Alternative 1 would involve application of aquatic herbicides and algaecides and operation of the Clifton Court Forebay intake gates to control flow of the water in and out of the Clifton Court Forebay. Because this action does not include changes in flows or reservoir levels or construction on agricultural land, this action is unlikely to result in conversion of agricultural land to nonagricultural purposes.

As discussed under No Action Alternative, the Tracy Fish Collection Facility and the Skinner Fish Facility project actions involve fish screening and hauling salvaged fish by truck to release sites. None of these activities affect flow or reservoir levels or surrounding land. These actions, as under the No Action Alternative, would not result in conversion of agricultural land to nonagricultural purposes, as compared to the No Action Alternative.

The San Joaquin Basin Steelhead Telemetry Study project action would continue a telemetry study for the migration and survival of San Joaquin Origin Central Valley Steelhead. This action is not part of the No Action Alternative. This action would not change flows or reservoir levels or involve construction. No conversion of agricultural land to nonagricultural uses is anticipated, as compared to the No Action Alternative.

<u>*San Francisco Bay Area Region*</u>

This region was not modeled under SWAP. As shown by CalSim modeling (Tables R.2-1 and R.2-2), deliveries for agricultural uses would increase under the average and dry/critical conditions in this region, so no conversion of agricultural land to nonagricultural use is anticipated.

<u>*Central Coast Region*</u>

This region was not modeled under SWAP. As shown by CalSim modeling (Tables R.2-1 and R.2-2), there would be no change in deliveries for agricultural uses under the average and dry/critical conditions in this region, so no conversion of agricultural land to nonagricultural use is anticipated.

<u>*Southern California Region*</u>

This region was not modeled under SWAP. Because there are no CVP/SWP agricultural water deliveries in this region (Tables R.2-1 and R.2-2), no conversion of agricultural land to nonagricultural use is anticipated.

Potential changes in land use related to cross-Delta transfers.

Alternative 3 would allow the same volume of water transfer to take place during the same time period as the No Action Alternative. However, because the amount of water available in flows and reservoirs would change with respect to the No Action Alternative, modeling indicates that water transfers would also change. Table R.2-18 shows the projected changes in water transfer costs across the regions. Water transfer costs in all regions would either remain the same or decrease. In addition, it is unlikely that changes in water transfers would result in changes in land use or conversion of agricultural land.

R.2.5.2 *Program-Level Effects*

Potential changes in land use

<u>Sacramento River Region</u>

The Small Screen Program program action in the Sacramento River region would continue to work within existing authorities to screen small diversions throughout CVP and SWP streams and the Bay-Delta. This action would not change flows or reservoir levels. However, a small amount of land may be needed to construct these screens, and some of this land may be agricultural. Because this action would not change flows, local jurisdictions would have adequate water to implement their general plans. Therefore, no change in land use is anticipated.

The Adult Rescue program action, which is not part of the No Action Alternative, would trap and haul adult salmonids and sturgeon from Yolo and Sutter Bypasses during droughts and after periods of bypass flooding and move them up the Sacramento River to spawning grounds. The Adult Rescue program action would involve placement of temporary juvenile collection weirs at key feasible locations, downstream of spawning areas in the Sacramento River, and transport of collected fish to a safe release location(s) in the Bay-Delta upstream of Chipps Island. These actions would not affect flow or reservoir levels. Because this action would not change water deliveries, local jurisdictions would have adequate water to implement their general plans. Therefore, no change in land use is anticipated.

The Trap and Haul program action, which is not part of the No Action Alternative, would capture and transport juvenile Chinook Salmon and Steelhead in the Sacramento River watershed in drought years when low flows and resulting high water temperatures are unsuitable for volitional downstream migration and survival. Reclamation would place temporary juvenile collection weirs at key feasible locations, downstream of spawning areas in the Sacramento River. This action would not involve changes in flows. Because this action would not change water deliveries, local jurisdictions would have adequate water to implement their general plans. Therefore, no change in land use is anticipated.

San Joaquin River Region

The Lower San Joaquin River Habitat program action would implement the San Joaquin River Restoration Program, as described in the No Action Alternative. In addition, this action would implement rearing habitat restoration on the lower San Joaquin River not included in the No Action Alternative. This would involve a large-scale floodplain habitat restoration effort in the lower San Joaquin River. This action would not change flows, although it would involve connecting a floodplain to its river. Because the action would not change water deliveries, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated.

Bay-Delta Region

The Removing Predator Hot Spots program action, which is not part of the No Action Alternative, would not involve changes in flows or construction on agricultural land but rather would involve minimizing lighting at fish screens and bridges and possibly removing abandoned structures. Because the action would not change flows, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated

The Small Screen Program action, which is not part of the No Action Alternative, could involve construction on agricultural land. The action does not involve changes in flows. Because the action would not change flows, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated.

The Sacramento Deepwater Ship Channel program action, which is not part of the No Action Alternative, would involve repairing and/or replacing the West Sacramento lock system to hydraulically reconnect the ship channel with the mainstem of the Sacramento River. The action would not involve changes in flows or reservoir levels. Because the action would not change flows, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated.

The North Delta Food Subsidies/Colusa Basin Drain Study program action would increase food entering the north Delta through flushing nutrients from the Colusa Basin into the Yolo Bypass and north Delta. DWR, Reclamation, and water users would work with partners to flush agricultural drainage (i.e., nutrients) from the Colusa Basin Drain through Knight's Landing Ridge Cut and Tule Canal to Cache Slough, improving the aquatic food web in the north Delta for fish species. Reclamation would work with DWR and partners to augment flow in the Yolo Bypass in July and/or September by closing Knights Landing Outfall Gates and routing water from Colusa Basin into Yolo Bypass to promote fish food production. This action would involve increasing flows into the Bay-Delta. Because the action would not reduce flows, local jurisdictions would continue to have adequate water for implementing their general plans, and no change in land use is anticipated.

The Additional Habitat Restoration (25,000 acres within the Bay-Delta) program action would restore an addition 25,000 acres of habitat within the Bay-Delta. Depending on where the restoration is located, it is possible that the action would use agricultural land. In this case, agricultural productivity would be affected and land could be converted from agricultural to nonagricultural use. This action would have a greater effect than the No Action Alternative.

The Tracy Fish Facility Improvements program action, which is not part of the No Action Alternative, would involve (1) incorporating additional fish exclusion barrier technology into the primary fish removal barriers, (2) incorporating additional debris removal systems at each trash removal barrier, screen, and fish barrier, (3) constructing additional channels to distribute the fish collection and debris removal among redundant paths through the facility, (4) constructing additional fish handling systems and holding tanks to improve system reliability, and (5) incorporating remote operation into the design and construction of the facility. Construction activities, depending on where they are located, could involve use of agricultural land. This action would not involve changes in flows, and therefore local jurisdictions would continue to have adequate water for implementing their general plans. No change in land use is anticipated.

The Skinner Fish Facility Improvements program action, which is not part of the No Action Alternative, would involve (1) electroshocking and relocating predators, (2) controlling aquatic weeds, (3) developing a fishing incentives or reward program for catching predators, and (4) operational changes when listed species are present. None of these activities would involve reduction of flow. Therefore, local jurisdictions would continue to have adequate water for implementing their general plans. No change in land use is anticipated.

The Delta Fish Species Conservation Hatchery program action, which is not part of the No Action Alternative, would involve construction and operation of a conservation hatchery for Delta Smelt. Depending on where this facility is sited, it could cause use of agricultural land. This action would not involve changes in flows, and therefore local jurisdictions would continue to have adequate water for implementing their general plans. No change in land use is anticipated.

The Reintroduction Efforts from Fish Conservation and Culture Laboratory program action would supplement populations of Delta Smelt, focusing on capturing existing genetic diversity. The action would not affect flows, and therefore local jurisdictions would continue to have adequate water for implementing their general plans. No change in land use is anticipated.

Potential changes in irrigated agricultural acreage and total production value

<u>Sacramento River Region</u>

The Small Screen Program program action in the Sacramento River region would continue to work within existing authorities to screen small diversions throughout CVP and SWP streams and the Bay-Delta. This action would not change flows or reservoir levels. However, a small amount of land may be needed to construct these screens, and some of this land may be agricultural. It is possible that a small amount of agricultural land could be converted to nonagricultural uses compared to the No Action Alternative. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land.

The Adult Rescue program action, which is not part of the No Action Alternative, would trap and haul adult salmonids and sturgeon from Yolo and Sutter Bypasses during droughts and after periods of bypass flooding and move them up the Sacramento River to spawning grounds. The Trap and Haul program action would involve placement of temporary juvenile collection weirs at key feasible locations, downstream of spawning areas in the Sacramento River, and transport of collected fish to a safe release location(s) in the Bay-Delta upstream of Chipps Island. These actions would not affect flow or reservoir levels or agricultural land. Accordingly, no land would be converted from agricultural to nonagricultural uses.

The Trap and Haul program action, which is not part of the No Action Alternative, would capture and transport juvenile Chinook Salmon and Steelhead in the Sacramento River watershed in drought years when low flows and resulting high water temperatures are unsuitable for volitional downstream migration and survival. Reclamation would place temporary juvenile collection weirs at key feasible locations, downstream of spawning areas in the Sacramento River. This action would not involve changes in flows or use of agricultural land. Therefore, no change in agricultural productivity compared to the No Action Alternative is anticipated, and no land would be converted from agricultural to nonagricultural use.

San Joaquin River Region

The Lower San Joaquin River Habitat program action would implement the San Joaquin River Restoration Program, as described in the No Action Alternative. In addition, this action would implement rearing habitat restoration on the lower San Joaquin River not included in the No Action Alternative. This would involve a large-scale floodplain habitat restoration effort in the lower San Joaquin River. This action could remove agricultural land from agricultural use for restoration purposes, thus resulting in conversion of agricultural land to nonagricultural use. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land.

Bay-Delta Region

The Removing Predator Hot Spots program action, which is not part of the No Action Alternative, would not involve changes in flows or construction on agricultural land but rather would involve minimizing lighting at fish screens and bridges and possibly removing abandoned structures. No effects on agricultural productivity are anticipated and accordingly, no conversion of agricultural land would result.

The Sacramento Deepwater Ship Channel program action, which is not part of the No Action Alternative, would involve repairing and/or replacing the West Sacramento lock system to hydraulically reconnect the ship channel with the mainstem of the Sacramento River. The action would not involve changes in flows or reservoir levels or construction on agricultural land. The action would not result in conversion of agricultural land.

The North Delta Food Subsidies/Colusa Basin Drain Study program action would increase food entering the north Delta through flushing nutrients from the Colusa Basin into the Yolo Bypass and north Delta. DWR, Reclamation, and water users would work with partners to flush agricultural drainage (i.e., nutrients) from the Colusa Basin Drain through Knight's Landing Ridge Cut and Tule Canal to Cache Slough, improving the aquatic food web in the north Delta for fish species. Reclamation would work with

DWR and partners to augment flow in the Yolo Bypass in July and/or September by closing Knights Landing Outfall Gates and routing water from Colusa Basin into Yolo Bypass to promote fish food production. This action would involve increasing flows into the Bay-Delta. Therefore, no reduction to agricultural productivity is anticipated, and no conversion of agricultural land to nonagricultural use would result.

The Additional Habitat Restoration (25,000 acres within the Bay-Delta) program action would restore an addition 25,000 acres of habitat within the Bay-Delta. Depending on where the restoration is located, it is possible that the action would use agricultural land. In this case, agricultural productivity would be affected and land could be converted from agricultural to nonagricultural use. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land.

The Tracy Fish Facility Improvements program action, which is not part of the No Action Alternative, would involve (1) incorporating additional fish exclusion barrier technology into the primary fish removal barriers, (2) incorporating additional debris removal systems at each trash removal barrier, screen, and fish barrier, (3) constructing additional channels to distribute the fish collection and debris removal among redundant paths through the facility, (4) constructing additional fish handling systems and holding tanks to improve system reliability, and (5) incorporating remote operation into the design and construction of the facility. Construction activities, depending on where they are located, could involve use of agricultural land. In this case, the action would result in conversion of agricultural land. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land.

The Skinner Fish Facility Improvements program action, which is not part of the No Action Alternative, would involve (1) electroshocking and relocating predators, (2) controlling aquatic weeds, (3) developing a fishing incentives or reward program for catching predators, and (4) operational changes when listed species are present. None of these activities would involve reduction of flow or use of agricultural land. Therefore, no reduction in agricultural productivity is anticipated, and no conversion of agricultural land to nonagricultural use would result.

The Delta Fish Species Conservation Hatchery program action, which is not part of the No Action Alternative, would involve construction and operation of a conservation hatchery for Delta Smelt. Depending on where this facility is sited, it could cause use of agricultural land. If this is the case, this action would result in conversion of agricultural land to nonagricultural purposes.

The Reintroduction Efforts from Fish Conservation and Culture Laboratory program action would supplement populations of Delta Smelt, focusing on capturing existing genetic diversity. The action would not affect flows or use agricultural land, so no change in agricultural productivity is anticipated. No conversion of agricultural land to nonagricultural use would result.

Potential changes in land use related to cross-Delta transfers.

While program actions could affect the amount of water available for beneficial purposes for water transfers, any effect on water transfers would be indirect, and assessment of the magnitude of any subsequent change would be speculative.

R.2.6 Alternative 4

Project-level action alternatives would change operations of the CVP and SWP, as described in Appendix F, *Model Documentation*. The changes to CVP and SWP operations would change river flows and reservoir levels, which in turn could, if flows and levels are decreased, affect the ability of local jurisdictions to fulfill plans described in their general plans, affect productivity of agricultural land to the extent that land is converted from agricultural to nonagricultural use, and change water transfer patterns.

R.2.6.1 *Project-Level Effects*

Potential changes in land use

<u>Effects Modeled by CWEST</u>

As described in Appendix F, *Model Documentation* and in Tables R.2-1 and R.2-2, CVP and SWP water deliveries to M&I water users would be less overall under Alternative 4 than under the No Action Alternative. The decreased CVP and SWP water supply availability would require water users to seek other sources of water to make up the difference. These other water sources would come with an increased cost, as shown in the final row of Table R-22. It is anticipated that the additional water supplies would not result in changes in the general plan development plans without subsequent environmental documentation. Adequate water supplies from CVP/SWP and other sources would be available to support future municipal and industrial land uses projected in existing general plans under Alternative 4 and the No Action Alternative. Table R.2-23 shows the modeled changes in average annual CVP/SWP deliveries, delivery costs, new supply, annualized new supply costs, surface and groundwater storage costs, lost water sales revenues, transfer costs, shortage costs, groundwater pumping savings, excess water savings, and average annual cost by region for Alternative 4.

Table R.2-23. Differences in Water Supply and Costs Between the No Action Alternative and Alternative 4

	Trinity River	Sacramento River	San Francisco Bay Area		San Joaquin River	Bay-Delta	Central Coast	Southern California	Total
Average Annual CVP/SWP Deliveries (TAF)	0	-2	-11		-10	-14	-2	-91	-130
Delivery Cost ($1,000)	$0	-$33	-$402		-$900	-$351	-$448	-$13,506	-$15,640
New Supply (TAF)	0	0	0		0	0	0	8	9
Annualized New Supply Costs ($1,000)	$0	$0	$0		$89	$0	$0	$3,870	$3,959
Surface/ Groundwater Storage Costs ($1,000)	$0	$0	-$65		$0	$321	$0	$859	$1,115
Lost Water Sales Revenues ($1,000)	$0	$8	$647		$0	$676	$0	$5,412	$6,743
Transfer Costs ($1,000)	$0	$121	$2,789		$1,115	$369	$0	$2,990	$7,384
Shortage Costs ($1,000)	$0	$2	$218		$0	$212	$0	$8,249	$8,681
Groundwater Pumping Savings ($1,000)	$0	$14	$70		$521	$54	$391	$8,564	$9,615
Excess Water Savings ($1,000)	$0	$23	-$15		$385	$228	$241	-$159	$704
Average Annual Cost ($1,000)	$0	$137	$3,242		$1,211	$1,509	$184	$16,278	$22,562

TAF = thousand acre-feet

No municipal and industrial land uses in the Trinity River region are served by CVP and SWP water supplies. Therefore, the municipal and industrial land uses would be the same under Alternative 4 and the No Action Alternative in this region.

Table R.2-23 shows that the average annual CVP/SWP deliveries would be less than under the No Action Alternative and the average annual cost would be greater in all regions except the Trinity River region. In some regions, such as the Sacramento River region and the Central Coast region, the differences between Alternative 4 and the No Action Alternative would not be great. However, in the other regions, particularly in the Southern California region, the difference between Alternative 4 and the No Action Alternative is substantial. In this region, nearly 100,000 acre-feet less of CVP/SWP water would be delivered and the average annual cost would be over $16 million. While it is possible that local jurisdictions would be able to replace this deficit in deliveries through other surface water sources, recycling or desalination, or groundwater pumping, the increased cost would be substantial. Therefore, in the Southern California region, local jurisdictions might have difficulty replacing the water not delivered if they are unprepared. Mitigation Measure AG-1 could reduce effects by encouraging water agencies to diversify their water portfolios, thus increasing likelihood that water users would have adequate water.

In addition to project actions that were modeled, Alternative 4 includes project actions that were not modeled. These are described by region below and their effects are compared to those of the No Action Alternative.

Effects Not Modeled by CWEST

Bay-Delta Region

As discussed under No Action Alternative, the Tracy Fish Collection Facility and the Skinner Fish Facility project actions involve fish screening and hauling salvaged fish by truck to release sites. None of these activities affect flow or reservoir levels or surrounding land. It is unlikely that this action would result in local jurisdictions being unable to implement general plans because of lack of water. Changes in land use as a result of this action are unlikely, as compared to the No Action Alternative.

Potential changes in irrigated agricultural acreage and total production value

Effects Modeled by SWAP

Sacramento River and San Joaquin River Regions as Modeled under SWAP

As CalSim II modeling results show (Appendix F, *Model Documentation*), flows and reservoir storage would decrease in the Sacramento River, San Joaquin River, and Bay-Delta regions. In addition, deliveries for agricultural uses would decrease (Tables R.2-1 and R.2-2). Note that counties in the Bay-Delta region are reported under the Sacramento River and San Joaquin River regions because the relevant SWAP regions span the Bay-Delta region and the Sacramento River and San Joaquin River regions.

Assumptions in the SWAP model do not account for any change in groundwater use under SGMA implementation, which requires that local public agencies and Groundwater Sustainability Agencies (GSAs) in high- and medium-priority basins develop and implement Groundwater Sustainability Plans (GSPs) or Alternatives to GSPs in order to map how groundwater basins will reach long term sustainability. Alternative 4 would reduce CVP and SWP deliveries, so demand on groundwater and other alternative water sources could increase. Because sufficient groundwater might not be available in the future to replace reduced CVP/SWP supplies, it is possible that SWAP acreage and production value decreases under Alternative 4 could be greater than modeled under SWAP..

Table R.2-24 below shows the difference in acreage planted in the average year condition with respect to water availability between the No Action Alternative and Alternative 4, and Table R.2-25 shows the difference in productivity in the average year condition in millions of dollars. Table R.2-26 shows the difference in acreage planted in the dry and critical year condition with respect to water availability between the No Action Alternative and Alternative 4, and Table R.2-27 shows productivity in the dry and critical year condition in millions of dollars.

Table R.2-24. Difference in Crops in the SWAP Regions (acres) in the Average Year Condition between the No Action Alternative and Alternative 4

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	-50	-3	-4	-3	-1	-60
San Joaquin River	-3,612	-649	-835	-52	-610	-5,758
Total Irrigated Acreage (Acres)	-3,662	-652	-840	-54	-611	-5,818

Table R.2-25. Difference in Crop Productivity in the SWAP Regions (millions of dollars) in the Average Year Condition between the No Action Alternative and Alternative 4

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	0	0	0	0
San Joaquin River	-6	-1	-2	0	-5	-14
Total Irrigated Acreage (Acres)	-6	-1	-2	0	-5	-14

Table R.2-26. Difference in Crops in the SWAP Regions (acres) in the Dry and Critical Year Condition between the No Action Alternative and Alternative 4

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	-177	1	-1,998	-13	-241	-2,427
San Joaquin River	-7,426	-937	-2,533	-53	-1,384	-12,333
Total Irrigated Acreage (Acres)	-7,603	-936	-4,530	-66	-1,625	-14,760

Table R.2-27. Difference in Crop Productivity in the SWAP Regions (millions of dollars) in the Dry and Critical Year Condition between the No Action Alternative and Alternative 4

Crop Category	Grains	Field crops	Forage crops	Vegetable, truck, specialty	Orchards and vineyards	Total
Sacramento River	0	0	-2	0	-1	-3
San Joaquin River	-12	-2	-6	0	-10	-29
Total Irrigated Acreage (Acres)	-12	-2	-8	0	-11	-33

As shown in Table R.2-24, SWAP modeling shows that in the average year condition, there would be approximately 5,758 fewer acres of irrigated farmland in the San Joaquin River region and approximately 60 fewer acres in the Sacramento River Region under Alternative 4 compared to the No Action Alternative. As shown in Table R.2-25, the San Joaquin River region would have a decreased productivity of approximately $14 million. Agricultural productivity in the Sacramento River region would be the same as under the No Action Alternative because deliveries to this region in the average year condition would decrease minimally under Alternative 4 compared to the No Action Alternative.

As shown in Table R.2-26, in the dry and critical year condition, there would be approximately 12,333 fewer acres of irrigated farmland in the San Joaquin River region and approximately 2,427 acres of irrigated farmland in the Sacramento River Region under Alternative 4 compared to the No Action Alternative. As shown in Table R.2-27, the San Joaquin River region would have a decreased productivity of approximately $29 million and the Sacramento River region a decreased productivity of approximately $3 million.

In both the average and dry/critical year conditions, overall crop acreage would be less in the San Joaquin River and Sacramento River regions under Alternative 4 compared to the No Action Alternative. In addition, crop productivity would decrease for both regions under the dry/critical condition. Crop productivity would also be less for the San Joaquin River region in the average condition, but would remain the same for the Sacramento River region compared to the No Action Alternative. Therefore, some conversion of agricultural land to nonagricultural is expected to occur in both regions under both conditions.

In addition to project actions modeled under CalSim II and SWAP, Alternative 4 includes project actions that were not modeled. These are described by region in the following sections and their effects are compared to those of the No Action Alternative.

Effects Not Modeled by SWAP

Trinity River Region

The Trinity River region was not modeled under SWAP. Because there are no CVP/SWP agricultural water deliveries in this region, no conversion of agricultural land to nonagricultural use is anticipated.

Sacramento River Region

Bay-Delta Region

The counties that constitute the Bay-Delta region do not correspond exactly to SWAP regions; rather, these counties span multiple SWAP regions. For this reason, the SWAP modeling analysis of the Bay-Delta region has been reported in the Sacramento River region and the San Joaquin River region in Tables R.2-8, R.2-9, R.2-10, and R.2-11 above.

As discussed under No Action Alternative, the Tracy Fish Collection Facility and the Skinner Fish Facility project actions involve fish screening and hauling salvaged fish by truck to release sites.

San Francisco Bay Area Region

This region was not modeled under SWAP. As shown by CalSim II modeling (Tables R.2-1 and R.2-2), deliveries for agricultural uses would decrease slightly under the average and dry/critical conditions in this region. Accordingly, there could be some conversion of agricultural land to nonagricultural use under Alternative 4. Implementation of Mitigation Measure AG-1 would reduce this effect by encouraging water users to develop alternative sources of water.

Central Coast Region

This region was not modeled under SWAP. Because there are no CVP/SWP agricultural water deliveries in this region (Tables R.2-1 and R.2-2), no conversion of agricultural land to nonagricultural use is anticipated.

Southern California Region

This region was not modeled under SWAP. As shown by CalSim II modeling (Tables R.2-1 and R.2-2), there would be no change in deliveries for agricultural uses under the average and dry/critical conditions in this region, so no conversion of agricultural land to nonagricultural use is anticipated.

Potential changes in land use related to cross-Delta transfers.

Alternative 4 would allow the same volume of water transfers as the No Action Alternative to take place over a longer period of time (from July to November rather than July to September) than under the No Action Alternative, providing for more flexibility in timing of water transfers. Environmental analysis for water supply for the increased period of water transfers would be analyzed separately, apart from this document. Because the amount of water available in flows and reservoirs would change with respect to the No Action Alternative, modeling indicates that water transfers would also change. Table R.2-23 shows the projected changes in water transfer costs across the regions. Water transfer costs in all regions would increase except for the Trinity River and Central Coast regions, where water transfer costs would remain the same as under the No Action Alternative. In the San Joaquin River, San Francisco Bay Area, and Southern California regions, water transfer costs would increase by between approximately $1 million and $3 million. Because water transfer costs would increase substantially in these regions over costs in the No Action Alternative, it is possible that changes in water transfers could result in changes in land use or conversion of agricultural land in the San Joaquin River, San Francisco Bay, and Southern California regions.

However, because Alternative 4 would allow for a longer period of time when transfers can take place than under the No Action Alternative, growers who want to participate in a water transfer contract would have more flexibility in their operations in the home region. Therefore, it is likely, because the same volume of water would be allowed for transfers under Alternative 4 as under the No Action Alternative, that growers would be able to participate in cross-Delta transfers without choosing cropland idling as the method of making water available for transfer. This is a countervailing factor in the effect of water transfers on agricultural lands, reducing the likelihood that Alternative 4 would result in conversion of agricultural land to nonagricultural uses in the Sacramento River region as a result of cross-Delta water transfers. Nevertheless, it is possible that changes in water transfers could result in changes in land use or conversion of agricultural land in the San Joaquin River, San Francisco Bay, and Southern California regions. Implementation of Mitigation Measure AG-1 could reduce effects by encouraging water agencies to diversify their water portfolios, thus increasing likelihood that water users would have adequate water in years with these actions.

R.2.6.2 *Program-Level Effects*

Potential changes in land use

Alternative 4 proposes water use efficiency measures which would increase irrigation efficiency and urban water use efficiency. These measures are primarily focused on upgrades to existing systems and installation of small scale devices to capture water and increase efficiency in an agricultural or urban setting. A potential method of water use efficiency is the alteration of land use for lands with high water use or whose irrigation contributes to significant problems, including problem drainage.

Through implementation of this measure it is possible that high water use land could be converted to another purpose and effects to land use could occur. The exact nature of the water use efficiency measures to be implemented has not been defined and the magnitude of this effect is speculative at this time; however, implementation of conversion of land use could have an effect on land uses in the study area under Alternative 4. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land. These effects will be determined and analyzed at a later date.

Potential changes in irrigated agricultural acreage and total production value

Alternative 4 proposes water use efficiency measures which would increase irrigation efficiency and urban water use efficiency. These measures are primarily focused on upgrades to existing systems and installation of small scale devices to capture water and increase efficiency in an agricultural or urban setting. A potential method of water use efficiency is the alteration of land use for lands with high water use or whose irrigation contributes to significant problems, including problem drainage.

Implementation of this measure has the potential to convert agricultural land to nonagricultural uses or to convert existing crops to more water efficient crops, changing the total production value. The exact nature of the water use efficiency measures to be implemented has not been defined and the magnitude of this effect is speculative at this time; however, implementation of conversion of land use could have a large scale effect on agricultural land in the study area under Alternative 4. Mitigation Measure AG-2 could reduce effects by encouraging agencies with discretionary land approval powers to require land or conservation easements or in-lieu fees to mitigate for conversion of agricultural land. These effects will be determined and analyzed at a later date.

Potential changes in land use related to cross-Delta transfers.

While program actions could affect the amount of water available for beneficial purposes for water transfers, any effect on water transfers would be indirect, and assessment of the magnitude of any subsequent change would be speculative.

R.2.7 Mitigation Measures

Mitigation Measure AG-1: Diversify Water Portfolios

Water agencies should diversify their water portfolios. Diversification could include the sustainable conjunctive use of groundwater and surface water, water transfers, water conservation and efficiency upgrades, and increased use of recycled water or water produced through desalination where available.

Mitigation Measure AG-2: Impose Conditions on Discretionary Land Use Approvals

Agencies that approve changes in land use that involve conversion of agricultural land to nonagricultural use should impose conditions on such approvals. Conditions should provide for the protection of an equal area of agricultural land to the agricultural land that would be converted and could include the following methods.

- Provide for a new conservation easement through grant or purchase to protect agricultural land that is not protected at the time of approval.
- Pay in-lieu fees sufficient to purchase easement or land into a fund specified for such purposes.

R.2.8 Summary of Impacts

Table R.2-28 includes a summary of impacts, the magnitude and direction of those impacts, and potential mitigation measures for consideration.

Table R.2-28. Impact Summary

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential changes in land use (Project-Level)	No Action	No Impact	–
	1–3	Land uses would not change under this alternative	–
	4	In the Southern California region, reduced CVP/SWP deliveries could result in local jurisdictions being unable to implement their general plans. In other regions, although deliveries would be less than under the No Action alternative, local jurisdictions would be able to replace water not delivered with water from other sources	MM-AG-1
Potential changes in land use (Program-Level)	No Action	No Impact	–
	1-3	Land uses would not change under program actions for these alternatives	–
	4	There is a potential for water use efficiency measures to cause changes in land use as a result of alteration of land use for those with exceptionally high water use or significant irrigation problems. Magnitude of these effects is undetermined; however, there is a potential for large scale changes	MM-AG-1
Potential changes in irrigated agricultural acreage and total production value (Project-Level)	No Action	No Impact	–
	1	During years with a fall action to maintain the X2 position or operations of the Suisun Marsh Salinity Control Gates for the Summer-Fall Delta Smelt Habitat Action, agricultural crop acreage and productivity could decrease slightly in areas affected by these actions Otherwise, irrigated farmland acreage and crop productivity would increase in	MM AG-1 MM AG-2

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
		the San Joaquin River region and would remain the same in other regions	
	2	Irrigated farmland acreage and crop productivity would increase in the San Joaquin River region and would remain the same in other regions	–
	3	Irrigated farmland acreage and crop productivity would increase in the San Joaquin River region and would remain the same in other regions	–
	4	Irrigated farmland acreage and crop productivity would decrease in the Sacramento River and San Joaquin River regions. In addition, agricultural water deliveries to the San Francisco Bay Area would decrease, so some conversion of agricultural farmland could result	MM-AG-1 MM-AG-2
Potential changes in irrigated agricultural acreage and total production value (Program-Level)	No Action	No Impact	–
	1	Construction and restoration on agricultural land could result in conversion	MM AG-2
	2	n/a	n/a
	3	Construction and restoration on agricultural land could result in conversion	MM AG-2
	4	There is a potential for changes in agricultural land use to nonagricultural land use or changes in production value as a result of water use efficiency measures leading to alteration of land use for those with exceptionally high water use or significant irrigation problems. Magnitude of these effects is undetermined; however, there is a potential for large scale changes	MM AG-2

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential changes in land use related to cross-Delta transfers (Project-Level)	No Action	No Impact	–
	1	Extended time period for transfers would allow participants in water transfer contracts more flexibility; water transfer costs would either remain the same or decrease in all regions	–
	2, 3	Water transfer costs would either remain the same or decrease in all regions	–
	4	Reduced deliveries would increase water transfer costs and potentially result in changes in land use or conversion of agricultural land to nonagricultural use in the San Joaquin River, San Francisco Bay, and Southern California regions	MM AG-1
Potential changes in land use related to cross-Delta transfers (Program-Level)	No Action	No Impact	–
	1, 3, 4	No Impact	–
	2	n/a	–

n/a = not applicable

R.2.9 Cumulative Effects

R.1.1.1 Changes in Land Use

The No Action Alternative would not result in any changes to water operations. Therefore, the No Action Alternative would not contribute to changes in land use Accordingly, the No Action Alternative is not evaluated further in this section..

Alternative 4, because of reduced M&I water deliveries and increased water use efficiency measures, could potentially result in local jurisdictions being unable to implement their general plans, particularly in the Southern California region.

The past, present, and reasonably foreseeable future projects, described in Appendix Y, *Cumulative Methodology*, may have effects on the ability of local jurisdictions to implement their general plans due to M&I water availability. The cumulative projects include actions across California to develop new water storage capacity, new water conveyance infrastructure, new water recycling capacity, and the reoperation of existing water supply infrastructure, including surface water reservoirs and conveyance infrastructure. The cumulative projects also include ecosystem improvement and habitat restoration actions to improve conditions for special status species whose special status in many cases constrains water supply delivery operations.

Implementation of Alternative 4 resource management plans and water efficiency measures could have cumulative operations impacts on local jurisdictions' ability to implement their general plans. Mitigation

Measure AG-1 could reduce effects by encouraging water agencies to diversify their water portfolios, thus increasing likelihood that water users would have adequate water. However, despite mitigation, the contribution of Alternative 4 to conditions resulting in an inability of local jurisdictions to implement their general plans would be substantial.

Collectively, the cumulative projects and Alternative 4 could potentially adversely affect land use by decreasing M&I water deliveries and increasing water use efficiency measures, resulting in a cumulative impact. The alternative's contribution to this cumulative impact would be substantial.

R.1.1.2 Changes in Irrigated Agriculture

The No Action Alternative would not result in any changes to water operations or proposed restoration activities. Therefore, the No Action Alternative would not contribute to changes in irrigated agriculture Accordingly, the No Action Alternative is not evaluated further in this section..

Alternatives 1 and 4 could cause a conversion of a small area of agricultural land to nonagricultural use in years with a fall action to maintain the X2 position for the Summer-Fall Delta Smelt Habitat Action as a result of changed agricultural water deliveries. Alternative 4 would potentially cause conversion of agricultural land to nonagricultural use as a result of reduced agricultural water deliveries and increased water use efficiency measures, which could in turn result in a reduction in crop productivity. In addition, Alternatives 1 and 3 would cause conversion of agricultural land to nonagricultural use as a result of habitat restoration activities.

The past, present, and reasonably foreseeable projects, described in Appendix Y, *Cumulative Methodology*, may have effects on irrigated agriculture. The cumulative projects include actions across California to develop new water storage capacity, new water conveyance infrastructure, new water recycling capacity, and the reoperation of existing water supply infrastructure—including surface water reservoirs and conveyance infrastructure. The cumulative projects also include ecosystem improvement and habitat restoration actions to improve conditions for special status species whose special status in many cases constrains water supply delivery operations. Collectively these cumulative projects would both benefit agriculture by improving agricultural water supply reliability and potentially adversely affect agriculture by increasing water flows for fish, which can simultaneously decrease water availability for agriculture. In addition, these cumulative projects would potentially adversely affect agriculture by locating ecosystem restoration projects on land currently used for agricultural purposes, thus resulting in conversion of agricultural land to nonagricultural uses if the restoration does not allow continued agricultural activities.

At the same time, there is increasing pressure on agricultural land in California from other sources.

- Expanding urban areas is exerting pressure to convert agricultural land to urban and semiurban uses (DOC 2015). For example, approximately 67,500 acres (105 square miles) of Important Farmland and grazing land were converted to urban uses in Kern County between 1988 and 2014.
- Projected climate change is anticipated to affect agricultural productivity (Pathak et al. 2018, CNRA 2009) and could lead to conversion of irrigated farmland to nonagricultural uses.
- In some areas of the San Joaquin Valley, agricultural drainage combined with selenium-rich soil and a perched groundwater layer have led to an agreement with the federal government to retire up to to 200,000 acres of irrigated farmland (San Joaquin River Exchange Contractors Water Authority et al.

2003), that is, to remove them voluntarily from agriculture for the purpose of minimizing the contribution to poor-quality perched groundwater.

- The Sustainable Groundwater Management Act (SGMA) is anticipated to constrain the amount of groundwater that is pumped for all uses, including agriculture (Downey-Brand 2014). In years when surface water supplies for agriculture are constrained due to shortage, limits on groundwater pumping can lead to fallowing of agricultural land.

According to the most recent California Farmland Conversion Report, which reports on agricultural land conversions, between 2010 and 2012California's irrigated farmlands decreased by 91 square miles (DOC 2015), or approximately 58,600 acres. Prime farmland constituted 81 percent of the decrease, or approximately 47,600 acres. The primary cause was long-term idling or land retirement in the southern San Joaquin Valley and the counties surrounding the San Joaquin-Sacramento Delta. At the same time, urban land increased by approximately 29,000 acres. This was the lowest urbanization rate in the Farmland Mapping and Monitoring Program's history, reflecting the impact of the economic recession of the period. Nonetheless, in general the southern San Joaquin Valley and most of the counties surrounding the San Joaquin-Sacramento Delta have been areas of rapid urban and suburban growth. As discussed above in *Background Information*, conversion of irrigated farmland to nonagricultural uses has continued in recent years in areas affected by the alternatives.

Climate change is anticipated to affect California's crop productivity through a range of mechanisms (Pathak et al. 2018, CNRA 2009). CalSim modeling, which provides input to SWAP modeling for surface water availability, takes into account some water supply effects of climate change. An increase in average temperatures is projected to result in, among other effects, higher demand for water because of increased evapotranspiration; a decline in winter chill hours required for many fruit and nut trees to properly set fruit; increased frequency and intensity of heat waves that could affect temperature-sensitive crops; an increase in weeds and expanded ranges of existing weeds as weed populations migrate north; and an increase in insect pests because of earlier emergence, longer persistence and potential migration of new pests from warmer climates, and survival and increased reproduction rate of frost-sensitive insects. An increase in heat waves is anticipated to lead to yield losses for multiple crops, including rice, corn, sunflower, and tomato; reduced photosynthesis and increased respiration which would lessen plant growth and decrease the quality of the agricultural product; early bolting in annual crops; and reduced pollination success. Changes in precipitation patterns and temperature are anticipated to result in more rain and less snow falling in the Sierra. This will lead to shallower snowpacks, earlier snowmelt with associated increase in winter floods, and loss of snowpack as a reservoir to store water. This will decrease water availability during the growing season and lead to an associated reduction in crop productivity. Flood and unseasonal rains (discussed below) will result in increased risk of soil-borne and rot diseases and potential washing away of pollen during flowering.

Increased incidence of drought resulting from climate change is anticipated to result in crop yield losses due to water stress, reduced root growth, exacerbated insect and disease problems, and surface water shortages. Climate change might also result in increased flood risk in northern California due to warmer storms that will drop rain rather than snow at higher elevations, with a proportional increase in runoff compared to colder storms. Increased flood risk is anticipated to result in water logging where soil is saturated with water; low oxygen, light, and rates of gas exchange that could affect some crops, and changes in timing for both sowing and harvesting (fields that are unseasonably wet limit access by farm machinery at crucial times in the growing cycle). While adaptation strategies such as planting different crops and adopting different irrigation and cultivation practices might improve the chances that California agriculture can continue its productivity in the face of changing climate, it remains likely that some climate change effects could result in conversion of irrigated farmland to nonagricultural uses.

Soil, groundwater, and drainage conditions within the Westlands Water District have combined to result in the retirement of substantial amounts of previously irrigated farmland. As discussed above in *Response to Reduced Water Supplies in Westlands Water District*, approximately 95,000 acres of irrigated farmland with inadequate drainage has been removed from irrigation in the Westlands Water District (WWD 2008, 2013a) and its water transferred to other lands within the District. In all, the Westside Regional Drainage Plan (San Joaquin River Exchange Contractors Water Authority et al. 2003) provides for retirement of 200,000 acres of irrigated farmland in the southern San Joaquin Valley in order to address agricultural drainage problems. Local soil is high in selenium, an element that is essential in minute quantities for human health but that is an environmental toxin when concentrated (Presser and Schwartzback 2008; Presser et al. 2009). Local conditions also include a layer of hardpan clay near ground surface that is impermeable to water, leading to a perched or shallow groundwater table in addition to the deep groundwater table (San Joaquin River Exchange Contractors Water Authority et al. 2003). Agricultural runoff containing selenium and other materials from agricultural activities, specifically fertilizer and pesticides, has accumulated in this perched groundwater, resulting in both water quality issues and a saturated root zone. Both of these factors limit agricultural productivity. Accordingly, the federal government and local water agencies agreed to retire land in order to minimize the accumulation of agricultural drainage in the shallow groundwater.

The San Joaquin Valley's groundwater basins are chronically overdrafted. SGMA was enacted in 2014 to require water users to manage and use "groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results (DWR 2019b). SGMA mandates the establishment of Groundwater Sustainability Agencies (GSAs) made up of local agencies to prepare Groundwater Sustainability Plans (GSPs) that will meet this goal. Through SGMA, groundwater basins are intended to be managed by the GSAs on a county or regional level to maintain the "safe yield" of the basin, as defined by existing case law, at the same time that economic, social, and environmental effects of limiting withdrawals from groundwater basins are addressed (Downey-Brand 2014). Implementation of SGMA is expected to slow or arrest groundwater depletion, reduce subsidence, and maintain or improve groundwater quality levels. In order to achieve this result, implementation of the GSPs prepared under SGMA will reduce the amount of groundwater that users currently withdraw, including agricultural water users. As a result, large areas of agricultural land are predicted to come out of agricultural production to be retired (Kelsey et al. 2018, Hanak et al. 2017). This includes lands that receive surface water and depend on groundwater as a supplemental source, and those that are solely dependent on groundwater for their water supply.

Implementation of Alternatives 1 and 4 resource management plans could have cumulative operation impacts related to changes in agricultural water deliveries associated with the X2 position for the Summer-Fall Delta Smelt Habitat Action. Mitigation Measure AG-1 could reduce effects by encouraging water agencies to diversify their water portfolios, thus increasing likelihood that water users would have adequate water. Mitigation Measure AG-2 would encourage agencies with discretionary land use approval powers to require land or conservation easement grants or payment of in-lieu fees to mitigate conversion of agricultural land to nonagricultural use, thus increasing protection on remaining agricultural land with the intention of minimizing future conversion. The contribution of Alternative 1 to conditions resulting in conversion of irrigated agricultural farmland would not be substantial with respect to water deliveries. In the case of cumulative projects anticipated to potentially generate temporary reductions in water supply deliveries or reduce surplus water supply availability to neighboring water users, the Alternative 1 improvement to water supply deliveries for many water users would help to reduce the severity of any potential cumulative effect. For those users who would not see improvements in water supply deliveries under this alternative, the potential changes in water supply deliveries under this alternative would not contribute to any cumulative water supply impacts because of Alternative 1's similarity to the No Action Alternative. Implementation of Alternative 4 resource manage plans and water efficiency measures could have cumulative operation impacts related to reduced agricultural water deliveries and increased water use efficiency measures. Mitigation Measure AG-1 could reduce effects by encouraging water agencies to diversify their water portfolios, thus increasing likelihood that water users would have adequate water. Measure AG-2 would encourage agencies with discretionary land use approval powers to require land or conservation easement grants or payment of in-lieu fees to mitigate conversion of agricultural land to nonagricultural use, thus increasing protection on remaining agricultural land with the intention of minimizing future conversion. However, despite mitigation, the contribution of Alternative 4 to conditions resulting in conversion of irrigated agricultural farmland would be substantial.

In addition, several thousand acres are proposed for restoration under Alternatives 1 and 3 restoration measures. These proposed restoration actions, in combination with restoration actions proposed under the cumulative projects and other existing pressures on agricultural farmland, would result in a substantial adverse effect on irrigated agricultural land as a result of construction. Measure AG-2 would encourage agencies with discretionary land use approval powers to require land or conservation easement grants or payment of in-lieu fees to mitigate conversion of agricultural land to nonagricultural use, thus increasing protection on remaining agricultural land with the intention of minimizing future conversion. However, despite mitigation, the contribution of Alternatives 1 and 3 to conditions resulting in conversion of irrigated agricultural farmland would be substantial.

Collectively, the cumulative projects and Alternatives 1, 3, and 4 could potentially adversely affect agriculture by increasing water flows for fish or acquiring agricultural land for habitat restoration, simultaneously decreasing water availability for agriculture, resulting in a cumulative impact. The alternatives' contribution to this cumulative impact would be substantial.

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Appendix S Recreation Technical Appendix

This appendix documents the recreation technical analysis to support the impact analysis in this environmental impact statement (EIS).

S.1 Background Information

S.1.1 Trinity River

The Trinity River Region includes the area along the Trinity River, including Trinity Lake, the Trinity River between Trinity Lake and Lewiston Reservoir, and Lewiston Reservoir. Many recreational opportunities occur in the Trinity River Region, including motorized and non-motorized boating, camping, day use activities such as wildlife viewing, hiking, swimming, and picnicking, and fishing.

S.1.1.1 *Trinity Lake*

Trinity Lake is a Central Valley Project (CVP) facility on the Trinity River located approximately 50 miles northwest of Redding, California. Trinity Lake is part of the Whiskeytown-Shasta-Trinity National Recreation Area (NRA) and the Shasta-Trinity National Forest. Recreational facilities and activities at Trinity Lake are administered by the U.S. Forest Service (USFS). When the water storage in Trinity Reservoir is at full capacity (water elevation is at 2,370 feet mean sea level [msl]), Trinity Lake has a surface area of 17,222 acres and 147 miles of shoreline (USFS 2014). Under current conditions, the water levels at Trinity Lake vary seasonally but elevations generally remain between 2,275 and 2,325 msl and the lake achieves full capacity only in very wet years. Elevations are such that water access is possible at most recreational locations during the spring and summer when recreational opportunities are in highest demand.

Boating, windsurfing, and fishing primarily occur in the northern part of the lake near Trinity Center. Houseboats, motorboats, waterskiing primarily occur in the southern part of the lake. There are six public boat ramps on Trinity Lake, as summarized in Table S.1-1.

Table S.1-1. Trinity Lake Boat Ramps

Boat Ramp	Comments	Useable Elevations (feet mean sea level)
Bowerman	–	2,370 to 2,320
Clark Spring	Americans with Disabilities Act accessible boat loading platform	2,370 to 2,324
Fairview	–	2,370 to 2,313
Minersville	–	65 to 200
Stuart Fork	–	2,370 to 2,338
Trinity Center	–	2,370 to 2,300

Source: USFS 2014

A boating safety issue that arises with fluctuations in water levels is the depth to surface of submerged obstacles. When the water level decreases, many rocks, shoals, and islands are much closer to the water surface and can be easily struck by boats. When the water level rises, debris and obstacles that were previously easily visible may be dangerously out of sight and struck by boats (Reclamation 2014a).

Trinity Lake has three marinas and two moorage facilities; the USFS can permit up to 1,000 boat slips at these facilities (USFS 2014). At Trinity Lake, 637 of the boat slips have been permitted, leaving availability for an additional 363 boat slips. Commercial houseboats are available for rent at four of the marinas. Trinity Lake shoreline includes approximately 32 miles of prime houseboating areas, where a density of 4 houseboats per mile can reside, and 18.5 miles of secondary houseboating areas, where a density of 2 houseboats per mile can reside. USFS issues permits for houseboats and privately-owned recreational occupancy vehicles that use the water overnight. At Trinity Lake, up to 99 permits for privately owned vessels and 85 permits for commercially owned vessels may be issued each year. The three marinas and two moorage facilities located at Trinity Lake are summarized in Table S.1-2.

Table S.1-2. Trinity Lake Marinas and Moorage Facilities

Marina and Moorage Facility	Number
Cedar Stock Resort & Marina	31 commercial and 220 private slips, including 10 commercial houseboats
KOA Campground	15 commercial and 110 private slips
Pinewood Cove Docks	52 private slips
Trinity Alps Marina	31 commercial and 63 private slips, including 25 commercial houseboats
Trinity Center Marina	80 private slips

Source: USFS 2014

The Trinity Unit of the Whiskeytown-Shasta-Trinity National Recreation Area includes many campground sites, including campgrounds for group camping opportunities (USFS 2014), as summarized in Table S.1-3. There are other campgrounds in the upper elevations of the Trinity Lake watershed that are not directly or indirectly affected by changes in surface water elevations.

Table S.1-3. Trinity Lake Campgrounds

Campground	Comments	Number of Campsites
Alpine View	–	53
Bushytail	–	11
Captain’s Point	Boat-in campground	3
Clark Springs	–	21
Fawn	Group campground	60
Hayward Flat	–	98
Jackass Springs	–	10
Mariner’s Roost	Boat-in campground	7
Minersville	–	14
Ridgeville	Boat-in campground	10
Ridgeville Island	Boat-in campground	3
Stoney Creek	Group campground	10
Stoney Point	–	15
Tannery Gulch	–	82

Source: USFS 2014

Trinity Lake recreational areas also include day use activities such as picnicking, swimming, and other recreational opportunities, as summarized in Table S.1-4. The locations for shoreline day use activities are limited because of the steep and rocky elevations at the shorelines. To develop two swimming beaches at Trinity Lake, the rocky shorelines were covered with sand and/or decomposed granite at a specific elevation. Seasonal fluctuations in water level make accessing these locations more difficult.

Table S.1-4. Trinity Lake Day Use Areas

Day Use Area	Comments	Number
Clark Springs Day Use and Beach	Picnicking, swimming	34 picnic sites
North Shore Vista	Vistas, interpretative site	–
Osprey Info Site	Vistas, interpretative site	–
Stoney Creek	Picnicking, swimming	4 picnic sites
Tanbark Picnic	Picnicking	8 picnic sites
Trail of Trees	Interpretative trail at Tannery Gulch Campground	1-mile roundtrip trail
Trinity Lakeshore Trail	Trail	8-mile roundtrip trail
Trinity Vista	Vistas, interpretative site	–

Source: USFS 2014

Trinity Lake is stocked several times per year with non-native fish species, including Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), Rainbow Trout (*Oncorhynchus mykiss*), Brown Trout (*Salmo trutta*), Chinook Salmon (*Oncorhynchus tshawytscha*), and Kokanee Salmon (*Oncorhynchus nerka*) (USFS 2014). White Catfish (*Ameiurus catus*), Brown Bullhead (*Ameiurus nebulosus*), Green Sunfish (*Lepomis cyanellus*), Bluegill (*Lepomis macrochirus*), Klamath Smallscale Sucker (*Catostomus rimiculus*), and Pacific Lamprey (*Entosphenus tridentatus*) also are also present but are not generally considered as part of the recreational fishing opportunities. Wildlife viewing opportunities extend throughout the Trinity Lake area, including viewing of bald eagles (*Haliaeetus leucocephalus*), black-tailed deer (*Odocoileus hemionus columbianus*), black bear (*Ursus americanus*), gray squirrel, rabbit, turkey, and California quail (*Callipepla californica*).

S.1.1.2 *Lewiston Reservoir*

Lewiston Reservoir is a CVP facility on the Trinity River located immediately downstream of the Trinity Dam. Lewiston Reservoir is part of the Whiskeytown-Shasta-Trinity National NRA and the Shasta-Trinity National Forest. Recreational facilities and activities are administered by USFS. When the water storage in the Lewiston reservoir is at full capacity (the water elevation is at 1,874 feet msl), the reservoir has a surface area of 759 acres and 15 miles of shoreline (USFS 2014).

The water levels at Lewiston Reservoir are stable because it is used as a regulating reservoir for releases to downstream uses. Water is diverted from the lower outlets in Trinity Lake downstream to Lewiston Reservoir to provide cold water to Trinity River. In addition, Lewiston Reservoir supplies water to Whiskeytown Lake via the Clear Creek Tunnel, which is activated when water levels in Whiskeytown Lake decrease. Recreational opportunities in Lewiston Reservoir include boating and fishing; however, there are fewer opportunities for swimming and waterskiing compared to Trinity Lake. Lewiston Reservoir does not support houseboats. There is one boat ramp, as well as one marina and one moorage facility at Lewiston Reservoir, as summarized in Tables S.1-5 and S.1-6, respectively.

Table S.1-5. Lewiston Reservoir Boat Ramp

Boat Ramp	Comments	Open until Lake Drawdown (feet)
Pine Cove	Open all year	Lake level is constant

Source: USFS 2014

Table S.1-6. Lewiston Lake Marina and Moorage Facilities

Marina and Moorage Facility	Number
Lakeview Terrace Docks	14 commercial and 7 private slips
Pine Cove Marina	20 commercial and 34 private slips

Source: USFS 2014

The Whiskeytown-Shasta-Trinity NRA includes campsites near the Lewiston Reservoir shoreline, including campgrounds for group camping opportunities (USFS 2014), as summarized in Table S.1-7. Lewiston Reservoir recreational areas also include day use activities such as picnicking, swimming, and other recreational opportunities, as summarized in Table S.1-8. Because the water surface elevations are more stable in Lewiston Reservoir than Trinity Lake, areas where day use activities occur are more vegetated along the shoreline.

Table S.1-7. Lewiston Lake Campgrounds

Campground	Number of Campsites
Ackerman	51
Cooper Gulch	5
Mary Smith	17
Tunnel Rock	6

Source: USFS 2014

Table S.1-8. Lewiston Lake Day Use Areas

Day Use Area	Comments	Number
Baker Gulch Trail	Trail	0.2-mile trail
Lewiston Vista	Vistas, interpretative site	–
North Lakeshore Trail	Trail	2-mile trail
Pine Cove	Picnic	2 picnic sites
South Lakeshore Trail	Trail	1-mile trail

Source: USFS 2014

Lewiston Reservoir fishing opportunities include Smallmouth Bass, Rainbow Trout (stocked annually), Brown Trout, Three-spine Stickleback, Golden Shiner, and Kokanee Salmon (USFS 2014). Klamath Smallscale Sucker, and Pacific Lamprey also are present but are not generally considered as part of the recreational fishing opportunities. Wildlife viewing opportunities extend throughout the Lewiston Reservoir area, including viewing of bald eagles, black-tailed deer, river otter (*Lontra canadensis*), ring-tailed cats (*Bassariscus astutus*), raccoon, California quail, and the occasional western pond turtle (*Actinemys marmorata*). Waterfowl use Lewiston Reservoir throughout the year, with increased populations in the winter.

S.1.2 Sacramento River

Recreational opportunities in the Sacramento Valley upstream of the Sacramento-San Joaquin Delta (Delta) that are influenced by CVP and State Water Project (SWP) operations occur at Shasta Lake; Keswick Reservoir; Whiskeytown Lake; Sacramento River, between Keswick Dam and the Delta; Lake Oroville and Thermalito Afterbay; Yuba River, from between New Bullards Bar and the Feather River; Bear River, between Camp Far West Reservoir and Feather River; Feather River, between Thermalito Dam and Sacramento River; Folsom Lake and Lake Natoma; American River, between Nimbus Dam and Sacramento River; and wildlife refuges that use CVP water supplies.

S.1.2.1 *Shasta Lake*

Shasta Lake is a CVP facility on the Sacramento River that is located near Redding. Shasta Lake is part of the Whiskeytown-Shasta-Trinity NRA and the Shasta-Trinity National Forest. Recreational facilities and activities at Shasta Lake are administered by USFS. When the water storage in the lake is at full capacity (water elevation is at 1,067 feet msl), Shasta Lake has a surface area of approximately 30,000 acres and 365 miles of shoreline (United States Department of the Interior, Bureau of Reclamation [Reclamation] 2014; USFS 2014).

Boating, waterskiing, other water sports, and fishing occur at many locations at the lake. Many types of boats are used, including fishing boats, deck boats, houseboats, cabin cruisers, pontoon boats, personal watercraft, runabouts, and ski boats (Reclamation 2014a; USFS 2014). There are seven public boat ramps on Shasta Lake, as summarized in Table S.1-9.

Table S.1-9. Shasta Lake Boat Ramps

Boat Ramp	Comments	Useable Elevations (feet mean sea level)
Antlers	Americans with Disabilities Act accessible boat loading platforms	1,067 to 992
Bailey Cove	–	1,067 to 1,017
Centimudi	–	1,067 to 857
Hirz Bay	–	1,067 to 972
Jones Valley	–	1,067 to 857
Packers Bay	–	1,067 to 952
Sugar Loaf	–	992 to 907

Source: USFS 2014

A boating safety issue that arises with fluctuations in water levels is the depth to surface of submerged obstacles. When the water level decreases, many rocks, shoals, and islands are much closer to the water surface and can be easily struck by boats. When the water level rises, debris and obstacles that were previously easily visible may be dangerously out of sight and struck by boats (Reclamation 2014a).

The marinas and moorage facilities located at Shasta Lake are summarized in Table S.1-10. The USFS can permit up to 3,000 boat slips at Shasta Lake (USFS 2014). Of the 3,000 possible boat slips, 2,600 have been permitted, leaving 400 additional boat slips to be permitted. Many commercial houseboats are available for rent at the marinas. Shasta Lake shoreline includes approximately 109 miles of prime houseboating areas and 153 miles of secondary houseboating areas. The USFS issues permits for houseboats and privately-owned recreational occupancy vehicles that use the water overnight.

Table S.1-10. Shasta Lake Marinas and Moorage Facilities

Marina and Moorage Facility	Number
Antlers Resort and Marina	101 commercial and 200 private slips, including 35 commercial houseboats
Bridge Bay Resort	140 commercial and 7,773 private slips, including 92 commercial houseboats
Digger Bay Marina	75 commercial and 145 private slips, including 50 commercial houseboats
Holiday Harbor	95 commercial and 330 private slips, including 70 commercial houseboats
Jones Valley Marina	90 commercial and 99 private slips, including 64 commercial houseboats
Packers Bay Marina	51 commercial slips, including 26 commercial houseboats
Shasta Lake RV Resort	22 private slips
Shasta Marina	54 commercial and 139 private slips, including 24 commercial houseboats
Silverthorn Resort Marina	59 commercial and 113 private slips, including 35 commercial houseboats
Sugarloaf Cottages	16 private slips
Sugarloaf Marina	41 commercial and 40 private slips, including 21 commercial houseboats
Tsasdi Resort	30 private slips

Source: USFS 2014

The Shasta Unit of the Whiskeytown-Shasta-Trinity NRA includes many campsites, including group campsites (USFS 2014), as summarized in Table S.1-11. Seasonal fluctuations in water elevations change the distance from the campsites to the shoreline. There are other campgrounds within the upper elevations of the Shasta Lake watershed that are not directly or indirectly affected by changes in surface water elevations.

Table S.1-11. Shasta Lake Campgrounds

Campground	Comments	Number of Campsites
Antlers	–	59
Arbuckle Flat	Boat-in campground	11
Beehive	Shoreline campground	No specified number
Bailey Cove	–	7
Dekkas Rock	Group campground	60 group sites
Ellery Creek	–	19
Gooseneck Cove	Boat-in campground	8
Green’s Creek	Boat-in campground	9
Gregory Creek	Shoreline campground	18
Hirz Bay	Individual and group campground	48 individual sites and 200 group sites
Jones Valley (Upper & Lower)	Shoreline campground at inlet	21
Lakeshore East	–	26

Campground	Comments	Number of Campsites
Lower Salt Creek	Shoreline campground	No specified number
Mariners Point	Shoreline campground	No specified number
McCloud Bridge	–	14
Moore Creek	Individual and group campground	12 individual sites, 90 group sites
Nelson Point	Individual and group campground	8 individual sites, 60 group sites
Oak Grove	–	45
Pine Point	Individual and group campground	14 individual sites, 100 group sites
Ski Island	Boat-in campground	23

Source: USFS 2014

Shasta Lake recreational areas also include day use activities such as picnicking, swimming, and other recreational opportunities, as summarized in Table S.1-12. The locations for shoreline day use activities are limited because of the steep and rocky elevations at the shorelines. Uses of these locations are less desirable when water elevations decline.

Table S.1-12. Shasta Lake Day Use Areas

Day Use Area	Comments	Number
Bailey Cove	Picnic, trail	9 picnic sites, 3.1-mile trail
Clikapudi	Trail	8-mile trail with 1-mile advanced mountain bike loop
Dekkas Rock	Picnic	5 picnic sites
Dry Fork Creek	Trail	4.7-mile trail
Fisherman's Point	Picnic, trail	7 picnic sites, 0.5-mile trail
Hirz Bay	Trail	1.6-mile trail
McCloud Bridge	Picnic	5 picnic sites
Packers Bay	Trail	4 trails: 0.4- to 2.8-miles each
Potem Falls	Trail	0.3-mile trail
Samwel Cave Nature Trail	Interpretative trail	1-mile trail
Sugarloaf	Trail	1-mile trail

Source: USFS 2014

Recreational opportunities available at the Shasta Dam Visitors Center include picnicking and free tours of Shasta Dam.

Fishing is also popular at Shasta Lake, performed mostly by boat as opposed to from the shoreline. Anglers can catch warmwater and coldwater fish species year-round, owing to the summer stratification of the lake into a warm layer above a coldwater pool (Reclamation 2014a). Shasta Lake warmwater fishing opportunities include Black Bass (*Micropterus salmoides*), Smallmouth Bass, Largemouth Bass, Spotted Bass (*Micropterus punctulatus*), Black Crappie (*Pomoxis nigromaculatus*), Channel Catfish (*Ictalurus punctatus*), and Bluegill (*Lepomis macrochirus*) (USFS 2014). There are many bass tournaments at Shasta Lake each summer. The cooler water strata supports fishing for Rainbow Trout and Chinook Salmon.

S.1.2.2 *Keswick Reservoir*

Keswick Reservoir is a CVP afterbay (a type of reservoir that receives water from an upstream waterbody) that extends 9 miles along the Sacramento River from Shasta Dam to Keswick Dam. Recreational facilities and activities at Keswick Reservoir are administered by the Bureau of Land Management (BLM), Shasta County, and USFS for Reclamation. The maximum water storage elevation at the top of the Keswick Dam spillway is 587 feet msl (Reclamation 2019a). The water level fluctuates frequently in Keswick Reservoir, depending on the operations of Shasta Dam.

Water-related recreational activities include boating, fishing, and water sports. The Keswick boat ramp, operated by BLM, is located on the western shoreline at the south end of the reservoir (BLM 2005).

There are several trails along Keswick Reservoir and areas for off-highway vehicles (OHVs) with camping allowed at one of the locations (BLM 2005; BLM 2010). The Sacramento Rail Trail extends from Moccasin Creek, below Shasta Dam, to Redding, along the western shoreline of Keswick Reservoir and the Sacramento River downstream of Keswick Dam. The Fisherman Trail extends along the shoreline from the lower Sacramento Rail Trail to Keswick Dam. The F.B. Trail extends from the Ribbon Bridge, downstream of the Keswick Dam, to Walker Mine Road, along the eastern side of the Keswick Reservoir. There are several other trails at higher elevations above Keswick Reservoir, including the Hornbeck Trail, Upper and Lower Sacramento Ditch Trails, Flanagan Trail, and Chamise Peak Trail.

The Chappie-Shasta OHV Area provides over 250 miles of roads within approximately 52,000 acres (Reclamation 2014a). The area is accessed through two staging areas. The Chappie-Shasta OHV Staging Area and Shasta Campground includes a staging area for day use activities, including picnics and 27 campsites (BLM 2005). This site is located along the western shoreline of Keswick Reservoir, at the trailhead of the Sacramento Rail Trail at Moccasin Creek. The Copley Mountain OHV Staging Area is located along the western shoreline of Keswick Reservoir, about midway between Shasta and Keswick Dams. This site also provides a staging area for day use activities, including picnics.

Fishing opportunities are primarily for German Brown Trout and Rainbow Trout.

S.1.2.3 *Whiskeytown Lake*

Whiskeytown Lake is a CVP facility on Clear Creek that is located approximately 8 miles west of Redding on the eastern slope of the Coast Range. Whiskeytown Lake is part of the Whiskeytown-Shasta-Trinity NRA. Recreational facilities and activities are administered by the National Park Service (NPS). When water storage in the reservoir is at full capacity (water elevation is at 1,210 feet msl), Whiskeytown Lake has a surface area of 3,250 acres and 36 miles of shoreline (NPS 2012; Reclamation 2019b).

Boating, waterskiing, sailing, kayaking, canoeing, swimming, and fishing occur at many locations at the lake. Boat ramps are available at Oak Bottom, Brandy Creek, and Whiskey Creek, and at marinas at Oak Bottom and Brandy Creek (NPS 2012), as summarized in Table S.1-13.

Table S.1-13. Whiskeytown Lake Boat Ramps

Boat Ramp	Useable Elevations (feet mean sea level)
Brandy Creek	1,210 to 1,190
Oak Bottom	1,210 to 1,195
Oak Bottom Marina	1,210 to 1,198
Whiskey Creek	1,210 to 1,195

Source: NPS 2012

The lake level is relatively stable and does not affect the functionality of the boat ramps until late summer or early fall.

The Whiskeytown Unit of the Whiskeytown-Shasta-Trinity NRA includes many campsites, including campgrounds for group camping opportunities (NPS 2012), as summarized in Table S.1-14.

Table S.1-14. Whiskeytown Lake Campgrounds

Campground	Comments	Number of Campsites
Brandy Creek RV	–	37 RV sites
Brandy Creek	Primitive campground	2 sites
Coggins Park	Primitive campground	1 site
Crystal Creek	Primitive campground near Crystal Creek	2 sites
Dry Creek	Group campground	2 sites; 50 people each
Horse Camp	Primitive campground	2 sites
Oak Bottom Tent and RV	–	98 tent sites, 22 RV sites
Peltier Bridge	Primitive campground near Clear Creek	9 sites
Sheep Camp	Primitive campground	4 sites

Source: NPS 2012
RV = recreational vehicle

Whiskeytown Lake recreational areas also include day use activities such as picnicking, swimming, and other recreational opportunities, as summarized in Table S.1-15. Shoreline day use activities are limited at some locations because of the steep and rocky elevations at the shorelines.

Table S.1-15. Whiskeytown Lake Day Use Areas

Day Use Area	Comments	Number
Boulder Creek Falls	Moderate and advanced trails	1-mile (moderate) trail, 2.75-mile (advanced) trail
Brandy Creek Beach and Falls	Picnicking, swimming, 2 moderate trails	1.6- and 1.5-mile trails
Buck Hollow	Easy trail	1-mile trail
Camden Water Ditch	Easy trail	1.1-mile trail
Clear Creek Canal and Vista	Picnicking, 2 moderate trails	2.4- and 4.5-mile trails
Crystal Creek Water Ditch and Falls	Picnicking, easy and Americans with Disabilities Act (ADA)-accessible trails	0.75-mile (easy) trail, 0.3-mile (ADA-accessible) trail
Davis Gulch	Moderate trail	3.3-mile trail
East Beach	Swimming	–
Guardian Rock	Easy and ADA-accessible trails	1-mile (easy) trail, 0.25-mile (ADA-accessible) trail
James K. Carr Trail	Advanced trail	1.7-mile trail
Judge Francis Carr Powerhouse	Picnic	–
Kanaka Peak	Advanced trail	3.6-mile trail
Logging Camp	Easy trail	1-mile trail

Day Use Area	Comments	Number
Mill Creek	Advanced trail	6.1-mile trail
Mt. Shasta Mine Loop	Moderate trail	3.5-mile trail
Mule Mountain Pass	Moderate trail	4.4-mile trail
Oak Bottom Beach	Picnicking, swimming	–
Oak Bottom Ditch	Easy trail	2.75-mile trail
Papoose Pass	Advanced trail	5.5-mile trail
Peltier	Moderate trail	1.75-mile trail
Rich Gulch	Advanced trail	1.8-mile trail
Salt Creek Loop	Moderate trail	1.8-mile trail
Salt Gulch	Advanced trail	1.6-mile trail
Shasta Divide Nature Trail	Moderate trail	0.4-mile trail
Whiskey Creek	Group picnic area, swimming	–

Source: NPS 2012
ADA = Americans with Disabilities Act

Additional recreational opportunities are provided at the Whiskeytown Visitors Center, including exhibits highlighting the history and development of the Whiskeytown NRA.

Fishing opportunities at Whiskeytown Lake include Brown Trout, Rainbow Trout, Kokanee Salmon, Smallmouth Bass, Largemouth Bass, Spotted Bass, Bluegill, Crappie and Sacramento Pikeminnow (*Ptychocheilus grandis*) (NPS n.d.).

S.1.2.4 *Sacramento River from Keswick Dam to the Delta*

The Sacramento River, from Keswick Dam to the Delta, is divided into three reaches for discussion in this section: Keswick Reservoir to Red Bluff, Red Bluff to the Feather River, and the Feather River confluence with the Delta (near the City of West Sacramento).

S.1.2.4.1 Sacramento River from Keswick Dam to Red Bluff

The upper reach of the Sacramento River flows for approximately 60 miles from Keswick Dam to Red Bluff, California (Reclamation 2004). Water-related recreational activities include motorized and non-motorized boating. Boating opportunities include motorboating, jet skiing, kayaking, canoeing, and whitewater rafting in some locations (Reclamation 2014a; Reclamation et al. 2002). Other activities include picnicking, camping, and wildlife viewing. River flows can increase for short periods when water is being released from the CVP facilities and during and following storm events in the upper Sacramento River watershed. Flows in the late fall months may decrease to levels that are not favorable for boating. Water temperatures in this reach are generally cold throughout the year.

Much of the land along the Sacramento River between Balls Ferry, California and Red Bluff is owned and managed by BLM (Reclamation 2014a). Public access points are provided by the Cities of Redding and Anderson and BLM. Lake Redding Park, Turtle Bay, and Anderson River Park are some of the prominent access areas. Boat launching can occur at eight public boat ramps and two smaller launch facilities, including Turtle Bay, Caldwell Park, and South Bonneyview in Redding; Ball Ferry; the Battle Creek confluence with the Sacramento River; Bend Bridge; and Red Bluff River Park in Red Bluff.

There are two easy whitewater river reaches: between Keswick Dam and the Anderson-Cottonwood Irrigation District Diversion Dam, and between Anderson River Park and William B. Ide Adobe State Historic Park.

Camping facilities include public campgrounds along the Sacramento River at Lake Red Bluff Recreation Area (Reclamation 2014a).

There are trails or trail access and picnicking facilities with access to the river in this reach of the Sacramento River (Reclamation 2014a). Trails include the 13-mile Sacramento River Trail, between Keswick Dam and Turtle Bay Park in Redding. Many of the picnicking locations are managed by local municipalities, including the Cities of Redding, Anderson, and Red Bluff. Coleman National Fish Hatchery, located along Battle Creek near the Sacramento River, provides recreational and educational opportunities.

Fishing opportunities along the upper Sacramento River include Chinook Salmon, steelhead, Rainbow Trout, Sunfish, and Striped Bass (Reclamation 2014a). Fishing can occur from boats positioned along the Sacramento River and at four public fishing access points: Turtle Bay East, Kapusta Property, Deschutes Road, Reading Island. Sites that provide fishing and trail access on are Diestlehorst Pasture River Access, Jellys Ferry, and Sacramento River Island.

The Mouth of Cottonwood Creek Wildlife Area is operated by California Department of Fish and Wildlife (CDFW). This area provides viewing opportunities for Swainson’s hawk, bald eagle, ringtail cat, river otter, and other birds and mammals (Reclamation 2014a). Hunting opportunities on BLM land occur at Inks Creek, Massacre Flat, Perry Rifle, Paynes Creek, Bald Hill, and Iron Canyon. Commonly hunted game includes quail, dove, waterfowl, deer, pig, turkey, and bear (Reclamation 2014a).

S.1.2.4.2 Sacramento River from Red Bluff to the Feather River

The middle reach of the Sacramento River flows approximately 160 miles from Red Bluff to the confluence with the Feather River (Reclamation 2004). Water-dependent recreational activities along the middle reach include boating, swimming, and fishing (Reclamation 2005a). Water-contact recreational activities are popular in this section of the river because of relatively warm water. Public access points are provided along this reach by California Department of Parks and Recreation (State Parks), and Tehama, Glenn, Colusa, and Sutter Counties (Reclamation 2004, 2005a). River access in this reach is primarily provided at private fishing access points, marinas, and resorts.

The three State Parks properties along the middle reach include the Woodson Bridge State Recreation Area (SRA), Bidwell-Sacramento River State Park, and the Colusa-Sacramento River SRA (CDFW 2004; Reclamation 2014a). Public access for fishing, hunting, and wildlife viewing also is provided at the CDFW Fremont Weir Wildlife Area (CDFW 2018c).

Fishing opportunities include Chinook Salmon, steelhead, trout, American Shad (*Alosa sapidissima*), Sturgeon, Catfish, and Striped Bass (*Morone saxatilis*) (Reclamation 2005a).

Seasonal game hunting opportunities include ring-necked pheasants, California quail, various species of ducks and geese, mourning doves (*Zenaida macroura*), and mule deer (*Odocoileus hemionus*) (Reclamation 2014a).

S.1.2.4.3 Sacramento River from the Feather River to the Northern Delta Boundary

The lower reach of the Sacramento River flows for approximately 20 river miles between its confluence with the Feather River to immediately downstream of the confluence with the American River (U.S. Army Corps of Engineers [USACE] 1991). Most of this reach of the Sacramento River flows along private property.

Water-related recreational activities in this reach include boating, swimming and beach use, and fishing. Picnicking, biking, and sightseeing are also available. Public access is provided by Yolo County at Elkhorn Regional Park (Yolo County); Sacramento County and the City of Sacramento at Discovery Park and Miller Park, respectively (Sacramento County 2012; Reclamation 2005a); and by the City of West Sacramento at Broderick Boat Ramp (West Sacramento 2016).

Fishing opportunities in this area include Chinook Salmon, steelhead, American Shad, Sturgeon, Catfish, and Striped Bass (Reclamation 2004, 2005a).

S.1.2.5 *Sacramento Valley Wildlife Refuges*

Wildlife refuges in the Sacramento Valley that rely on CVP water supplies include the Sacramento National Wildlife Refuge (NWR) Complex; Sacramento, Delevan, Colusa, and Sutter NWRs; and the Gray Lodge Wildlife Area (Reclamation 2012). Water-related recreational activities include wildlife viewing, hiking along the refuge wetlands, and waterfowl hunting. Shoreline fishing opportunities at Gray Lodge Wildlife Area include Black Crappie, Largemouth Bass, Green Sunfish, Logperch, Channel Catfish, and Common Carp (*Cyprinus carpio*) (CDFW 2018a).

S.1.3 Clear Creek

The initial reaches of Clear Creek downstream of Whiskeytown Dam are located within the Whiskeytown-Shasta-Trinity NRA. The remaining portions of Clear Creek flow to the Sacramento River through lands owned by BLM and private owners. All of these reaches are located within Shasta County and the most eastern reaches are within the City of Redding.

BLM has established the Clear Creek Greenway along a large portion of Lower Clear Creek from within the Whiskeytown-Shasta-Trinity NRA to the Sacramento River (BLM n.d.). The area also includes the Horsetown-Clear Creek Preserve, which is a private-public partnership recreation area.

Hiking, picnicking, kayaking, swimming, fishing, and gold panning occur along lower Clear Creek (Sacramento River Watershed Project [SRWP] 2010). The Clear Creek Greenway includes ten trails and eight picnic areas (BLM n.d.). Hunting is allowed in the Swasey and Muletown Road areas of the Clear Creek Greenway. Fishing opportunities include steelhead, Chinook Salmon, carp, suckers, Bluegill, bass, and Sacramento Pikeminnow (SRWP 2010).

S.1.4 Feather River

Antelope Lake, Lake Davis, and Frenchman Lake (located in the Upper Feather River), Lake Oroville and Thermalito Forebay and Afterbay, and the Lower Feather River, are located within areas in the Feather River watershed that could be affected by changes in CVP and/or SWP operations.

S.1.4.1 *Upper Feather River Lakes*

The Upper Feather River lakes, including Antelope Lake, Lake Davis, and Frenchman Lake, are SWP facilities on the Upper Feather River upstream of Lake Oroville. These lakes are part of the Plumas National Forest (California Department of Water Resources [DWR] 2013a). Recreational facilities and activities at all three lakes are managed by private concessionaires under contract with the Plumas National Forest.

When water storage in Antelope Lake is at full capacity (water elevation is at 5,002 feet msl), the lake has a surface area of 930 acres and 15 miles of shoreline (DWR 2013a; USFS 2011). Available recreation activities include boating, waterskiing, swimming, fishing, camping, and picnicking. There is a boat ramp, three fishing access sites, and a picnic area. There are three campgrounds at Antelope Lake, including Boulder Creek, Lone Rock, and Long Point. There are approximately 194 campsites and 4 group campsites at the 3 campgrounds open for use between May and October. Fishing opportunities in Antelope Lake include Rainbow Trout, Brook Trout (*Salvelinus fontinalis*), crappie, Channel Catfish, Smallmouth Bass, and Largemouth Bass. Hunting opportunities around Antelope Lake include mule deer and black-tailed deer.

When water storage in Lake Davis is at full capacity (water elevation is at 5,785 feet msl), the lake has a surface area of 4,030 acres and 32 miles of shoreline (DWR 2013a; USFS 2006a). Recreational activities include boating, fishing, camping, and picnicking. There are boat ramps at Lightning and Honker Cove, a car-top boat launch (used for small water craft that can be transported on the roof of a car or truck) at Mallard Cove, a fishing access site, and a picnic area. There are three campgrounds at Lake Davis, including Grizzly, Grasshopper, and Lightning Tree. There are approximately 180 campsites at the 3 campgrounds open for use between May and October. Fishing opportunities in Lake Davis include Rainbow Trout, German Brown Trout (*Salmo trutta*), Eagle Lake Trout (*Oncorhynchus mykiss aquilarum*), Brown Bullhead, and Largemouth Bass. Hunting opportunities around Lake Davis include mule deer and black-tailed deer.

When Frenchman Lake is at full capacity (water elevation is at 5,588 feet msl), it has a surface area of 1,580 acres and 21 miles of shoreline (DWR 2013a; USFS 2006b). Recreational activities include boating, waterskiing, swimming, fishing, camping, picnicking, and ice fishing. There are two boat ramps (Frenchman and Lunker Point), six fishing access sites, and a picnic area. There are five campgrounds at Frenchman Lake, including Chilcoot, Cottonwood Springs, Frenchman, Spring Creek, and Big Cove. There are approximately 209 campsites and 2 group campsites at the 5 campgrounds open for use between May and October. Fishing opportunities in Frenchman Lake include Rainbow Trout, Brown Trout, Eagle Lake Trout, and Smallmouth Bass. Hunting opportunities around Frenchman Lake include deer and waterfowl.

S.1.4.2 *Lake Oroville and Thermalito Forebay and Afterbay*

Lake Oroville and Thermalito Forebay and Afterbay are SWP facilities on the Feather River. The upper North Fork arm of Lake Oroville is part of the Lassen National Forest, and the upper Middle Fork and South Fork arms of Lake Oroville are part of the Plumas National Forest. The Middle Fork Feather River (from Beckwourth, downstream of Lake Davis, to Lake Oroville) was designated as part of Public Law 90-542 (the Wild and Scenic Rivers Act) to be part of the National Wild and Scenic Rivers system on October 2, 1968. Recreational facilities and activities at the Lake Oroville Complex (including Lake Oroville and Thermalito Forebay and Afterbay) are managed by State Parks as part of the Lake Oroville SRA. When the Lake Oroville water storage is at full capacity (water elevation is at 900 feet msl), the lake has a surface area of 15,810 acres. Thermalito Forebay has a surface area of 630 acres. Thermalito

Afterbay has a surface area of 4,300 acres and 17 miles of shoreline when water elevation is at 136.5 feet msl (DWR 2007a, n.d.).

Recreational activities include boating, whitewater boating, camping, picnicking, and fishing (DWR 2007a). Boat types include kayaks, canoes, and fishing boats. Whitewater boating for intermediate to expert level boaters occurs on the Big Bend area of the North Fork Feather River when Lake Oroville elevations are sufficiently low to expose several miles of river. This portion of the North Fork Feather River forms the Upper North Fork arm of Lake Oroville. Generally, this area is exposed in the late fall months. Another whitewater area is located in the Bald Rock Canyon on the Middle Fork Feather River. This whitewater area is located upstream of the Middle Fork arm of Lake Oroville.

There are 11 boat ramps on Lake Oroville, as summarized in Table S.1-16. Two of the boat ramps are located at marinas (DWR 2007a).

Table S.1-16. Lake Oroville, Thermalito Forebay, and Thermalito Afterbay Boat Ramps

Location	Boat Ramp	Comments	Useable Elevations (feet mean sea level)
Lake Oroville	Bidwell Canyon	Day use area, marina with 280 berths and 400 mooring anchors	900 to 700
Lake Oroville	Dark Canyon	Car-top launching	900 to 765
Lake Oroville	Enterprise	–	900 to 835
Lake Oroville	Foreman Creek	Car-top launching	900 to approximately 700
Lake Oroville	Lime Saddle	Day use area, marina, including houseboat rentals	900 to 702
Lake Oroville	Loafer Creek	Boat-in campground	900 to 775
Lake Oroville	Monument Hill	Day use area	900 to approximately 700
Lake Oroville	Nelson Bar	Car-top launching	900 to 850
Lake Oroville	Spillway	Day use area	900 to 700
Lake Oroville	Stringtown Creek	Car-top launching	900 to 866
Lake Oroville	Vinton Gulch	Car-top launching	900 to 850
Thermalito Forebay	North Thermalito Forebay	Day use area, also used by California State University, Chico	Water elevation does not vary substantially
Thermalito Forebay	South Thermalito Forebay	Day use area	Water elevation does not vary substantially
Thermalito Afterbay	Larkin Road	Car-top launching	Water elevation does not vary substantially
Thermalito Afterbay	Oroville Wildlife Area	–	Water elevation does not vary substantially
Thermalito Afterbay	Thermalito Afterbay Outlet	Unsurfaced boat ramp	Water elevation does not vary substantially
Thermalito Afterbay	Wilbur Road	Unsurfaced boat ramp	Water elevation does not vary substantially

Sources: DWR 2006, 2007a

There are 16 campgrounds at Oroville Lake and the Thermalito complex (DWR 2007a), as summarized in Table S.1-17. During seasons when water elevations are lower than 850 feet msl, shoreline campgrounds at Bidwell Canyon, Lime Saddle, and Loafer Creek are more difficult to access.

Table S.1-17. Lake Oroville, Thermalito Forebay, and Thermalito Afterbay Campgrounds

Location	Campground	Comments	Number of Campsites
Lake Oroville	Bidwell Canyon	Campground	75
Lake Oroville	Bloomer Cove	Boat-in campground	5
Lake Oroville	Bloomer Group	Boat-in group campground	1 site; 75 people maximum
Lake Oroville	Bloomer Knoll	Boat-in campground	6
Lake Oroville	Bloomer Point	Boat-in campground	25
Lake Oroville	Craig Saddle	Boat-in campground	18
Lake Oroville	Floating Campsites	Boat-in campground	10 different locations; approximately 15 sites per location
Lake Oroville	Foreman Creek	Boat-in campground	26
Lake Oroville	Goat Ranch	Boat-in campground	5
Lake Oroville	Lime Saddle	Campground Group campground	44 6 (3 ADA-accessible)
Lake Oroville	Loafer Creek	Campground Group campground Equestrian campground	137 6 (ADA-accessible) 15
Thermalito Forebay	North Thermalito Forebay “En Route”	RV campground	15
Thermalito Afterbay	Oroville Wildlife Area	Primitive campground, sites not marked	Several

Sources: DWR 2006, 2007a
ADA = Americans with Disabilities Act

Lake Oroville recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table S.1-17. Because the shoreline is steep and rocky, day use activities can be limited during seasons when water elevations are lower than 850 feet msl.

Table S.1-18. Lake Oroville, Thermalito Forebay, and Thermalito Afterbay Day Use Areas

Location	Day Use Area	Comments	Number
Lake Oroville	Bidwell Canyon Saddle Dam trailhead	Trail, picnicking	4.9-mile trail (hiking and bicycling), 21 picnic sites
Lake Oroville	Chaparral Trail	Interpretative trail	0.2-mile trail
Lake Oroville	Dan Beebe Trail Saddle Dam, Lakeland Boulevard, Oro Dam Boulevard, and visitor center trailheads	Trail	14.3-mile trail (equestrian and hiking)
Lake Oroville	Lake Oroville Visitors Center	Visitors center, picnicking	18 picnic sites
Lake Oroville	Lime Saddle	Picnicking	13 picnic sites

Location	Day Use Area	Comments	Number
Lake Oroville	Loafer Creek	Trails, swimming, picnicking	3.2-mile trail (equestrian and hiking), 1.7-mile trail (hiking), 30 picnic sites
Lake Oroville	Model Aircraft Flying Facility	Aircraft staging, picnicking	6 picnic sites
Lake Oroville	Oroville Dam Overlook and Spillway Day Use Area	Trail, picnicking, shoreline fishing	1-mile trail along Oroville Dam crest, 8 picnic sites
Lake Oroville	Potter's Ravine	Trail	5.5-mile trail
Lake Oroville	Roy Rogers Trail	Trail	4-mile (equestrian and hiking)
Lake Oroville	Sewim Bo Trail	Trail (much of trail is outside action area), picnicking	0.5-mile trail (bicycle, equestrian, and hiking), 1 picnic site
Lake Oroville	Wyk Island Trail	Trail (ADA-accessible)	0.2-mile trail
Feather River downstream of Oroville Dam	Feather River Fish Hatchery	Hatchery, picnicking	1 picnic site
Oroville Dam Crest, Diversion Pool, Thermalito Forebay, and Thermalito Afterbay	Brad Freeman Trail Diversion Pool access road, East Hamilton Road, Powerhouse Road, Toland Road, and Tres Vias Road trailheads	Trail loop	41-mile trail (bicycle and hiking)
Thermalito Forebay	North Thermalito Forebay	Picnicking, swimming, en-route camping	117 picnic sites
Thermalito Forebay	South Thermalito Forebay	Picnicking, swimming, shoreline fishing	10 picnic sites
Thermalito Afterbay	Monument Hill	Picnicking, swimming, shoreline fishing	10 picnic sites
Oroville Wildlife Area	Rabe Road Shooting Range	Range and target shooting, picnicking	7 picnic sites
Oroville Wildlife Area	Clay Pit State Vehicular Recreation Area	Off-highway vehicle riding	–
Thermalito Afterbay	Thermalito Afterbay Outlet and Oroville Wildlife Area	Trails, picnicking, shoreline fishing, hunting	Several trails and day use areas

Sources: DWR 2006, 2007a
ADA = Americans with Disabilities Act

Fishing is popular at the Lake Oroville complex and is performed by boat and from the shoreline (DWR 2007a). Fishing opportunities in Lake Oroville include Smallmouth Bass, Largemouth Bass, Spotted Bass, Red-Eye Bass, Black Crappie, Bluegill, Green Sunfish, Channel Catfish, White Catfish, Coho Salmon, Rainbow Trout, and Brown Trout. In Thermalito Forebay, fish species include Brook Trout, Brown Trout, Rainbow Trout, and Chinook Salmon. In Thermalito Afterbay, fishing opportunities include Smallmouth Bass, Largemouth Bass, trout, Channel Catfish, White Catfish, and carp. Downstream in the Feather River, fishing opportunities include steelhead, Chinook Salmon, American Shad, Smallmouth Bass, Largemouth Bass, and White Sturgeon (*Acipenser transmontanus*).

Hunting opportunities occur around Thermalito Afterbay and/or the Oroville Wildlife Area for turkey (in the spring), dove, quail, waterfowl, pheasant, deer, squirrel, and rabbit.

S.1.4.3 *Feather River from Thermalito Afterbay/Oroville Wildlife Area to Sacramento River*

The Feather River flows from Thermalito Dam to approximately 40 miles downstream to the confluence with the Sacramento River (Reclamation 2004). The Feather River Wildlife Area, managed by CDFW, is located along the Feather River near the confluence with the Bear River. The Feather River Wildlife Area includes Abbott Lake, Star Bend, O'Connor Lakes, Lake of the Woods, and Nelson Slough Units, and Bobelaine Audubon Ecological Reserve (CDFW 2018b). The southern boundary of the wildlife area is located adjacent to the Sutter Bypass. In Sutter County, water-related recreational opportunities along the Feather River also include public access at Donahue Road Park, Tisdale Boat Ramp, Boyd's Pump boat ramp, Feather River Parkway, Yuba City Boat Ramp, Riverfront Park in Marysville, and Live Oak Park and Recreation Area (Sutter County 2011). There are several private facilities that offer camping, boating, and river access.

S.1.5 American River

Folsom Lake and Lake Natoma on the American River and the lower American River are located within areas in the American River watershed that could be affected by changes in CVP and/or SWP operations.

S.1.5.1 *Folsom Lake and Lake Natoma*

Folsom Lake is a CVP facility on the American River. The El Dorado National Forest is located in the upper American River watershed upstream of Folsom Lake. The State of California designated the North Fork American River, from the source to Iowa Hill Bridge upstream of Folsom Lake, as wild and scenic. Recreational facilities and activities in the Folsom Lake area are within the Folsom Lake SRA or the Folsom Powerhouse State Historic Park that are managed by State Parks. Recreational activities upstream of Folsom Lake occur on or adjacent to many lands owned by BLM, State Parks, and El Dorado County. When the water storage in Folsom Lake is at full capacity (water elevation is at 466 feet msl), it has a surface area of 11,450 acres and 75 miles of shoreline (State Parks and Reclamation 2003, 2007).

The upper extent of Lake Natoma is located about 1 mile downstream of Folsom Dam. Lake Natoma continues from the Rainbow Bridge to Nimbus Dam, about a 4-mile distance (State Parks and Reclamation 2003, 2007). Recreational facilities and activities at Lake Natoma area are part of the Folsom Lake SRA and managed by State Parks. When the water storage in Lake Natoma is at full capacity (water elevation is at 132 feet msl), the lake has a surface area of 540 acres and 14 miles of shoreline.

Water-related recreational activities at Folsom Lake include boating, jet skiing, waterskiing, windsurfing, rafting, sailing, canoeing, kayaking, swimming, and fishing (Reclamation 2005b; State Parks and Recreation 2003, 2007). The South Fork American River has 21 miles of whitewater boating that includes stretches ranging from beginner to stretches that are more appropriate for intermediate to expert boaters. Two reaches (both approximately 10 miles long) are the most popular: Upper Chili Bar to Lotus Shuttle and Lower Salmon Falls to Skunk Hollow (American Whitewater 2017). These reaches are moderately difficult and therefore appropriate for intermediate to advanced level rafters. Parking is available at put-ins and take-outs. Camping is available along the river as well.

Water-related activities at Lake Natoma generally only include paddling, rowing, and fishing because of a 5 mile-per-hour speed limit for motorized watercraft. California State University, Sacramento operates an aquatic center at Lake Natoma (Reclamation et al. 2006).

Folsom Lake Marina at Brown's Ravine is the only marina at Folsom Lake. There are six boat ramp facilities at Folsom Lake and three boat ramp facilities at Lake Natoma, as summarized in Table S.1-19.

Table S.1-19. Folsom Lake and Lake Natoma Boat Ramps

Location	Boat Ramp	Comments	Useable Elevations (feet mean sea level)
Folsom Lake	Beal's Point	Day use area Informal boat ramp	465 to 420
Folsom Lake	Brown's Ravine	Day use area Folsom Lake Marina with 685 wet slips and 175 dry storage slips	466 to 395
Folsom Lake	Folsom Point	–	466 to 406
Folsom Lake	Granite Bay	Day use area Largest boat ramp facility at Folsom Lake	466 to 360
Folsom Lake	Hobie Cove	–	426 to 375
Folsom Lake	Peninsula	Day use area	466 to 410
Folsom Lake	Rattlesnake Bar	–	466 to 425
Lake Natoma	Negro Bar	–	121 to 115
Lake Natoma	Nimbus Flat	Main boat ramp Informal boat ramp	128 to 115 128 to 120
Lake Natoma	Willow Creek	Informal boat ramp	125 to 115

Sources: Reclamation et al. 2006; State Parks and Reclamation 2003, 2007

Campgrounds are located at Folsom Lake and Lake Natoma, as summarized in Table S.1-20. During seasons when water levels are lower, campsites are farther from the shoreline.

Table S.1-20. Folsom Lake and Lake Natoma Campgrounds

Location	Campground	Comments	Number of Campsites
Folsom Lake	Beal's Point	–	49 campsites, 20 RV sites
Folsom Lake	Peninsula	Campground Boat-in campground	104 campsites
Lake Natoma	Negro Bar	Group campground	3 major campsites

Sources: State Parks and Reclamation 2003, 2007; Reclamation et al. 2006

Folsom Lake and Lake Natoma recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table S.1-21. The locations for shoreline day use areas are limited because of the steep and rocky elevations at the shorelines. These locations are less desirable for use when water elevations are low. The Jedediah Smith Memorial Trail begins at Beal's Point and extends along Lake Natoma to the confluence of the American River and Sacramento River, downstream of Nimbus Dam. The Pioneer Express Trail, which extends from the Auburn SRA to Beal's Point, is part of the Western States Pioneer Express Trail (a National Recreation Trail).

Table S.1-21. Folsom Lake and Lake Natoma Day Use Areas

Location	Day Use Area	Comments	Number
Folsom Lake	Beal's Point	Picnicking, swimming Trailhead for Jedediah Smith Memorial Trail	53 picnic sites in day use area 69 picnic sites at campground
Folsom Lake	Brown's Ravine Trail	Trail (to Old Salmon Falls)	12 miles
Folsom Lake	Darrington Trail	Trail	9 miles
Folsom Lake	Doton's Point ADA Trail	Trail	1 mile
Folsom Lake	Folsom Point	Picnicking, waterskiing Trail (to Brown's Ravine Trail)	50 picnic sites 4 miles
Folsom Lake	Folsom Powerhouse	Historic Site and Museum Trail	10 picnic sites 1 mile
Folsom Lake	Folsom Reservoir River Access Areas	Whitewater rafting (South Fork)	40 commercial rafting outfitters with 67 permits No permits for private boats
Folsom Lake	Granite Bay	Trail Picnicking, Swimming, fishing, equestrian, hiking	Several trails: 1 to 5 miles 100 picnic sites
Folsom Lake	Los Lagos Trail	Trail	1.5 miles
Folsom Lake	Old Salmon Falls	Swimming, equestrian, hiking Trailhead for Brown's Ravine and Sweetwater trails	–
Folsom Lake	Peninsula	Trail Picnicking	1 mile 6 picnic sites in day use area 104 picnic sites at campground
Folsom Lake	Pioneer Express Trail	Trail	21 miles
Folsom Lake	Rattlesnake Bar	Equestrian	–
Folsom Lake	Skunk Hollow and Salmon Falls	Whitewater rafting (South Fork)	–
Folsom Lake	Sweetwater Creek	Trailhead for Sweetwater Trail	–
Folsom Lake	Sweetwater Trail	Trail	2 miles
Lake Natoma	Lake Natoma Trails	Trail	Several trails: 1 to 10 miles
Lake Natoma	Lake Overlook	Trailhead for Lake Natoma Trail	–
Lake Natoma	Negro Bar	Picnicking, fishing, equestrian Trailhead for Lake Natoma Trail	32 picnic sites in day use area 17 at campground
Lake Natoma	Nimbus Fish Hatchery	Hatchery	–

Location	Day Use Area	Comments	Number
Lake Natoma	Nimbus Flat	California State University, Sacramento Aquatic Center Trailhead for Lake Natoma Trail	37 picnic sites
Lake Natoma	Willow Creek	Trailhead for Lake Natoma Trail	4 picnic sites

Sources: Reclamation et al. 2006; State Parks and Reclamation 2003, 2007
ADA = Americans with Disabilities Act

Fishing is also popular at Folsom Lake and Lake Natoma from boats and the shoreline. Anglers can catch warmwater and coldwater fish species owing to the summer stratification of the lake into a warm layer above a coldwater pool, especially in Folsom Lake (State Parks and Reclamation 2007). Warmwater fishing opportunities include Smallmouth Bass, Largemouth Bass, Spotted Bass, and Black and White Crappie. The cooler water strata support fishing for Rainbow Trout, Brown Trout, and Chinook Salmon.

S.1.5.2 *American River from Nimbus Dam to the Confluence with Sacramento River*

The American River, which flows 14 miles between Nimbus Dam and its confluence with the Sacramento River, was designated by the Secretary of the Interior to be part of the National Wild and Scenic Rivers system on January 19, 1981. The State of California also designated the Lower American River as wild and scenic under Public Resources Code Sections 5093.54 and 5093.545.

The Jedediah Smith Memorial Trail (also known as the American River Bike Trail) continues along the American River from Beal's Point at Folsom Lake, along Folsom Lake and Lake Natoma, and along the Lower American River through Discovery Park to its confluence with the Sacramento River (Reclamation 2005b).

The American River Parkway is a 26-mile green space designated and managed by Sacramento County Parks and Recreation along the Lower American River from Nimbus Dam to the confluence with the Sacramento River at Discovery Park. This parkway provides extensive recreational opportunities, including boating, rafting, kayaking, canoeing, swimming, and fishing (Reclamation 2005b; Sacramento County 2008). Pedestrian access is provided at 87 locations along the parkway. Bicycle access and equestrian access are provided at 65 and 37 locations, respectively. Boat ramps are provided at seven locations and car-top boat ramps are provided at 17 locations. Picnic sites exist at numerous locations along the American River. Fishing opportunities along the Lower American River include Chinook Salmon, steelhead, trout, Striped Bass, American Shad, Largemouth Bass, Bluegill, Crappie, Sunfish, and Catfish (Sacramento County 2008).

S.1.5.3 *Sacramento Municipal Utility District – Rancho Seco Park and Lake*

Rancho Seco Park and Lake, operated by Sacramento Municipal Utility District, is used to store CVP water (Reclamation 2005b). The lake has a surface area of 160 acres. Recreation activities include boating, camping, picnicking, bird watching, and fishing. Facilities available for these activities include two boat ramps and a fish cleaning facility. Game fish species found at the lake include Catfish, Bluegill, Crappie, and trout. Birds that use the area include ducks, geese, hawks, bald eagles, blue heron (*Ardea herodias*), and migratory birds (Sacramento Municipal Utility District 2013).

S.1.6 Stanislaus River

New Melones Reservoir and Tulloch Reservoir on the Stanislaus River and the lower Stanislaus River are located within areas in the Stanislaus River watershed that could be affected by changes in CVP operations.

S.1.6.1 *New Melones Reservoir*

New Melones Reservoir is a CVP facility on the Stanislaus River. Recreational activities and facilities at New Melones Reservoir are managed by Reclamation. When the water storage in the New Melones Reservoir is at full capacity (water elevation is at 1,088 feet msl), it has a surface area of approximately 12,500 acres and 105 miles of shoreline (Reclamation 2010a).

Water-related recreational activities include boating, waterskiing, camping, picnicking, wildlife viewing, spelunking, rock climbing, gold panning, and fishing (Reclamation 2010a). Float planes can land within the north, middle, and south bays of the reservoir. A model airplane club operates an airstrip near New Melones Dam. Cave exploration occurs in the Stanislaus River Canyon. Rock climbing occurs on Table Mountain. The reservoir level varies and in dry years when the reservoir water level is low and the flow of the river quickens, whitewater rafters are able to launch at the Old Camp Nine Bridge. In wet years, when the water level in the reservoir is high, there is not enough flow to create whitewater conditions and whitewater rafting is not available.

There are five boat ramps at New Melones Reservoir, as summarized in Table S.1-22.

Table S.1-22. New Melones Reservoir Boat Ramps

Boat Ramp	Comments	Useable Elevations (feet mean sea level)
Angels Creek	–	1,088 to 975
Glory Hole	Location of New Melones Lake Marina	Several boat ramps: 1,088 to 860
Mark Twain	Unimproved ramp	1,088 to 760
Parrotts Ferry	Unimproved ramp	Several boat ramps: 1,088 to 900

Source: Reclamation 2010a

The New Melones Marina is the only location with mooring facilities and houseboat rentals (Reclamation 2010a). Up to 50 private houseboats on mooring balls, 38 private houseboats in slips, and 20 rental houseboats may be maintained on the reservoir.

Campgrounds are located at Glory Hole and Tuttletown, as summarized in Table S.1-23 (Reclamation 2010a). Some of the campsites are located along the shoreline and the water can be more difficult to access during seasons characterized by low water levels.

Table S.1-23. New Melones Reservoir Campgrounds

Campground	Comments	Number of Campsites
Glory Hole	Two campgrounds	144
Tuttletown	Three campgrounds Two Group campgrounds	161 16

Source: Reclamation 2010a

New Melones Reservoir recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table S.1-24 (Reclamation 2010a). The locations for shoreline day use areas are less desirable when water elevations are low.

Table S.1-24. New Melones Reservoir Day Use Areas

Day Use Area	Comments	Number
Glory Hole	Picnicking, trails	61 sites Several trails: 0.25 to 2.5 miles
Mark Twain	Picnicking, Norwegian Gulch Trail	0.5 miles
Natural Bridges	Trail	0.7 miles
Shoreline	Swimming, recreational gold panning	–
Table Mountain	Trail	Several trails: 1.5 to 4.0 miles
New Melones Lake Visitor	Visitor Center	–
Tuttletown	Picnicking, trail	52 sites Several trails: 0.4 to 1.7 miles

Sources: Reclamation 2010a, 2010b, 2014b

S.1.6.2 *Tulloch Reservoir*

Tulloch Reservoir is a reservoir owned and operated by the Oakdale and South San Joaquin Irrigation Districts on the Stanislaus River, downstream of New Melones Reservoir. When the water storage in Tulloch Reservoir is at full capacity (water elevation is at 510 feet msl), the reservoir has a surface area of 1,260 acres and 55 miles of shoreline (Clark Broadcasting Corporation 2013; Tri-Dam Project 2015).

Water-related recreational activities include boating, sailing, windsurfing, jet and waterskiing, and fishing. Camping and picnicking is also available. Most of the shoreline is privately owned, with shoreline access and more than 500 private docks for residents (Tri-Dam Project 2015). Public access is provided at a CDFW marina and campground, with a boat ramp at South Shore Marina & Campground.

S.1.6.3 *Stanislaus River from Tulloch Dam to the San Joaquin River*

Downstream of Tulloch Dam, the Stanislaus River flows to Goodwin Dam, and then continues approximately 40 miles to the confluence with the San Joaquin River. Recreational activities along the lower portion of the Stanislaus River include whitewater rafting, camping, picnicking, swimming, and fishing. Intermediate to expert level whitewater rafting begins at Goodwin Dam and continues almost 4 miles to Knights Ferry (American Whitewater 2014a). Downstream of Knights Ferry, there are seven parks, including Caswell Memorial State Park, a 258-acre park managed by State Parks (Stanislaus County 2015; State Parks 2018). Fishing opportunities on the lower Stanislaus River include Bass, Catfish, and Crappie.

S.1.7 San Joaquin River

S.1.7.1 *Millerton Lake*

Millerton Lake is a CVP facility on the San Joaquin River. Millerton Lake is part of the Millerton SRA. Recreational facilities and activities at Millerton Lake are administered by State Parks. When the water storage in Millerton Lake is at full capacity (water elevation is at 580.6 feet msl), it has a surface area of approximately 4,900 acres and 44 miles of shoreline (Reclamation and DWR 2011).

Recreational opportunities include boating, sailing, waterskiing, jet skiing, swimming, tournament and recreational fishing, camping, and picnicking (Reclamation and DWR 2011; Reclamation and State Parks 2010). Whitewater rafting opportunities for intermediate level rafters occur upstream of Millerton Lake between August and November when low water levels in the lake increase the water flow (American Whitewater 2018). The public boat ramps on Millerton Lake are summarized in Table S.1-25.

Table S.1-25. Millerton Lake Boat Ramps

Boat Ramp	Comments	Useable Elevations (feet mean sea level)
Crow's Nest	On South Shore	580 to 487
Grange Cove	On South Shore	Several Boat Ramps: 580 to 500
McKenzie Point	On South Shore	580 to 472
North Shore	On North Shore	580 to 470
South Bay	On South Shore	580 to 500

Sources: Reclamation and DWR 2011; Reclamation and State Parks 2010

The marina at Millerton Lake is located at Winchell Cove on the South Shore (Reclamation and State Parks 2010). The marina includes 500 boat slips. There are also eight boat slips at Crow's Nest.

Campgrounds are located along the Millerton Lake North Shore, as summarized in Table S.1-26. Many of these campsites are located along the shoreline. These campsites are less used at low water elevations because the distance from the campsites to the shoreline is increased.

Table S.1-26. Millerton Lake Campgrounds

Campground	Comments	Number of Campsites
Dumna Strand	–	10
Fort Miller	Shoreline campground	36
Group Campsites	Group campground Amphitheater	2 sites with total of 120 sites
Meadows	Campsites Equestrian campsites	59 4 corrals and campsites
Mono	–	16
North Fine Gold Campground	Boat-in campground	15
Rocky Point	–	21
Temperance Flat Boat	Boat-in campground	25
Valley Oak	–	6

Source: Reclamation and State Parks 2010

Millerton Lake recreational areas also include day use areas for picnicking, swimming, and other recreational opportunities, as summarized in Table S.1-27 (Reclamation and State Parks 2010). The locations for shoreline day use areas are less desirable when water elevations are low.

Table S.1-27. Millerton Lake Day Use Areas

Day Use Area	Comments	Number
Blue Oak	Picnicking and trail along the South Shore	3 sites 4 miles
Buzzard's Roost Trail	Picnicking, trail	2 sites 0.5 miles
Crow's Nest	Picnicking	13 sites
Eagle's Nest	Picnicking, trailhead	2 sites
Fort Miller	Trail	0.25 miles
Grange Grove	Picnicking	74 sites
La Playa	Picnicking, swimming	95 sites
McKenzie Point	Picnicking	–
Meadows	Picnicking	10 sites
Millerton Courthouse	Historic site, picnicking	3 sites
San Joaquin River Trail	Portions along the Millerton Lake shoreline	14 miles
South Bay	Picnicking	9 sites
South Fine Gold	Picnicking, trail	10 sites 11 miles

Sources: Reclamation and State Parks 2010; State Parks 2017a

S.1.7.2 *San Joaquin River from Friant Dam to the Delta*

The San Joaquin River flows 100 miles from Friant Dam to the Delta. Downstream of Friant Dam, the San Joaquin River flows 23 miles through lands within the San Joaquin River Parkway, which includes parks, trails, and ecological reserve areas between Friant Dam and State Route 145 managed by the San Joaquin River Parkway and Conservation Trust (Reclamation and DWR 2011).

Water-related recreational activities include boating, canoeing, kayaking, whitewater rafting, and fishing (Reclamation and DWR 2011). Camping, picnicking, and hunting are also available. Access and facilities for these activities are available at several locations along and adjacent to the San Joaquin River.

Between Friant Dam and the confluence with the Merced River, beginner level whitewater rafting occurs between Friant Dam to Skaggs Bridge Park at State Route 145 (American Whitewater 2014b). Public access locations are generally located within the San Joaquin River Parkway. Seven boat ramps are located along the San Joaquin River Parkway that are managed by the San Joaquin River Parkway and Conservation Trust and/or CDFW, Fresno County, or private operators. Lost Lake Park, managed by the San Joaquin River Parkway and Conservation Trust and CDFW, provides a nonpowered car-top boat ramp. Sycamore Island Park, managed by San Joaquin River Parkway and Conservation Trust, offers a boat ramp for small boats. River access also is available at Skaggs Bridge Park, managed by Fresno County. Picnicking is provided at most of the public access locations and at several other locations within the parkway. Camping is provided at Scout Island and Lost Lake Park, managed by Fresno County and the private Fort Washington Beach. Trails include the 5-mile-long Lewis S. Eaton Trail.

Downstream of State Route 145, recreational areas include the 85-acre Mendota Pool in Mendota, California; Dunkle and Maldonado parks in the City of Firebaugh; and Las Palmas Fishing Access and Laird Park in Stanislaus County. Public access is provided at all of these sites. A boat ramp is located upstream of Mendota Dam.

The majority of these areas permit fishing. Fishing opportunities in the San Joaquin River include sunfish, crappie, Bluegill, Striped Bass, Largemouth Bass, and catfish (Reclamation and DWR 2011).

S.1.7.3 *San Joaquin Valley Refuges*

Wildlife refuges in the San Joaquin Valley that rely on CVP water supplies include the San Luis NWR (including the San Luis Unit, West Bear Creek Unit, East Bear Creek Unit, Freitas Unit, and Kesterson Unit); Merced NWR; Los Banos Wildlife Area; Volta Wildlife Area; Mendota Wildlife Area; North Grasslands Wildlife Area (including China Island Unit and Salt Slough Unit); and Grasslands Resource Conservation District (Reclamation 2012). Water-related activities include wildlife viewing and hunting. Hunting opportunities include waterfowl, shorebirds, and pheasants (Reclamation and DWR 2011).

Several wildlife areas along the San Joaquin River rely on CVP operations of Millerton Lake to provide water (Reclamation and DWR 2011). West Hilmar Wildlife Area includes 340 acres of wildlife area accessible by boat. The San Joaquin River NWR includes over 7,000 acres of riparian woodlands, wetlands, and grasslands for native wildlife, and the 4-mile long Pelican Nature Trail (U.S. Fish and Wildlife Service [USFWS] 2012).

In the southern San Joaquin Valley, the Kern and Pixley NWRs provide wildlife viewing opportunities.

S.1.8 Bay-Delta

The Delta is located at the terminus of the Sacramento River and the San Joaquin River. Water-related activities in the Delta include boating, sailing, waterskiing, canoeing, kayaking, picnicking, fishing, and hunting. Recreational opportunities exist in many areas of the Delta; however, the analysis in this EIS is related to areas that could be affected by changes in CVP and/or SWP water supply operations and restoration in the Yolo Bypass. The following discussion describes recreation throughout the Delta, followed by more specific discussions of recreation within the Yolo Bypass and Cache Slough.

S.1.8.1 *Delta Recreational Opportunities*

The primary recreational activities in the Delta are related to boating and fishing (Delta Protection Commission [DPC] 2012a). Public recreation facilities are limited within the Delta. Most recreational opportunities are provided by private enterprises, including marinas, restaurants, hunting venues, and wineries and farm visits. Public access is provided at CDFW and USFWS sites.

The most recent survey of boating opportunities in the Delta was completed in 2002 by the California Department of Boating and Waterways (California Department of Boating and Waterways 2014; DPC 2012a). The survey indicated that of the 95 marinas surveyed, three were publicly owned and 92 were privately owned (including 87 that were open to the public and five that were for members). The survey indicated that within the Delta, there were over 11,600 boat slips, 55 boat ramps, 2,182 campsites, and 324 picnic sites.

Public access sites for boating and wildlife and scenic viewing in the Delta include:

- USFWS: Stone Lakes NWR, Antioch Dunes NWR (Antioch 2017).
- CDFW: Calhoun Cut Ecological Reserve, Decker Island Wildlife Area, Lower Sherman Island Wildlife Area, Miner Slough Wildlife Area, Rhode Island Wildlife Area, White Slough Wildlife Area, Woodbridge Ecological Reserve, Fremont Weir Wildlife Area, Sacramento Bypass Wildlife Area, and Yolo Bypass Wildlife Area.
- State Parks: Brannan Island-Franks Tract SRAs, Delta Meadows SRA.

- Department of Water Resources: Clifton Court Forebay.
- The Nature Conservancy/CDFW: Cosumnes River Preserve.
- Solano Land Trust: Jepson Prairie Preserve.
- East Bay Regional Park District (EBRPD): Big Break Regional Shoreline, Antioch/Oakley Regional Shoreline, Browns Island Regional Preserve, Bay Point Regional Shoreline, Martinez Regional Shoreline, Carquinez Strait Regional Shoreline-Crockett Hills Regional Park, and Contra Costa Canal Trail.
- Municipal marinas, boat ramps, and fishing access facilities: City of Antioch Marina and Municipal Boat Ramp; City of Pittsburg Riverview Park; Sacramento County Cliffhouse, Georgiana Slough Fishing Access, Hogback Island Access, and Sherman Island Public Access Facility; City of Sacramento Garcia Bend Park; several public and private marinas in Sacramento County; 12 public and private marinas with over 900 boat slips and boat access within the City of Stockton; San Joaquin County Dos Reis Regional Park, Mossdale Crossing Regional Park, and Westgate Landing Regional Park; and Yolo County Clarksburg River Access.

Several of these sites include launch sites for boats, canoes, and kayaks and trails (DPC 2012; Delta Stewardship Council 2013; CDFW 2018a, 2018c, 2018d; EBRPD 2013a; Antioch 2017; Pittsburg 2010; Sacramento County 2019; Sacramento 2018; Stockton 2007; Yolo County 2009).

One of the larger bodies of water in the Delta is the SWP Clifton Court Forebay. Fishing is the only recreational opportunity that occurs within the Clifton Court Forebay, and the opportunities here are limited (DWR 2013b). Public access is restricted near the radial gate along West Canal. However, boat access is possible at two locations. There is a small boat dock located at the southern end of West Canal to the east of the radial gate. A second access point is located on the north bank of the intake canal from Clifton Court Road.

Fishing opportunities in the Delta generally include Striped Bass, Smallmouth Bass, Largemouth Bass, Spotted Bass, American Shad, Black Crappie, Chinook Salmon, steelhead, catfish, sunfish, Tule Perch (*Hysterocarpus traskii*), Warmouth (*Lepomis gulosus*), and White Sturgeon (DPC 2012b).

Hunting opportunities for waterfowl, shorebirds, doves, and pheasants occur in many areas of the Delta on privately owned land. Hunting also occurs at several publicly owned sites within the Delta, including:

- USFWS: Stone Lakes NWR.
- CDFW: Decker Island Wildlife Area, Lower Sherman Island Wildlife Area, Miner Slough Wildlife Area, Rhode Island Wildlife Area, White Slough Wildlife Area, Yolo Bypass Wildlife Area, and on some lands owned by DWR (including Sherman and Twitchell Islands and Clifton Court Forebay).

Recreational opportunities in the Bay-Delta region vary depending on CVP and SWP water facility operations (DPC 2012a).

S.1.8.2 *Yolo Bypass and Cache Slough Recreational Opportunities*

The primary recreational activities in the Yolo Bypass and Cache Slough areas are related to wildlife viewing and hunting. Many recreational hunting opportunities occur on private lands, including private hunting clubs. Areas within Yolo Bypass and Cache Slough that provide public access for wildlife viewing or hunting include:

- Fremont Weir Wildlife Area (CDFW 2018c): Activities include wildlife viewing, fishing, and hunting for pheasant, waterfowl, mourning dove, deer, quail, rabbit, and turkey.
- Sacramento Bypass Wildlife Area (CDFW 2018d): Activities include wildlife viewing, fishing for White Sturgeon, White Catfish, and Black Crappie in the Tule Canal; and Largemouth Bass, Bluegill, and White Catfish in the borrow pits.
- Yolo Bypass Wildlife Area (CDFW 2018e): Wildlife viewing and hiking. Fishing for sturgeon, Striped Bass, Black Bass, and catfish. Hunting for waterfowl, coots, moorhens, snipe, pheasants, and mourning doves. Educational and interpretative programs.
- Calhoun Cut Ecological Reserve (CDFW 2018f): Waterfowl hunting and fishing from a boat.

There are other publicly-owned lands within the Yolo Bypass and Cache Slough that provide habitat or will be restored to provide habitat. However, these lands are generally not available for public access to protect fragile ecosystems.

S.1.8.3 *Suisun Marsh*

Suisun Marsh is 106,511 acres of wetlands located between the Delta and the San Francisco Bay. Water-related activities at Suisun Marsh include waterfowl hunting, boating, kayaking, hiking, wildlife viewing, fishing, and hunting (Reclamation et al. 2011). Water-related recreation occurs within the two major channels (Montezuma and Suisun Sloughs), and several moderately sized channels (Cordelia, Denverton, Nurse, and Hill Sloughs).

The CDFW manages several areas within the Suisun Marsh for public access. These areas include (Reclamation et al. 2011):

- Grizzly Island Wildlife Area: Activities include wildlife viewing, hiking, fishing (February through July, and late September), hunting (August through mid-September, and October through January).
- Hill Slough Wildlife Area: Activities include wildlife viewing and fishing.
- Peytonia Slough Ecological Preserve: Activities include kayaking, wildlife viewing, and fishing.
- Belden's Landing Water Access Facility: Facilities include boat ramp and fishing pier.

Suisun City Marina and Solano Yacht Club, Suisun City Boat Launch, and McAvoy Yacht Harbor and Club also provide boat ramp facilities (Reclamation et al. 2011). Pier fishing opportunities are provided at Suisun City Boat Ramp.

The Solano Land Trust's Rush Ranch also provides opportunities for hiking and picnicking in the wetlands and upland areas near Potrero Hills (Reclamation et al. 2010).

Fishing opportunities within Suisun Marsh include Striped Bass, White Sturgeon, catfish, and carp (Reclamation et al. 2011). Occasionally, Chinook Salmon, steelhead, and Largemouth Bass are caught in Suisun Marsh near Grizzly Island.

Duck hunting generates the most frequent recreational visits in Suisun Marsh (Reclamation et al. 2011). About 37,500 acres of Suisun Marsh are owned and operated by private duck clubs. CDFW manages about 15,300 acres of public lands in Grizzly Island Wildlife Area for hunting waterfowl, snipe, coots, moorhens, mourning doves, pheasants, rabbits, and Tule elk.

There are other publicly-owned lands within Suisun Marsh that provide habitat or will be restored to provide habitat. However, these lands are generally not available for public access to protect fragile ecosystems.

S.1.8.4 *San Francisco Bay*

The San Francisco Bay Area includes portions of Contra Costa, Alameda, Santa Clara, San Benito, and Napa counties that are within the CVP and SWP service areas. This section describes reservoirs in the San Francisco Bay Area that could be affected by CVP and SWP operations, including the CVP Contra Loma and San Justo Reservoirs; the SWP Bethany Reservoir and Lake Del Valle; the Contra Costa Water District (CCWD) Los Vaqueros Reservoir; and the East Bay Municipal Utility District (EBMUD) Upper San Leandro, San Pablo, Briones, and Lafayette Reservoirs and Lake Chabot. CVP and SWP water is generally not stored in reservoirs within Santa Clara County (Santa Clara Valley Water District 2016).

S.1.8.4.1 Contra Loma Reservoir

The Contra Loma Reservoir is a CVP facility in Contra Costa County that provides offstream storage along the Contra Costa Canal. The recreation facilities are managed by EBRPD. The 80-acre reservoir is part of the 661-acre Contra Loma Regional Park and Antioch Community Park (Reclamation 2014c). Recreational activities include boating, windsurfing, kayaking, picnicking, and fishing. No bodily contact is to occur in Contra Loma Reservoir; therefore, a large swimming pool was constructed for the visitors by EBRPD. There is one boat ramp at the reservoir. Contra Loma Reservoir accommodates fishing all year-round. Fishing opportunities include catfish, Black Bass, Striped Bass, Largemouth Bass, Bluegill, crappie, trout, and Redear Sunfish (*Lepomis microlophus*) (EBRPD 2015).

S.1.8.4.2 San Justo Reservoir

The San Justo Reservoir is a CVP facility in San Benito County that provides offstream storage as part of the San Felipe Division. San Justo Reservoir recreation facilities have been closed to the public since 2009 because of an infestation of zebra mussel. Previously, the recreation facilities were managed by the San Benito County Water District (Reclamation 2015).

S.1.8.4.3 Bethany Reservoir

Bethany Reservoir is a SWP facility located between the California Aqueduct and South Bay Aqueduct in Alameda County. The recreation facilities are part of the Bethany Reservoir SRA and are managed by State Parks. When the water storage in Bethany Reservoir is at full capacity (water elevation is at 243 feet msl), it has 161 acres of surface area and 6 miles of shoreline (DWR 2001). Recreational activities include boating, windsurfing, picnicking, and fishing. There is one boat ramp at the reservoir (State Parks 2013). Fishing opportunities include Striped Bass, Smallmouth Bass, Largemouth Bass, Spotted Bass, White Bass, catfish, crappie, and trout.

S.1.8.4.4 Lake Del Valle

Lake Del Valle is a SWP facility located along the South Bay Aqueduct in Alameda County. The recreation facilities are managed by EBRPD as part of the Del Valle Regional Park. When the water storage in Lake Del Valle is at full capacity (water elevation is at 703 feet msl), it has 708 acres of surface area and 16 miles of shoreline (DWR 2001). Recreational activities include boating, windsurfing, camping, swimming, and fishing (DWR 2001). There is a boat ramp at the lake (EBRPD 2016a). When the water surface elevation reaches 678 feet msl, boating hazards are exposed. There are seven group campsites for up to 475 people and a family campground (DWR 2001; EBRPD 2016a). Fishing opportunities include trout, catfish, Largemouth Bass, Smallmouth Bass, Striped Bass, and panfish (EBRPD 2016a).

S.1.8.4.5 Los Vaqueros Reservoir

Los Vaqueros Reservoir is a CCWD offstream storage facility in Contra Costa County. Recreation facilities are managed by CCWD. Water-related activities include boating, using rented electrical boats, and fishing (CCWD 2018). The Los Vaqueros recreational facilities include a marina, four fishing piers, 55 miles of trails, several individual and group picnic areas, and an interpretative center. Fishing opportunities include Rainbow Trout, Brown Bullhead, White Catfish, Channel Catfish, Sunfish, White Crappie, Largemouth Bass, Striped Bass, Chinook Salmon, Kokanee Salmon, Green Sunfish, and Sacramento Perch (EBRPD 2016).

S.1.8.4.6 San Pablo Reservoir, Lafayette Reservoir, Lake Chabot, and East Bay Municipal Utility District Trails

EBMUD reservoirs in Alameda and Contra Costa County are used to store water within and near the EBMUD service area. Water stored in these reservoirs includes water from local watersheds, the Mokelumne River watershed, and CVP water supplies. Recreation is allowed within the waters of San Pablo and Lafayette reservoirs and Lake Chabot (EBMUD 2016). Recreation is not allowed within the waters of Upper San Leandro and Briones Reservoirs. EBMUD maintains over 26 miles of trails, many of which provide reservoir views, within the watersheds of the reservoirs (EBMUD 2007a).

Recreation facilities at San Pablo Reservoir are managed by EBMUD. Recreational activities at San Pablo Reservoir include boating, picnicking, and fishing (EBMUD 2019a). There is a boat ramp at the reservoir. There are individual sites and nine group picnic areas that can accommodate up to 100 people at each site. Hiking can occur in the San Pablo Reservoir watershed on 8.7 miles of trails, which connect to about 13 miles of trails in the Briones Reservoir watershed (EBMUD 2007b). The surface water of the reservoirs can be viewed from many locations along these trails. Fishing opportunities at San Pablo Reservoir include Rainbow Trout, catfish, Black Bass, Bluegill, and crappie (EBMUD 2019a).

Recreation facilities at Lafayette Reservoir are managed by EBMUD. Recreational activities at Lafayette Reservoir include boating, picnicking, and fishing (EBMUD 2019b). There is a private car-top boat ramp at the reservoir, and 125 picnic sites around the reservoir. Hiking can occur in the Lafayette Reservoir watershed on 7.4 miles of trails. Fishing opportunities at Lafayette Reservoir include Rainbow Trout, catfish, Black Bass, and sunfish.

Recreation facilities at Lake Chabot are managed by EBRPD as part of the Lake Chabot Regional Park (EBRPD 2018). Recreational activities at Lake Chabot include boating, camping, picnicking, and fishing. There is a boat ramp at the reservoir and boat rides are offered on the *Chabot Queen*. Individual and group campsites are located near the southern portion of the park. Picnic sites are located near the Lake Chabot Marina. Hiking can occur along the shoreline on over 9 miles of trails, which connect to more than 17 miles of other trails in the watershed (EBRPD 2018, 2016b). Other recreational activities, including equestrian trails and a marksmanship range, are located in the upper Lake Chabot watershed. Fishing opportunities at Lake Chabot include Rainbow Trout, catfish, Black Bass, crappie, Bluegill, and carp.

S.1.8.5 *Recreational Fishing in San Pablo, Suisun, and San Francisco Bays*

Recreational fishing for sturgeon, Striped Bass, steelhead, trout, and salmon occurs in San Pablo and San Francisco Bays. Of these species, the majority of recreational fishing in the San Francisco Bay Estuary is related to Striped Bass and sturgeon fishing, especially in San Pablo and Suisun Bays (CDFW 2018g).

Recreational fishing for White Sturgeon is limited to three sturgeons per person each year, with a daily bag limit of one fish per day and a size limit of 40 to 60 inches (from the nose tip to fork in the tail). White Sturgeon fishing is not allowed in San Francisco Bay from March 16 through December 31. Green Sturgeon fishing is not allowed at any time. Striped Bass fishing occurs throughout the year with a daily bag limit of two fish per day and a minimum size limit of 18 inches. Salmon sportfishing also occurs within the San Francisco Bay Estuary during periods specified by the National Marine Fisheries Service (CDFW 2019).

S.1.9 CVP and SWP Service Areas

S.1.9.1 *Delta-Mendota Canal*

Delta-Mendota Canal is a CVP facility. The Delta-Mendota Canal includes two fishing sites: one in Stanislaus County and the other in Fresno County (Reclamation 2007). Fishing opportunities include Striped Bass and catfish (Reclamation 2007).

S.1.9.2 *California Aqueduct/San Luis Canal*

The California Aqueduct is a SWP facility. A portion of the aqueduct is also co-located with the CVP San Luis Canal. Fishing is permitted at 12 sites along the California Aqueduct between Bethany Reservoir and Perris Lake in southern California. Fishing opportunities include Striped Bass, Largemouth Bass, catfish, crappie, Green Sunfish, Bluegill, and Starry Flounder (*Platichthys stellatus*) (Reclamation 2007).

S.1.9.3 *San Luis Reservoir State Recreation Area*

The San Luis Reservoir complex includes CVP and SWP offstream storage facilities located south of the Delta. The San Luis Reservoir complex includes San Luis Reservoir, O'Neill Forebay, and Los Banos Creek Reservoir and is located within the San Luis Reservoir SRA. The recreation facilities are operated by State Parks (State Parks 2017b). Los Banos Creek Reservoir is a flood detention basin designed to protect the community of Los Banos and San Luis Canal/California Aqueduct. This reservoir and a similar flood management reservoir that is not within the San Luis Reservoir SRA (Little Panoche Creek Reservoir) are not affected by CVP and SWP operations. Therefore, Los Banos Creek and Little Panoche Creek Reservoirs are not considered in detail in this EIS.

When the water storage in the San Luis Reservoir is at full capacity (water elevation is at 540 feet msl), the reservoir has a surface area of 12,700 acres and 65 miles of shoreline (Reclamation and State Parks 2013; State Parks 2017b).

The O'Neill Forebay is east of the San Luis Reservoir, downstream of San Luis Dam. When the water storage in the forebay is at full capacity (water elevation is at 230 feet msl), the forebay has a surface area of 2,210 acres and 14 miles of shoreline (Reclamation and State Parks 2013; State Parks 2017b).

Within the San Luis Reservoir SRA, recreational activities include boating, camping, picnicking, wildlife and scenic viewing, fishing, and hunting (Reclamation 2007; State Parks 2017b; Reclamation and State Parks 2013).

Boat ramps are available at the Basalt Area and Dinosaur Point in San Luis Reservoir (operational to 340 and 360 feet msl, respectively); the Group Campground and Medeiros Campground at O'Neill Forebay; and at the Los Banos Creek Campground at Los Banos Creek Reservoir.

Camping occurs at the Basalt Area at the San Luis Reservoir (79 sites), O'Neill Forebay (50 sites), the San Luis Creek Area (53 sites and two group campsites with 90 sites), and the Los Banos Creek Area (14 sites) (Reclamation and State Parks 2013).

Picnicking, swimming, and/or hiking occur at the Basalt Area, Medeiros Area, and Los Banos Creek Area (Reclamation 2007; State Parks 2017b; Reclamation and State Parks 2013).

Fishing opportunities in all three reservoirs include Striped Bass, American Shad, and catfish (Reclamation and State Parks 2013). Hunting opportunities occur at San Luis Reservoir for waterfowl, deer, and wild pig (Reclamation 2007; Reclamation and State Parks 2013).

S.1.9.4 *Cachuma Lake*

Cachuma Lake is a facility owned and operated by Reclamation in Santa Barbara County (CCWA 2018). Recreation facilities are managed by Santa Barbara County Parks Department. Water-related activities include boating and fishing within the lake and along the lake shoreline (Reclamation 2010c). Cachuma Lake recreation facilities include a marina with 87 rental boats and a public boat ramp, 94 private boat slips, 520 campsites, equestrian campsites, a family center, an amphitheater, and trails that range from 0.25 to 9 miles in length. Fishing opportunities include Rainbow Trout, Channel Catfish, Black Crappie, White Crappie, Largemouth Bass, Smallmouth Bass, Redear Perch, and Bluegill.

S.1.9.5 *Lake Piru*

Lake Piru is located on Piru Creek, a tributary of the Santa Clara River, in Ventura County (United Water Conservation District [UWCD] 2019). The lake is owned and operated by UWCD. Lake Piru is located within Los Padres National Forest (Parks Management Company [PMC] 2019). The lake is used to store SWP water.

Recreation facilities are managed by a private concessionaire for the district (UWCD 2019; PMC n.d.). Recreational activities include boating, camping, and picnicking. The marina includes a boat ramp and private boat slips. There are over 220 campsites, including several group campsites.

S.1.9.6 *Quail Lake*

Quail Lake is a SWP facility in Los Angeles County. Recreation facilities are managed by DWR (DWR 2019a). Water-related activities include fishing within the lake and along the shoreline. Fishing opportunities include Channel Catfish, Striped Bass, Blackfish, Tule Perch, Threadfin Shad, and Hitch.

S.1.9.7 *Pyramid Lake*

Pyramid Lake is a SWP facility located in Los Angeles County and upstream of Castaic Lake on the West Branch of the California Aqueduct. Recreation facilities are managed by USFS (DWR 2000, 2019b). Recreational activities include boating, camping, waterskiing, swimming, and fishing. Boat ramp facilities are available at Vaqueros Beach and Emigrant Landing. A marina and picnic sites are also available at Emigrant Landing. Four picnic and viewing sites are accessible only by boat. Family and group camping are available at two sites. Fishing opportunities include Largemouth Bass, Smallmouth Bass, and Striped

Bass, catfish, Bluegill, crappie, and trout. Reservoir elevations can vary substantially on a daily basis because the lake provides short-term storage for the downstream Castaic Powerplant.

S.1.9.8 *Castaic Lake*

Castaic Lake is a SWP facility located in Los Angeles County at the terminal end of the West Branch of the California Aqueduct. Recreation facilities are managed by the Los Angeles County Department of Parks (DWR 2007b). Recreational activities include boating, waterskiing, jet skiing, wakeboarding, camping, picnicking, swimming at the lagoon/afterbay, and fishing. Fishing opportunities include trout, Largemouth Bass, Striped Bass, catfish, and crappie (DWR 2019c).

S.1.9.9 *Silverwood Lake*

Silverwood Lake is a SWP facility located in San Bernardino County, along the East Branch of the California Aqueduct. Recreation facilities are managed by State Parks as part of the Silverwood Lake SRA (State Parks 2016a). Recreational activities include boating, waterskiing, camping, picnicking, swimming, and fishing. Facilities available for boating include a boat ramp, marina, and waterskiing area. Camping facilities include 136 family sites, seven walk-in sites, and several group sites for up to 120 people. The park includes two swimming beaches and 13 miles of trails. Fishing opportunities include Largemouth Bass, Striped Bass, Bluegill, crappie, and catfish.

S.1.9.10 *Crafton Hills Reservoir*

Crafton Hills Reservoir is a SWP facility located in the City of Yucaipa within San Bernardino County. Recreation facilities are managed by DWR (DWR 2009). Recreational activities near the reservoir are associated with hiking trails in the open space within the Crafton Hills watershed. The surface water of the reservoirs can be viewed from many locations along these trails.

S.1.9.11 *Lake Arrowhead*

Lake Arrowhead is located in San Bernardino County (Lake Arrowhead Community Services District [LACSD] 2019). The lake is owned and operated by Arrowhead Lake Association. LACSD stores SWP water in the lake. Recreation facilities are managed by the Arrowhead Lake Association. Recreational activities include boating, camping, and fishing (Lake Arrowhead 2019).

S.1.9.12 *Lake Perris*

Lake Perris is a SWP facility located in Riverside County at the terminal end of the East Branch of the California Aqueduct. Recreation facilities are managed by State Parks as part of the Lake Perris SRA (State Parks 2016b; DWR 2019d). Recreational activities include boating, camping, swimming, picnicking, and fishing. Boating facilities include a marina and three boat ramps. Other recreational facilities include two swimming beaches, a family campground, seven equestrian campsites, boat-in picnic sites on Alessandro Island, and the Ya'i Hek'i Regional Indian Museum. Fishing opportunities include Largemouth Bass, Catfish, Crappie, Carp, Bluegill, and Redear Sunfish.

S.1.9.13 *Diamond Valley Lake*

Diamond Valley Lake is an offstream storage facility located in Riverside County and is owned and operated by the Metropolitan Water District of Southern California (MWD) (MWD 2013). The lake is used to store SWP water. Water-related activities include boating and fishing. Boating facilities include a marina with boat rentals. Other recreational facilities include a visitor center, the Western Science Center, and the Valley-Wide Recreation and Park District Regional Aquatic Center and Community Park. Fishing opportunities include Black Bass, bluegill, Redear Sunfish, Rainbow Trout, Blue Catfish, and Channel Catfish (Diamond Valley Marina 2019).

S.1.9.14 *Lake Skinner*

Lake Skinner is an offstream storage facility located in Riverside County and is owned and operated by MWD. Recreation facilities are managed by Riverside County Parks (Riverside County 2018). The lake is used to store SWP water. Recreational activities include boating, camping, and fishing. Other recreational facilities include an amphitheater and splash pad. Fishing opportunities include Striped Bass, Largemouth Bass, Bluegill, Rainbow Trout, Catfish, and Carp.

S.1.9.15 *Dixon Lake*

Dixon Lake is located in the hills above the City of Escondido in San Diego County (Escondido 2019a). The lake is owned and operated by the City of Escondido. The lake is used to store SWP water.

Recreation facilities are managed by the City of Escondido (Escondido 2019b). Recreational activities include camping, picnicking, and fishing. There are 45 campsites and 22 picnic sites (Escondido 2019c, n.d.). Boats are allowed on the lake for fishing. Fishing opportunities include Rainbow Trout, Largemouth Bass, Striped Bass, Bluegill, carp, Channel Catfish, and Black Crappie.

S.1.9.16 *San Vicente, El Capitan, Lower Otay, Hodges, and Murray Reservoirs*

San Vicente Reservoir, El Capitan, Lower Otay, Hodges, and Murray Reservoirs are located in San Diego County (San Diego 2016). The reservoirs are owned and operated by the City of San Diego. The reservoirs are used to store SWP water.

Recreation facilities are managed by the City of San Diego (San Diego 2019a, 2019b, 2019c). Recreational activities at the reservoirs include boating, picnicking, and fishing (San Diego 2019b, 2019c, 2019d). There are 16 picnic sites at Lower Otay Reservoir. Fishing opportunities at Lower Otay Reservoir include Largemouth Bass, Bluegill, Black and White Crappie, Channel Catfish, Blue Catfish (*Ictalurus furcatus*), White Catfish, and Bullhead Catfish (*Ameiurus melas*). Recreational activities at San Vicente Reservoir are temporarily closed during construction to raise the dam (San Diego 2019e). Fishing opportunities at El Capitan Reservoir include Largemouth Bass, Bluegill, crappie, Channel Catfish, Blue Catfish, Green Sunfish, and carp (San Diego 2019f). Hodges Reservoir provides recreational opportunities including boating, windsurfing, and fishing for Largemouth Bass, Channel Catfish, Black Crappie, Bluegill, Bullhead Catfish, and Carp (San Diego 2019b). Murray Reservoir provides recreational opportunities for boating, floating, swimming, and fishing for Largemouth Bass, Bluegill, Channel Catfish, Black Crappie, and trout (San Diego 2019c).

S.1.9.17 *Lake Jennings*

Lake Jennings is located in San Diego County (Lake Jennings 2019). The lake is owned and operated by the Helix Water District (HWD). The lake is used to store SWP water.

Recreation facilities are managed by HWD (Lake Jennings 2019). Recreational activities include boating, camping, picnicking, and fishing. There are 96 campsites. There are a variety of picnic sites at Lake Jennings, including Cloister Cove, Siesta Point, Hermit Cove, and Eagle Point. Bird watchers at Lake Jennings can see loons, grebes, cormorants, herons, swans, geese, eagles, hawks, thrushes, warblers, and many other birds. Hikers at Lake Jennings have access to a variety of different trails near the lake, including a 5.5-mile loop around the lake. Fishing opportunities include Rainbow Trout, bass, Channel Catfish, and Blue Catfish.

S.1.9.18 *Sweetwater Reservoir*

Sweetwater Reservoir is located in San Diego County (Sweetwater Authority 2019). The lake is owned and operated by Sweetwater Authority. The reservoir is used to store SWP water. Recreation facilities are managed by Sweetwater Authority. Water-related activities include shoreline fishing.

S.1.10 Nearshore Pacific Ocean on the California Coast

S.1.10.1 *Recreational Salmon Fishing Along Northern California Coast*

Recreational fishing along California's coast is included in the analysis because changes in CVP and SWP operations could affect fish populations. Chinook Salmon, Coho Salmon, and steelhead are the primary recreational fish species found along the Pacific Coast of Northern California that could be affected by changes in CVP and SWP operations. Pacific salmon fisheries are managed by the Pacific Fishery Management Council (PFMC) from 3 to 200 nautical miles offshore (PFMC 2019). Along the California coast, salmon fisheries are managed by the CDFW from 0 to 3 nautical miles offshore with regulations that are generally similar to those applied by the PFMC. The PFMC analyzes the status of the fisheries each year and defines the length of the fishing season and minimum fish sizes allowed to be caught for commercial, recreational, and tribal salmon fishing activities.

S.2 Evaluation of Alternatives

This section describes the technical background for the evaluation of environmental consequences associated with the Project alternatives and the No Action Alternative.

S.2.1 Methods and Tools

This impact analysis considers changes in recreational resources related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative. Specifically, this analysis describes impacts on recreational activities (boating, camping, day use, and fishing access and opportunities) caused by potential changes in average water elevations, river flows, and seasonal fluctuations under the action alternatives, as well as the implementation of habitat restoration and fish intervention measures under Alternatives 1 and 3.

Potential changes in water elevations and flows were modeled for most rivers and reservoirs in the action area. Changes in average water elevations and average flows were analyzed using modeling results of various water bodies within the action area under the No Action Alternative and Alternatives 1 through 4. Each alternative was analyzed compared to the No Action Alternative. Deviations in average water elevation, flow, and seasonal fluctuations were noted as potential impacts to recreation. The modeled changes were also compared to boat ramp elevations to identify changes in the periods that ramps were available. For waterbodies where average water elevations or flows were not modeled, changes were evaluated qualitatively.

Modeling efforts included climate change conditions projected for Year 2030 and were applied consistently across the No Action Alternative and Alternatives 1 through 4. Conditions assumed for Year 2030 include 15 centimeters of sea level rise and the following parameters: inflows, water year types (wet, dry, critical, etc.), runoff forecasts, and Delta water temperature. These modeling results were used to understand the potential changes in river flows and reservoir elevations and their potential effects on recreational opportunities within the project area.

Impacts to recreation from habitat restoration and fish intervention measures were analyzed by identifying the general location of measure (these measures were programmatic in nature so there was no site specific information), type of measure (habitat restoration, fish facility improvements, etc.), and qualitatively assessing the degree of benefit to fish species and how this could impact recreation. Criteria for determining the degree of benefit to fish species includes habitability and safety. The fish species most likely to benefit from these measures were compared to the fish species that are commonly fished in the action area to assess extent of impact (minor, etc.).

S.2.2 No Action Alternative

Under the No Action Alternative, current CVP and SWP operations would continue. Water elevations in reservoirs would maintain their current patterns of seasonal variation and fluctuation. Water levels are generally lower in the late summer and fall when seasonal drawdowns are greatest and highest in winter when storms are most frequent and in spring when the snows melt.

Currently, seasonal low water levels affect campgrounds located near shorelines at Trinity Lake, Shasta Lake, Whiskeytown Lake, Oroville Lake and Thermalito Forebay and Afterbay, Folsom Lake and Lake Natoma, New Melones Reservoir, and Millerton Lake by increasing the distance between the shoreline and the campsites.

Whitewater rafting on the Sacramento, Stanislaus, San Joaquin Rivers would continue to be affected by seasonal fluctuations caused by current CVP and SWP operations. Low flows in the late summer and early fall limit whitewater rafting opportunities and this impact would continue under the No Action Alternative.

Under the No Action Alternative, current recreational conditions for activities such as boating, camping, day use, and recreational would remain the same so long as there are no major changes to seasonal variations. In dry years, reservoir levels drop and flows decrease, which generally decreases recreational opportunities. Should dry years become more common or get worse, water levels and flows could decrease further, decreasing and negatively impacting recreational opportunities.

There would be no short-term construction impacts and no changes to existing flow and water elevations operations; therefore, current conditions would continue. Recreational activities, including boating, camping, day use, and fishing, would not be affected by construction or changes in water elevation or flows. Because no additional habitat restoration and fish intervention actions would occur under the No Action Alternative, fishing access and success would not change from current conditions. Current procedures regarding recreational fishing, as conducted by recreational management authorities, would not change. Non-native fish species, which are most commonly fished, would continue to be stocked in reservoirs. Therefore, recreational fishing in reservoirs is not likely to be negatively affected under the No Action Alternative. Recreational fishing in reservoirs is not likely to be affected.

S.2.3 Alternative 1

S.2.3.1 *Project-Level Effects*

S.2.3.1.1 Potential Changes to Recreational Opportunities

Trinity River

Under Alternative 1, average water elevation at Trinity Lake could be slightly higher, by approximately 5 feet, compared to the No Action Alternative; seasonal fluctuations in water levels would remain approximately the same as the No Action Alternative (Figure S.2-1). There could be minor benefits on boating as there could be more days with access to boat ramps in the winter and summer months.

Camping and day use facilities are located along Trinity Lake. These facilities could potentially be affected by changes in water levels that could increase or decrease the distance from the campsites to the shoreline. Average water elevations could increase slightly under the Alternative 1 compared to the No Action Alternative (Figure S.2-1); therefore, Alternative 1 could have minor benefits on camping, day use opportunities at the campgrounds surrounding Trinity Lake. Increases in water elevation could also benefit recreational fishing access.

Water elevation is generally stable in Lewiston Reservoir because it is used as a regulating reservoir for releases to downstream uses. This condition is not expected to change under Alternative 1, so elevation levels would remain stable and would not affect boating activities and facilities on Lewiston Reservoir. Similarly, the campgrounds and day use facilities near Lewiston Lake that currently experience stable water levels would not be affected under Alternative 1. There would be no impacts to recreational fishing as access and population health and abundance would not change.

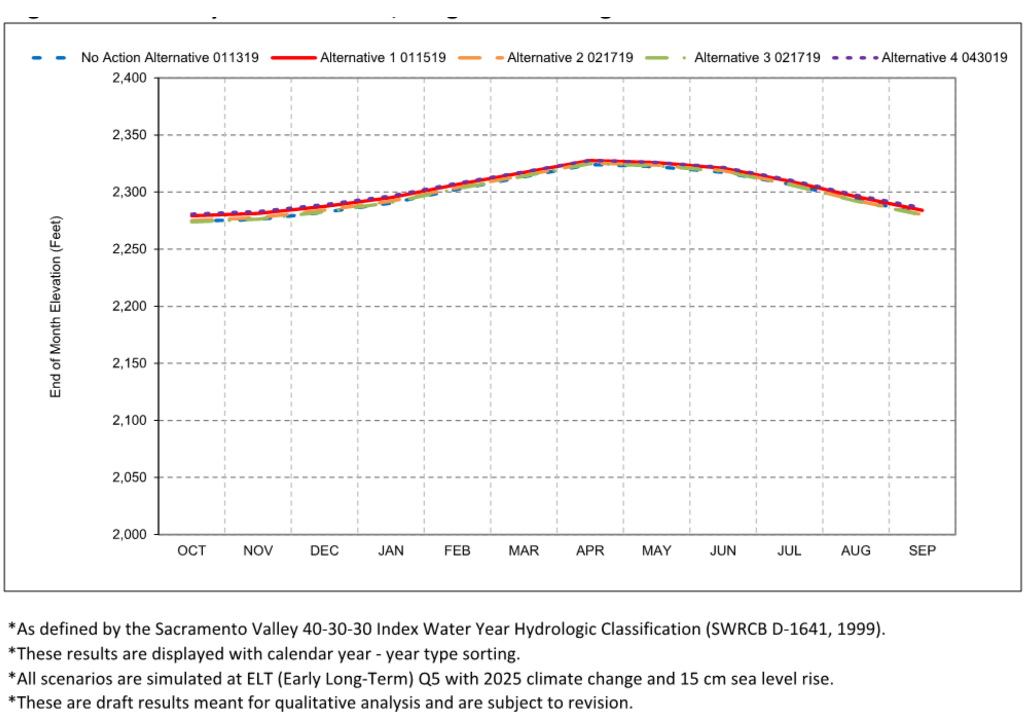
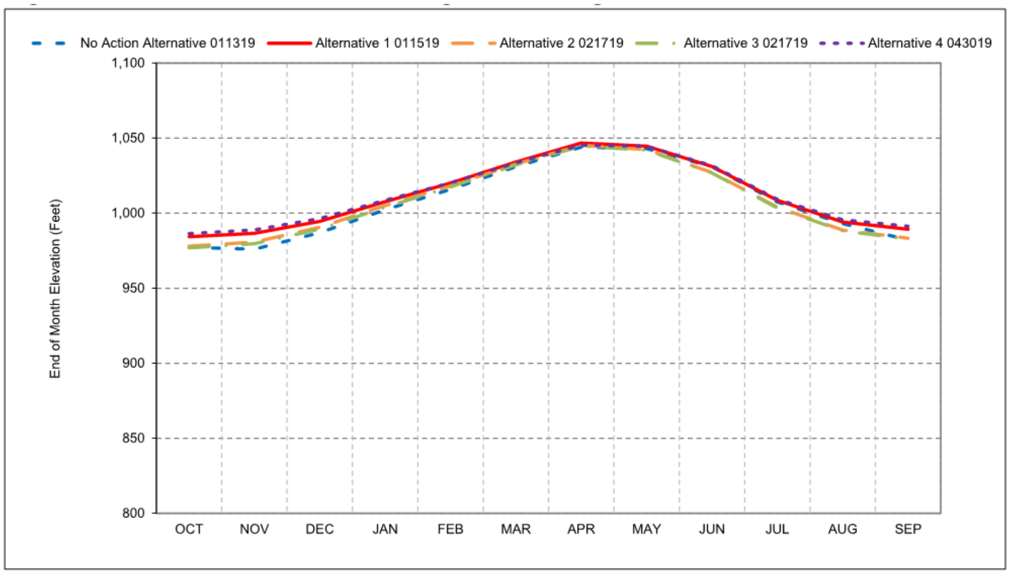


Figure S.2-1. Trinity Lake Long-Term Average Water Level Elevation Sacramento River

Under Alternative 1, the average water elevation of Shasta Lake would increase slightly (approximately 5-10 feet) from September through December compared to the No Action Alternative but would remain similar to the No Action Alternative from February through August, as shown in Figure S.2-2. The average water elevation would be highest in the spring and lowest in the fall, similar to the No Action Alternative. However, elevations in the fall season would be higher than the No Action Alternative, which would reduce seasonal fluctuations under Alternative 1. Water elevations under Alternative 1 would still be within the useable elevation range for most boat ramps on Shasta Lake during the spring and summer months. The slight increase in elevation could make the Bailey Cove Boat Ramp useable for a longer period during the year and would make Sugar Loaf Boat Ramp useable for less of the year. Because average water elevations would not be likely to substantively change during the spring and summer months, there would be no impact on camping, day use activities, or recreational fishing on Shasta Lake during those seasons. The approximately 5-10 foot elevation increase compared to the No Action Alternative from September to December on Shasta Lake could have minor benefits on camping and day use, as the shoreline would be closer to campgrounds and facilities, as well as activities such as hiking or wildlife viewing, and recreational fishing access..



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

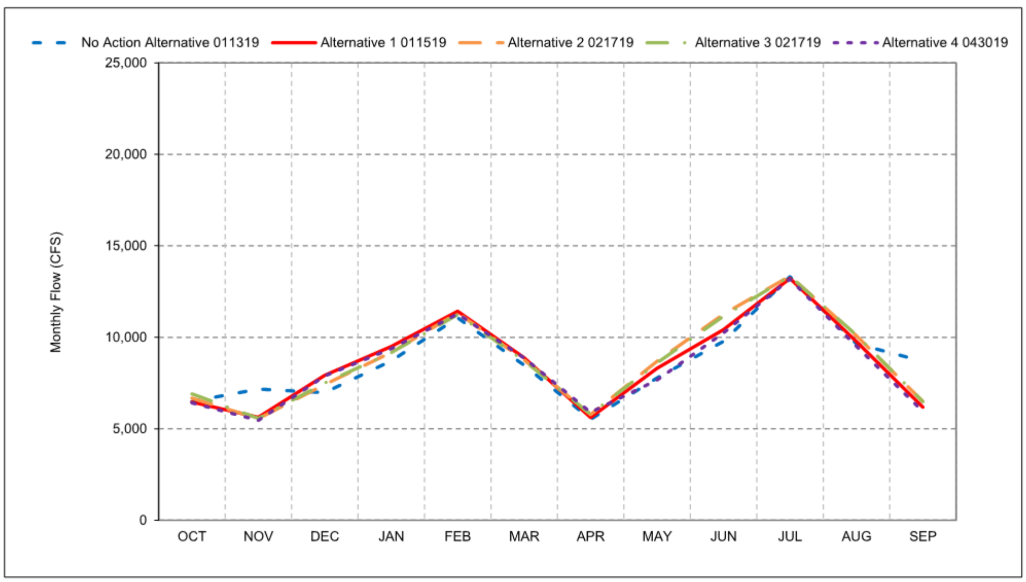
Figure S.2-2. Shasta Lake Long-Term Average Water Level Elevation

Average water elevations and seasonal fluctuations at Keswick Reservoir are not expected to substantially change under Alternative 1 compared to the No Action Alternative; therefore, impacts on boating activities are not expected. There are no camping opportunities at Keswick Reservoir, so no impacts on camping would occur. Because average water elevations are not expected to change at the Keswick Reservoir, there would be no impacts on day use activities nor recreational fishing opportunities.

Average water elevations and seasonal fluctuations at Whiskeytown Lake are not expected to change under Alternative 1 compared to the No Action Alternative; therefore, no impacts on boating activities or access on Whiskeytown Lake, camping or day use activities near the lake, or recreational fishing opportunities on the lake are expected.

Boating occurs along the Sacramento River, and there are whitewater rafting and kayaking opportunities on the Sacramento River between Keswick Dam and Red Bluff. Average flows on the Sacramento River under Alternative 1 compared to the No Action Alternative would increase from December through March and May through June; flows under Alternative 1 would decrease in September and November compared to the No Action Alternative, as shown in Figures S.2-3 and S.2-4. Slight increases in flow could affect whitewater boating in the spring and summer seasons by potentially increasing the experience for advanced whitewater rafters and decreasing the accessibility for less advanced boaters. Average flows are expected to decrease compared to the No Action Alternative in the fall season, and therefore could affect boating access as well as whitewater rafting by potentially improving the opportunities for less advanced whitewater boaters and decreasing the experience for advanced whitewater boaters.

Public campgrounds, day use activities, and recreational fishing also occur along the Sacramento River. Changes in average flows and flow fluctuations could affect camping, day use, and fishing opportunities along the river as aesthetics and access to the river may change. For example, decreases in flow during the fall season could adversely affect shoreline access for activities such as swimming and fishing, and increases in flow in May and June could improve access to the shoreline.



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
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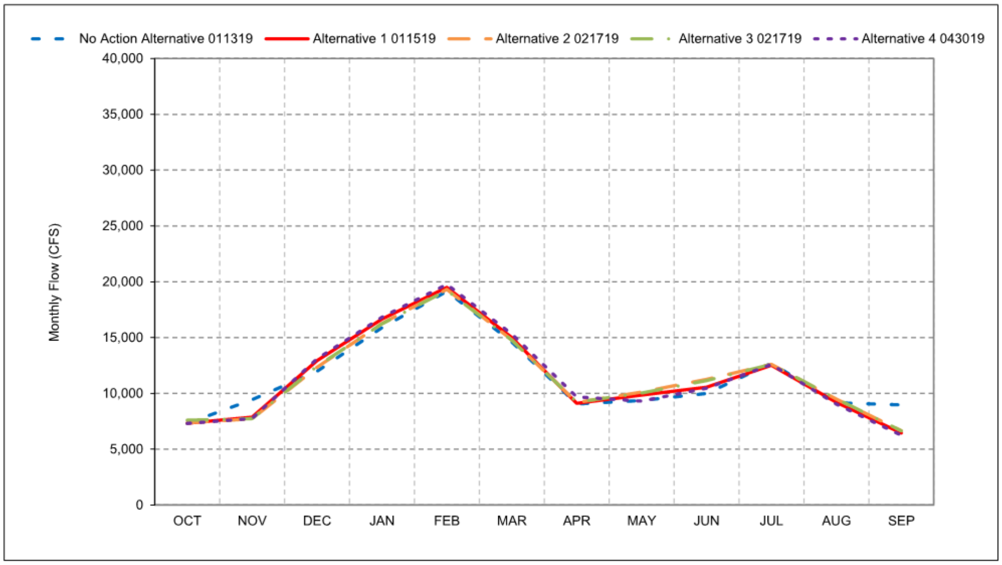
*These are draft results meant for qualitative analysis and are subject to revision.

Figure S.2-3. Sacramento River Long-Term Average Flow Downstream of Keswick Reservoir

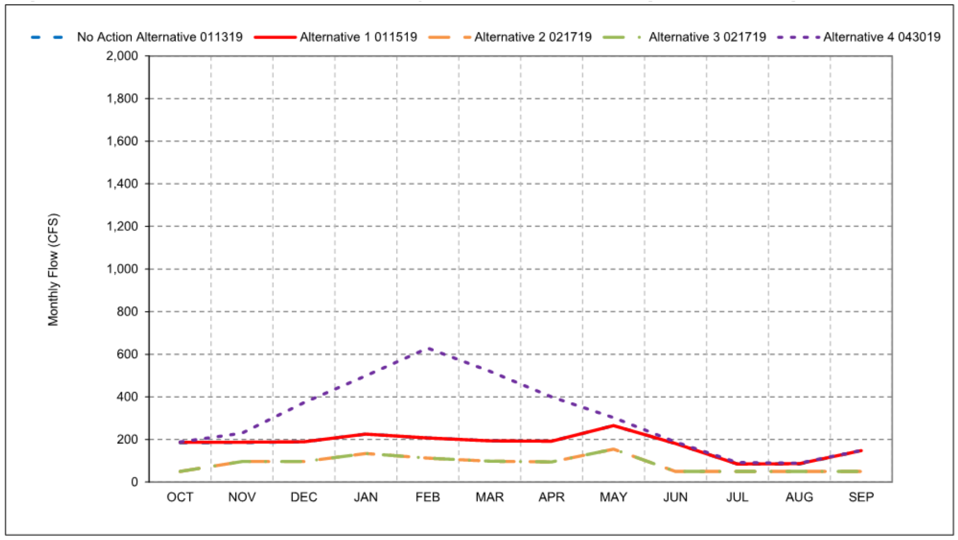


*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure S.2-4. Sacramento River Long-Term Average Flow Below Red Bluff Diversion Dam

Clear Creek

The average flows and seasonal fluctuations at Clear Creek below Whiskeytown Dam would be approximately the same under Alternative 1 as the average flows and seasonal fluctuations under the No Action Alternative throughout the year, as shown in Figure S.2-5. Therefore, existing kayaking opportunities, day use activities, and recreational fishing opportunities would not change under Alternative 1. There are no camping opportunities at Clear Creek, so Alternative 1 would have no impacts on camping.

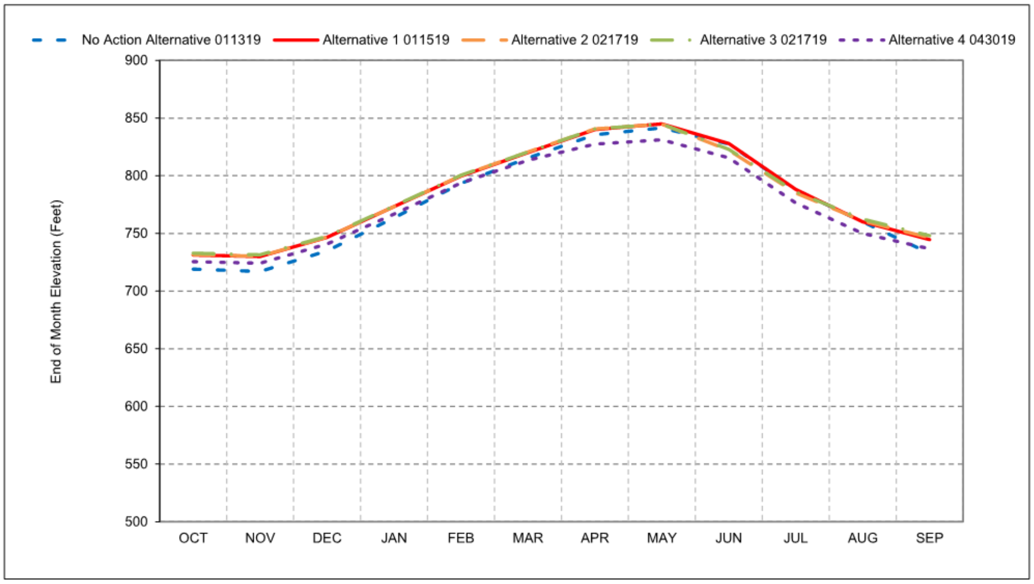


*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure S.2-5. Clear Creek below Whiskeytown Dam Long-Term Average Flow

Feather River

Boating activities occur on Lake Oroville and Lake Thermalito. Whitewater boating occurs on the Big Bend area of the North Fork Feather River and the Bald Rock Canyon on the Middle Fork Feather River. Under Alternative 1, the average elevation of Lake Oroville would increase compared to the No Action Alternative from September through June with the largest increase occurring in September through January. From June through August, the average elevation under Alternative 1 would be approximately the same as the average elevation under the No Action Alternative, as shown in Figure S.2-6. Thus, seasonal fluctuations would decrease compared to the No Action Alternative. There could be adverse impacts on whitewater boating in the Big Bend Area as boating occurs when Lake Oroville elevations are sufficiently low to expose several miles of river, particularly in the late fall months. However, there could be minor benefits on boating activities or access as more boat ramps could be accessible for a longer period of the year. Increased water elevations could also benefit recreational fishing access. On average, the shoreline would be closer to camping and day use activities, which could have minor benefits on these activities.



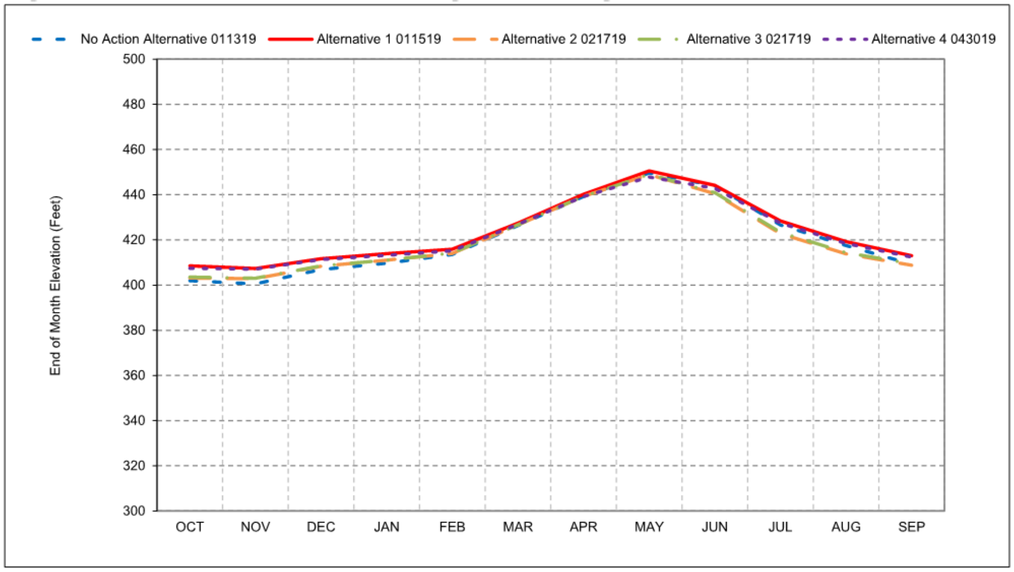
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure S.2-6. Lake Oroville Long-Term Average Water Level Elevation

American River

A variety of boating activities, including jet skiing, waterskiing, windsurfing, rafting, sailing canoeing, and kayaking, occur on Folsom Lake. Additionally, whitewater rafting occurs along the South Fork American River upstream of Folsom Lake, and at Skunk Hollow and Salmon Falls. Under Alternative 1, average Folsom Lake water elevations would increase from June through February compared to the No Action Alternative. The largest increase from the No Action Alternative, approximately 10 feet, would occur in October and November. From February through June, the average reservoir storage and elevation under Alternative 1 would be approximately the same as the No Action Alternative, as shown in Figure S.2-7. Thus, the lake would experience less seasonal fluctuation under Alternative 1 than the No Action Alternative. There could be minor benefits from increased average water elevations in the summer, fall, and winter seasons on boating activities and boat ramp access, as well as recreational fishing access. Additionally, there could be minor benefits on camping and day use activities near Folsom Lake as the shoreline would be closer to campgrounds and day use facilities in summer, fall, and winter seasons. Because the average water levels are generally lower during these seasons, it is unlikely that water levels would rise enough to flood nearby facilities or substantively shrink the beach. Water levels upstream of Folsom Lake are not expected to change under Alternative 1, so whitewater rafting would not change.

Under Alternative 1, average water elevation levels and seasonal fluctuations in Lake Natoma could increase in the summer, fall, and winter months, as Lake Natoma is located 1 mile downstream of Folsom Lake and could be influenced by changes in Folsom Lake (see Figure S.2-7). Boating, camping, day use activities, and recreational fishing could experience minor benefits as described above; however, average water elevations and fluctuations at Lake Natoma have not been explicitly modeled.

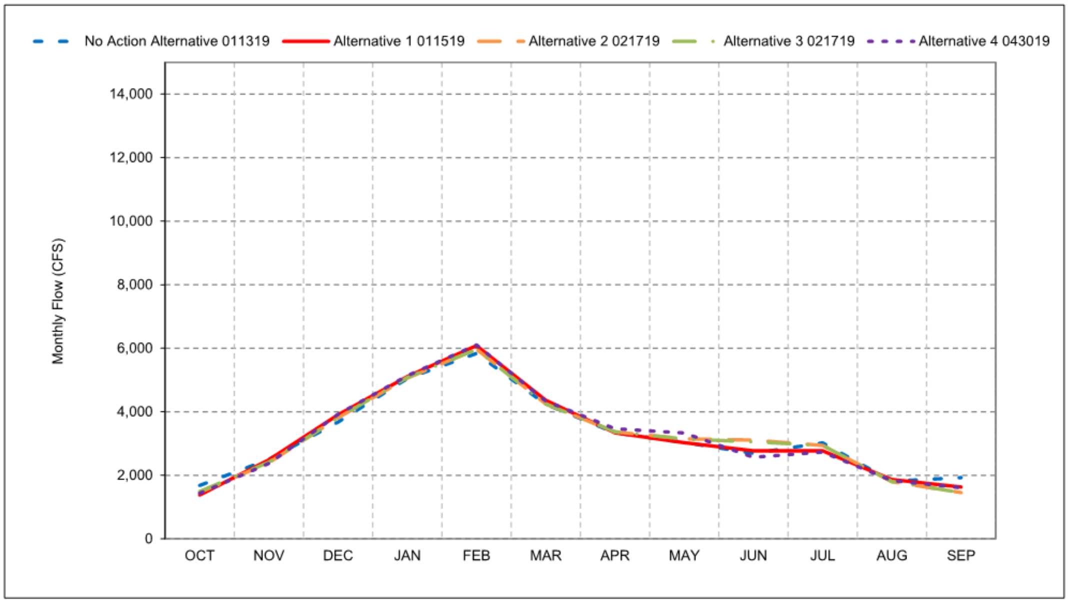


*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure S.2-7. Folsom Lake Long-Term Average Water Level Elevation

Compared to the No Action Alternative, there could be a slight decrease (approximately 300 cfs) in average flow in July, September, and October of the American River below Nimbus Dam, which is the beginning of the American River Parkway, under Alternative 1; there could also be a slight increase (approximately 100-200 cfs) increase in December through March compared to the No Action Alternative, as shown in Figure S.2-8. Seasonal fluctuations would remain approximately the same as the No Action Alternative with the highest flows occurring in February, and the lowest flows occurring in September and October. Increases in flows in the early spring could make the river more accessible to boating activities. Decreases in flow in July, September, and October (approximately 200-300 cfs), could make the river more accessible to novice rafters but could have minor adverse impacts on boating activities and the experience for advanced whitewater rafters. Day use activities would not be substantially affected by changes in flows. There is no camping along the American River Parkway, so no impacts would occur.

There are no anticipated changes to average water levels or seasonal fluctuations at Rancho Seco Park and Lake under Alternative 1. Therefore, boating, camping, day use activities, and recreational fishing access would not be affected.



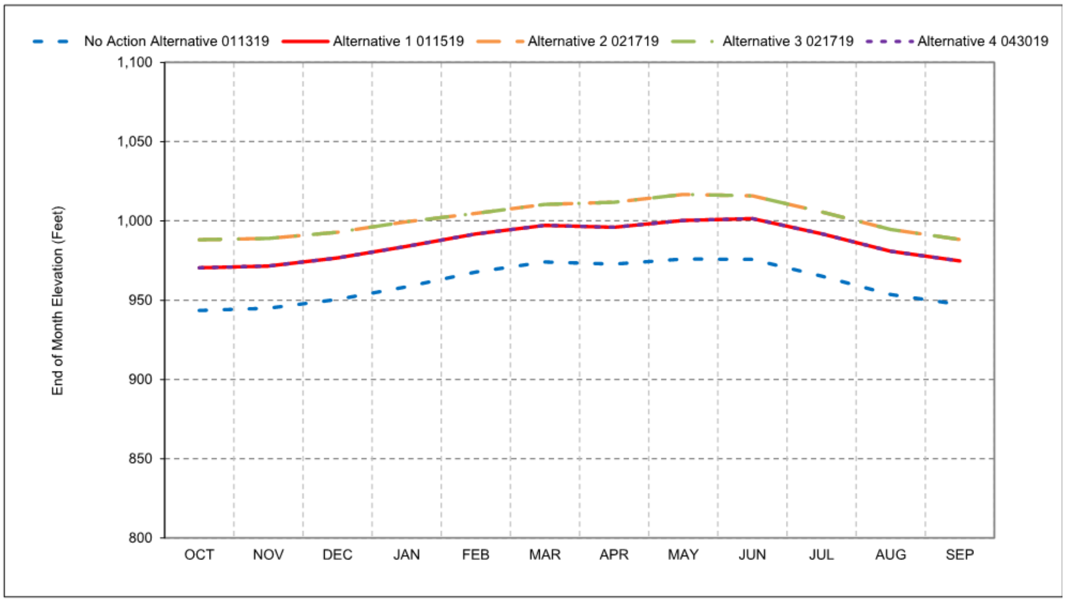
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure S.2-8. American River Average Flow below Nimbus Dam

Stanislaus River

Boating occurs on New Melones Reservoir and Alternative 1 would increase the average water level elevation of New Melones Reservoir year-round by approximately 20-30 feet, as shown in Figure S.2-9. The average reservoir elevations for Alternative 1 would still be within the useable elevation for boat ramps on the reservoir. Additionally, the elevation increases would make the boat ramp at Angels Creek useable for a longer period. Thus, Alternative 1 could benefit boating and recreational fishing access. Campgrounds and day use facilities at New Melones Reservoir that are located close to the water could be affected by changing water levels. This could benefit the campgrounds and day use activities near the reservoir by bringing the water levels closer to the campgrounds and day use facilities. This average increase in water elevation would not increase the likelihood that campgrounds and day use facilities would be flooded because the maximum elevation of the reservoir, 1,088 feet, would not change. An increase in average water elevations at New Melones Reservoir could benefit day use activities such as swimming, by increasing the size of the swimming area and could make the beach easier to access. This increase would not be expected to affect other day use activities such as hiking or wildlife viewing because the increases would be relatively small.

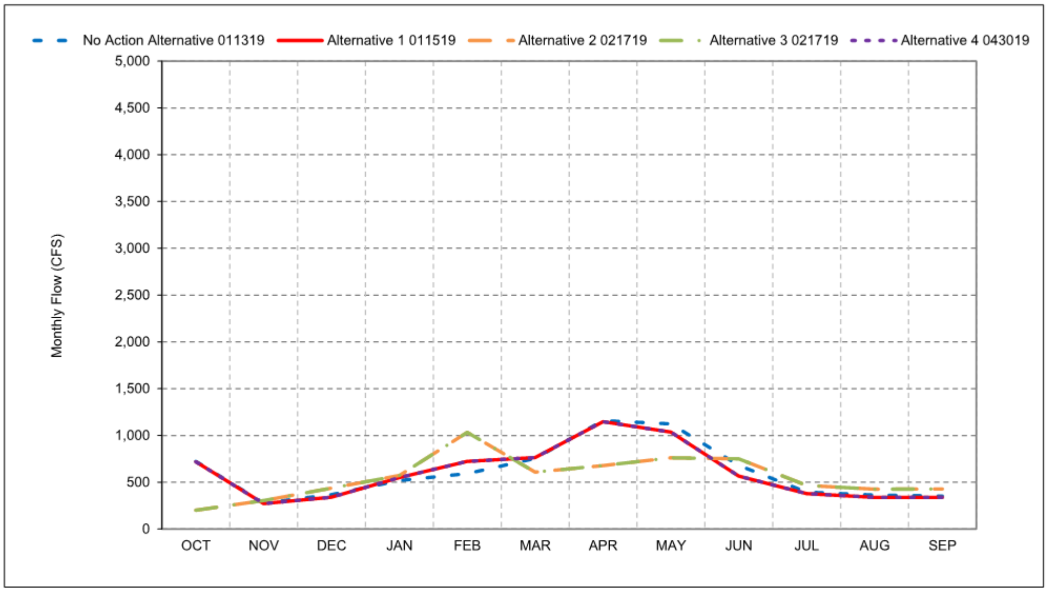
Tulloch Reservoir is located approximately 6 miles downstream of New Melones Reservoir. The proposed New Melones Reservoir stepped release plan would reduce the required amount of water released from New Melones Reservoir during above-normal and wet years; releases would remain the same for critical, dry, and below-normal water year types. Because these releases would only be reduced in above-normal and wet years, average water elevations are not anticipated to change at Tulloch Reservoir. Thus, there would no substantive impacts on boating, camping, day use activities, or recreational fishing access.



*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure S.2-9. New Melones Reservoir Long-Term Average Water Level Elevation

Whitewater rafting occurs on the lower stretch of the Stanislaus River, which includes the portion of the river that flows through Goodwin, California to the mouth at the San Joaquin River. Under Alternative 1, flows are anticipated to decrease slightly from April through July and increase between January and mid-March compared to the No Action Alternative, as presented in Figure S.2-10. Slightly weaker flows in the river during the spring and summer seasons could affect whitewater rafting opportunities along the river; slower currents could increase the opportunities for beginner and intermediate-level whitewater rafters and could lessen the experience for more advanced whitewater rafters. Increased flows in the winter and early spring could affect day use activities; for example, increased average flows could wash out hiking trails in very wet years. Increased flows in late winter and early spring could improve recreational fishing by improving fishing access.

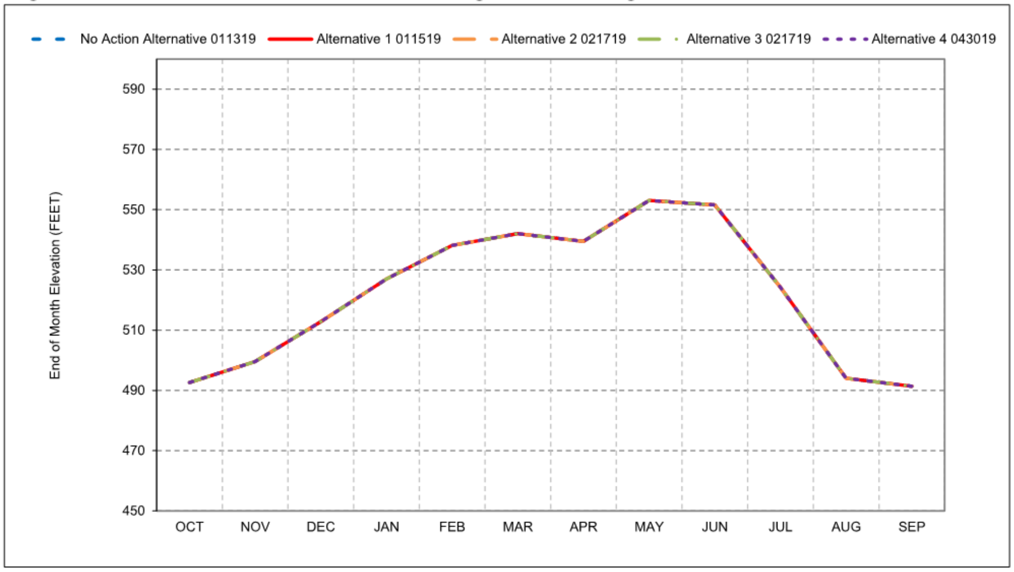


*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.
*New Melones forecasts are used as the basis of water operations.

Figure S.2-10. Stanislaus River Flow below Goodwin Long-Term Average Flow

San Joaquin River

A variety of boating activities occur on Millerton Lake and there are whitewater rafting opportunities upstream of Millerton Lake. As shown in Figure S.2-11, there would be no change in average lake elevations or seasonal fluctuations under Alternative 1 compared to the No Action Alternative, so boating activities would not be affected. Whitewater rafting opportunities upstream of Miller Lake would not be affected, as no changes are anticipated in flows between Alternative 1 and the No Action Alternative. With no expected changes to flows or average water elevations at Millerton Lake, on the San Joaquin River, or at the San Joaquin wildlife refuges, there would also be no impacts on camping, day use activities or fishing.



*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure S.2-11. Millerton Lake Long-Term Average Water Level Elevation

Boating activities occur on the San Joaquin River from Friant Dam to the Delta, and whitewater rafting occurs between Friant Dam and Skaggs Bridge Park, at State Route 145. Average flows on the San Joaquin River are not anticipated to substantively change under Alternative 1 compared to the No Action Alternative. Therefore, no impacts to boating activities or access, camping, day use activities, or recreational fishing would occur.

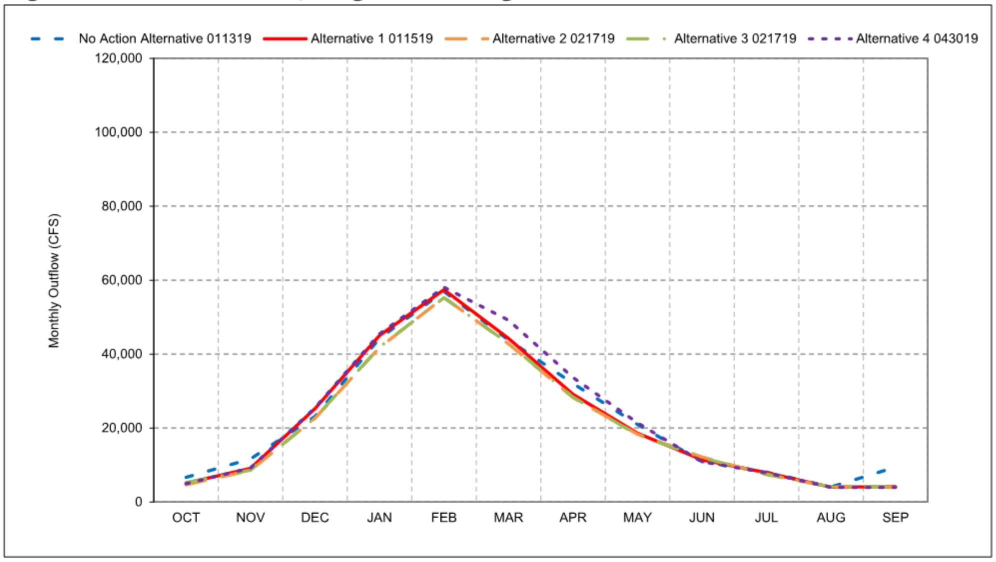
There are no boating, camping, or recreational fishing opportunities at the San Joaquin Valley Refuges, so no impacts on boating, camping, or fishing would occur. Day use activities would not be affected as flows would not substantively change.

Bay–Delta

It is anticipated that there would be slight changes in Delta outflow under Alternative 1, particularly in September (as shown in Figure S.2-12), but these changes would not be great enough to substantively affect boating, camping, day use activities, or fishing on the Delta.

Although flows would change, there would be no changes in average elevations in the Bay-Delta system under Alternative 1 as compared to the No Action Alternative. Therefore, no impacts on recreation are anticipated at the Yolo Bypass and Cache Slough, or in the San Francisco Bay reservoirs, including Contra Loma Reservoir, Bethany Reservoir, Lake Del Valle, Los Vaqueros Reservoir, San Pablo Reservoir, Lafayette Reservoir, or Lake Chabot. No recreation activities occur on two San Francisco Bay reservoirs, the San Justo Reservoir and the Upper San Leandro Reservoir, so there would be no impacts at these locations.

Under Alternative 1, water transfers would be allowed between July 1 and November 30; transfers could potentially increase average water elevation in the Bay-Delta region during these periods, but the potential impacts have not been explicitly modeled.



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure S.2-12. Bay-Delta Long-Term Average Outflow

If the Summer-Fall Delta Smelt Habitat action includes operations of the Suisun Marsh Salinity Control Gates or a Fall X2 action, the water requirements in summer and fall under Alternative 1 could be greater than shown in the modeling. Alternative 1 indicates minor changes to average water elevations and flows, as described in this section in more detail. In years with the summer or fall actions, these changes would be less than indicated in the Alternative 1 modeling due to the increased water requirements. Thus, benefits and impacts to recreation may be less in these years than what is anticipated under Alternative 1 without these actions.

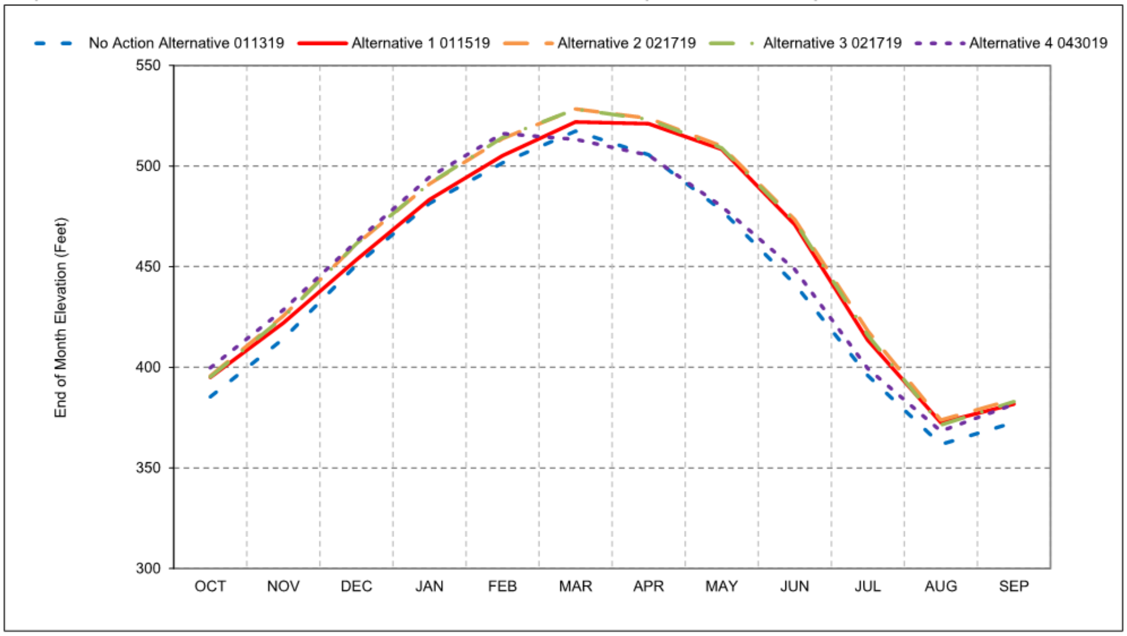
CVP and SWP Service Areas

Compared to the No Action Alternative, there are no anticipated changes to average flows, water elevations and seasonal fluctuations in water bodies in the CVP and SWP Service Areas under Alternative 1. Therefore, no changes to recreation are anticipated in this region.

San Luis Reservoir

Compared to the No Action Alternative, average water elevations under Alternative 1 could increase at San Luis Reservoir between mid-March and mid-December, with the largest increases approximately 25 feet) occurring between late April and mid-June (as shown in Figure S.2-13). Between mid-June and December, the average elevation could increase approximately 10 feet as compared to the No Action Alternative. These elevation increases largely follow the existing seasonal fluctuations at San Luis Reservoir. Boat ramps, which are open year-round, would still be usable with the anticipated spring to summer increases. An increase in average water elevations would also benefit boating because the depth to underwater hazards would be increased, making boating near those areas safer for a larger part of the year.

The increase in average water elevations at San Luis Reservoir would benefit camping because access to the lake would improve. Day use activities such as hiking and swimming would also benefit from increased water levels in spring and summer. Hiking trails are not located directly on the shore and are not likely to be flooded or washed out with the anticipated increase in water levels. The shoreline of San Luis Reservoir can be steep and rocky; therefore, the increase in water levels would benefit swimming by allowing easier access to the water. Indirect benefits to picnicking and hiking are possible because higher water levels could improve the aesthetics and desirability of the area. Additionally, higher water levels would improve recreational fishing access.



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure S.2-13. San Luis Reservoir Long-Term Average Water Level Elevation

Nearshore Pacific Ocean on the California Coast

Under Alternative 1, benefits to Fall-Run Chinook Salmon could improve recreational fisheries in the Nearshore Pacific Ocean area.

S.2.3.2 *Program-Level Effects*

S.2.3.2.1 Potential Changes to Recreational Opportunities

Habitat restoration and fish intervention actions would be implemented under Alternative 1 in most river regions. These actions could have short-term construction impacts on recreational opportunities associated with the river, lakes, and reservoirs. Construction impacts, such as exhaust from equipment, noise, and road closures, could temporarily prevent access to or affect the enjoyment of recreational opportunities, including boating, camping, day use activities, and fishing, in the short-term. Long-term benefits for fishing would be created by spawning and rearing habitat restoration and fish intervention actions that increase fish populations and the health of fisheries. In regions where no habitat restoration or fish intervention measures are implemented, there could still be indirect benefits to fish populations and fisheries from habitat restoration and fish intervention measures implemented elsewhere under Alternative 1.

S.2.4 Alternative 2

S.2.4.1 *Project-Level Effects*

S.2.4.1.1 Potential Changes to Recreational Opportunities

Trinity River

Under Alternative 2, the average elevation of Trinity Lake would remain roughly the same compared to the No Action Alternative, as shown in Figure S.2-1. Seasonal fluctuations in water levels would also remain roughly the same throughout the year. There would be no substantive impact on boating, as access to boat ramps, marinas, or moorage facilities would not be affected. Additionally, there would be no substantive impact on camping, day use activities, and fishing at and near Trinity Lake.

The water elevation is generally stable in Lewiston Reservoir because it is used as a regulating reservoir for releases to downstream uses. This is not expected to change under Alternative 2, so elevation levels would remain stable and would not affect boating, camping, day use and fishing at and near Lewiston Reservoir.

Sacramento River

Under Alternative 2, average Shasta Lake elevation levels would increase slightly from September to April and decrease slightly from May through August compared to the No Action Alternative, as shown in Figure S.2-2. However, these expected deviations are small (approximately 1-5 feet), and water elevations under Alternative 2 would remain similar to the No Action Alternative. Therefore, boating activities, camping, day use, and recreational fishing access would not be substantially affected.

Water elevations at Keswick Reservoir and Whiskeytown Lake are not anticipated to change under Alternative 2, so no impacts on boating and day use activities would occur. No camping occurs at Keswick Reservoir, so there would be no impacts on camping at this location.

Average flows at the Sacramento River below Keswick Dam and below Red Bluff Diversion Dam would decrease in September and November and generally increase for the remainder of the year compared to the No Action Alternative; the largest increases in flow would occur in May and June (Figures S.2-3 and S.2-4). Seasonal fluctuations in flows would therefore change compared to the No Action Alternative. Decreases in flow could affect boating and rafting by improving opportunities for less-advanced rafters and decreasing the experience for advanced boaters and rafters in September and November. Increases in flow over the remainder of the year could affect boating activities (including whitewater rafting) by potentially improving the experience for more advanced boaters and decreasing the opportunities for less-advanced boaters, particularly in May and June. Additionally, campgrounds, day use activities, and recreational fishing could be impacted by flow changes as aesthetics and access to the river may change, as described in Alternative 1.

Clear Creek

Under Alternative 2, the average flow at Clear Creek below Whiskeytown would be reduced by roughly half of the average flow under the No Action Alternative from September through June, as shown in Figure S.2-5. This could adversely affect kayaking on Clear Creek. There are no camping opportunities at Clear Creek, so Alternative 2 would have no impacts on camping. The changes in flows that could also adversely impact day use activities, such as wildlife viewing, and recreational fishing, as fish populations could be adversely affected by decreased flows.

Feather River

Water levels at the Feather River lakes are not anticipated to change under Alternative 2 compared to the No Action Alternative. Thus, boating activities, camping, day use, and fishing associated with the Feather River lakes would not be affected by changing water levels.

Under Alternative 2, the average elevation at Lake Oroville would slightly increase compared to the No Action Alternative from September through June. From June through August, the average elevation under Alternative 2 would be approximately the same as the average elevation under the No Action Alternative, as shown in Figure S.2-6. Seasonal fluctuations would decrease compared to the No Action Alternative. These changes are very similar to the changes that would occur under Alternative 1. Therefore, impacts to recreation under Alternative 2 would be very similar to those discussed under Alternative 1.

American River

Under Alternative 2, average Folsom Lake storage would increase slightly from September through February and decrease slightly from May through September compared to the No Action Alternative. The average water elevation would remain roughly the same from February through May under Alternative 2 and the No Action Alternative, as shown in Figure S.2-7. The slight elevation increases under Alternative 2 compared to the No Action Alternative would not be great enough to have substantive impacts on boating access, camping, day use, or recreational fishing access. Additionally, water levels upstream of Folsom Lake are not expected to change under Alternative 2, so whitewater rafting would not be affected. Boating and fishing access could experience minor adverse effects from decreases in water levels during the summer months. Similarly, campgrounds and day use facilities near Folsom Lake could be adversely affected in the summer season, as the shoreline could be slightly farther from facilities.

The average water elevations at Lake Natoma have not been explicitly modeled; however, average elevations may decrease in the summer months, as the lake is 1 mile downstream of Folsom Lake. Thus, there could be minor adverse effects on recreation.

Average flows of the American River below Nimbus Dam (the beginning of the American River Parkway) would be slightly higher under Alternative 2 than the No Action Alternative from November through June, with the greatest difference in flow occurring in June (approximately 420 cfs), as shown in Figure S.2-8. Average flows would decrease in July through November compared to the No Action Alternative, with the largest decrease occurring in November (approximately 470 cfs). The increase in spring and early summer flows would increase the difficulty of whitewater rafting, potentially limiting access to novice rafters. However, the lower flows in summer and fall would make the river more accessible to novice rafters. Increased spring flows could make the river more accessible to boating while lower flows in summer benefit fishing access by maintaining fisheries on the river. No impacts on camping or day use activities are expected to occur.

Average elevation levels and seasonal fluctuations are not anticipated to change Rancho Seco Park and Lake under Alternative 2, so there would be no impact on camping.

Stanislaus River

The year-round average elevation at New Melones Reservoir would increase under Alternative 2 by approximately 35-45 feet (shown in Figure S.2-9). The average reservoir elevations for Alternative 2 would still be within the useable elevation for the boat ramps. Additionally, the elevation increases would make the boat ramp at Angels Creek useable for a longer period. Thus, Alternative 2 could benefit boating. The higher average lake elevations would decrease the distance of campgrounds and day use facilities to the shoreline and therefore benefit camping. The average increase in water elevation would not increase the likelihood that campgrounds and day use facilities would be flooded because the maximum elevation of the reservoir would not change. The increase to average water elevations could affect day use activities such as swimming by increasing the swimming area and making the shoreline easier to access. Hiking trails situated near the shoreline may be affected if the water elevation increases enough, but this amount of change is not likely. There would not be impacts on other day use activities. The increase to average water elevations at New Melones Reservoir could increase recreational fishing access.

Under Alternative 2, average water elevations or seasonal fluctuations in Tulloch Reservoir are not expected to be affected; therefore, no changes to boating, camping, day use activities, or recreational fishing associated with the Tulloch Reservoir would occur.

Whitewater rafting and fishing occur on the lower stretch of the Stanislaus River. Under Alternative 2, average flows would be higher than the No Action Alternative in November through February and June through September, with the highest increase in flows occurring February (approximately 440 cfs). Average flows would decrease in March through May and October through mid-November, with the largest decreases occurring in October and April (approximately 500 cfs), as shown in Figure S.2-10. Thus, seasonal fluctuations would change compared to existing conditions. Weaker flows could affect whitewater rafting by making the river more accessible to less-advanced rafters and decreasing the enjoyment for advanced rafters. Reduced flows could also adversely impact recreational fishing access. Stronger flows occur in February when recreation is less popular, so there would not be substantive effects.

San Joaquin River

Under Alternative 2, there would be no changes to recreation on Millerton Lake compared to the No Action Alternative, as average water elevations and seasonal fluctuations are not changing (Figure S.2-11).

Average San Joaquin River flows are not likely to be substantively different under Alternative 2 compared to the No Action Alternative. Therefore, there would not be substantive impacts on boating, camping, day use activities, and fishing at this location.

There would be no changes to day use activities at the San Joaquin wildlife refuges under Alternative 2 compared to the No Action Alternative.

Bay–Delta

Similar to Alternative 1, it is anticipated that there would be slight flow changes to Delta outflow under Alternative 2 compared with the No Action Alternative (Figure S.2-12). However, these changes would not be large enough to substantively impact recreation associated with the Delta.

No changes in average reservoir elevations are expected under Alternative 2 compared to the No Action Alternative; therefore, no impacts on boating are anticipated at the Yolo Bypass and Cache Slough, or in the San Francisco Bay reservoirs, as discussed in Alternative 1.

CVP and SWP Service Areas

Similar to Alternative 1, there would be no changes in water bodies in the CVP and SWP Service Areas, and therefore no changes to recreation would occur under Alternative 2.

San Luis Reservoir

Similar to Alternative 1, average water levels under Alternative 2 would increase at San Luis Reservoir, and the seasonal fluctuation would remain similar to existing conditions (Figure S.2-13). Average water levels would be approximately 10 to 25 feet higher year-round compared to the No Action Alternative, with the greatest increases in water elevation anticipated between March and the end of June. During the rest of the year, water levels would be about 10 feet higher compared to the No Action Alternative. Increased water elevations could benefit recreation by improving water access at boat ramps, recreational fishing opportunities, and aesthetics. Day use activities such as hiking, swimming, and picnicking also benefit from these improvements and increases in water levels.

Nearshore Pacific Ocean on the California Coast

Alternative 2 would not benefit Fall-Run Chinook Salmon and could affect recreational fisheries in the Nearshore Pacific Ocean area.

S.2.4.2 *Program-Level Effects*

S.2.4.2.1 Potential Changes to Recreational Opportunities

No additional habitat restoration and fish intervention actions would occur under Alternative 2, so there would be no short-term construction impacts on recreational opportunities. Similar to the No Action Alternative, there would be no long-term beneficial effects on fish populations and the health of fisheries from the implementation of habitat restoration and fish intervention actions.

S.2.5 Alternative 3

S.2.5.1 *Project-Level Effects*

S.2.5.1.1 Potential Changes to Recreational Opportunities

Trinity River

Similar to Alternative 2, no changes in average water elevation or seasonal fluctuations are expected under Alternative 3 at Trinity Lake or Lewiston Reservoir; therefore, no impacts on recreation are anticipated.

Sacramento River

Similar to Alternative 2, average Shasta Lake elevation levels experience small deviations (approximately 1-5 feet) from the No Action Alternative. Therefore, boating activities and access, camping, day use, and fishing would not be substantively affected.

Water elevations at Keswick Reservoir and Whiskeytown Lake are not anticipated to change under Alternative 3, so no impacts to recreation are anticipated.

Under Alternative 3, average flows and seasonal fluctuations in flows would change compared to the No Action Alternative, in very similar ways as Alternative 2. Thus, impacts on recreation would be the approximately the same as those discussed in Alternative 2.

Clear Creek

Under Alternative 3, the average flow at Clear Creek would be reduced compared to the No Action Alternative by the same amount as under Alternative 2. Therefore, the impacts on recreation would be the same as the impacts discussed under Alternative 2.

Feather River

Water levels at the Upper Feather River lakes are not anticipated to change under Alternative 3 compared to the No Action Alternative. Thus, no impacts to recreation would occur.

Compared to the No Action Alternative, the changes in average Lake Oroville elevation and seasonal elevation fluctuations are anticipated to be very similar to the changes that occur under Alternatives 1 and 2. Therefore, potential impacts to recreation under Alternative 3 would be the same as those described in Alternatives 1 and 2.

American River

The same changes in average water elevation, flow, and seasonal fluctuations described in Alternative 2 would occur under Alternative 3; thus, the same impacts to recreation at Folsom Lake, Lake Natoma, and the American River Parkway described in Alternative 2 could occur under Alternative 3.

Stanislaus River

The same changes in average water elevation, flow, and seasonal fluctuations described in Alternative 2 would occur under Alternative 3; therefore, the same impacts to recreation at New Melones Reservoir, Tulloch Reservoir, and the lower Stanislaus River would occur.

San Joaquin River

Under Alternative 3, there would be no substantive changes to average water elevations, flows, or seasonal fluctuations in Millerton Lake, the San Joaquin River, or the San Joaquin wildlife refuges compared to the No Action Alternative. Thus, no impacts on recreation would occur in the San Joaquin River region.

Bay–Delta

Similar to Alternative 1 and 2, it is anticipated that there would be slight flow changes to Delta outflow under Alternative 3 compared with the No Action Alternative. However, these changes would not be large enough to substantively impact recreation associated with the Delta.

No changes in average reservoir elevations are expected under Alternative 3 compared to the No Action Alternative; therefore, no impacts on boating are anticipated at the Yolo Bypass and Cache Slough, or in the San Francisco Bay reservoirs, as discussed in Alternatives 1 and 2.

CVP and SWP Service Areas

Similar to Alternatives 1 and 2, there would be no changes in water bodies in the CVP and SWP Service Areas compared to the No Action Alternative, and therefore no changes to recreation would occur under Alternative 3.

San Luis Reservoir

Under Alternative 3, the changes in average water levels would be similar to Alternative (Figure S.2-13); therefore, the effects would also be similar. Benefits to boating, day use activities like hiking, swimming, and picnicking, and recreational fishing opportunities can be expected from the increased water levels. Nearshore Pacific Ocean on the California Coast

Alternative 3 would not benefit Fall-Run Chinook Salmon and could affect recreational fisheries in the Nearshore Pacific Ocean area.

S.2.5.2 *Program-Level Effects*

S.2.5.2.1 Potential Changes to Recreational Opportunities

Under Alternative 3, habitat restoration and fish intervention actions would be implemented in most river regions. As described in Alternative 1, these actions could have short-term construction impacts on recreational opportunities associated with the river, lakes, and reservoirs. Long-term benefits for fishing would be created by spawning and rearing habitat restoration and fish intervention actions that increase fish populations and the health of fisheries. Regions in which no habitat restoration or fish intervention measures are implemented, could still experience indirect benefits to fish populations and fisheries.

S.2.6 Alternative 4

S.2.6.1 *Project-Level Effects*

S.2.6.1.1 Potential Changes to Recreational Opportunities

Trinity River

Similar to Alternative 1, average monthly water elevation at Trinity Lake could be slightly higher, by approximately 5 feet, compared to the No Action Alternative; seasonal fluctuations in water levels would remain approximately the same under Alternative 4 as the No Action Alternative (see Figure S.2-1). Therefore, Alternative 4 could have minor benefits on recreational opportunities.

The water elevation is generally stable in Lewiston Reservoir because it is used as a regulating reservoir for releases for downstream uses. This is not expected to change under Alternative 4, so elevation levels would remain stable and would not affect recreational opportunities.

Sacramento River

Similar to Alternative 1, the average monthly water elevation of Shasta Lake under Alternative 4 would increase slightly (approximately 4-13 feet) from September through February compared to the No Action Alternative, but would remain similar to the No Action Alternative from March through August (an increase of 1-3 feet), as shown in Figure S.2-2. Thus, minor benefits to boating, camping, fishing, and day use could occur in the fall as discussed in Alternative 1.

Water elevations at Keswick Reservoir and Whiskeytown Lake are not anticipated to change under Alternative 4, so no impacts on boating, day use activities, or recreational fishing would occur. No camping occurs at Keswick Reservoir, so there would be no impacts on camping at this location.

Average flows on the Sacramento River between Keswick Reservoir and Red Bluff would increase slightly (450 cfs) in June and decrease slightly (less than -140 cfs) in May, July, and August relative to the No Action Alternative. The highest decrease in monthly average flows is expected to occur in September (-2,740 cfs). Average flows would increase in winter through early summer months (see Figures S.2-3 and S.2-4). Seasonal fluctuations in flows would therefore change compared to the No Action Alternative. Changes in flows could affect boating, whitewater rafting, camping, day use activities, and recreational fishing as aesthetics and access to the river may change (as described in Alternative 1).

Clear Creek

Under Alternative 4, there would be an increase in average flows from November through May; the highest increase would occur in February, where average flows under Alternative 4 would be more than 400 cfs greater than the average flows under the No Action Alternative, as shown in Figure S.2-5. Average flows would be approximately the same as the No Action Alternative for the remainder of the year. The increase in flow during the winter and spring months could benefit day use activities such as wildlife viewing and recreational fishing, as increased flows could benefit fish populations. Kayaking opportunities may change during this time, as the flows may increase the experience for advanced kayakers and decrease the opportunities for less advanced kayakers.

Feather River

Under Alternative 4, the average water elevations in Lake Oroville would be higher than the No Action Alternative (by approximately 3-7 feet) from September through January, approximately the same as No Action Alternative from February through mid-March, and lower than the No Action Alternative (by approximately an average of 9 feet) from mid-March through August (see Figure S.2-6). Thus, seasonal fluctuations would decrease compared to the No Action Alternative. There could be adverse impacts on whitewater boating in the Big Bend Area, as boating occurs when Lake Oroville elevations are sufficiently low to expose several miles of river, particularly in the late fall months. Additionally, Alternative 4 could have minor impacts on camping, day use activities, and recreational fishing access, as the water levels could be further from the shore in spring and summer months and fishing access may be affected.

American River

Similar to Alternative 1, the average water elevations at Folsom Lake under Alternative 4 would decrease slightly (less than 2 feet) in May and June, increase slightly in the fall and winter months compared to the No Action Alternative, and would be approximately the same as the No Action Alternative in the late summary and spring months (see Figure S.2-7). Thus, there could be minor benefits from increased average water elevations in the fall and winter seasons on boating, recreational fishing access, camping, and day use activities.

Under Alternative 4, average water elevation levels and seasonal fluctuations in Lake Natoma could increase in the summer, fall, and winter months, as Lake Natoma is a regulating reservoir for Folsom Lake and could be influenced by changes in Folsom Lake (see Figure S.2-7). Boating, camping, day use activities, and recreational fishing could experience minor benefits as described above; however, average water elevations and fluctuations at Lake Natoma have not explicitly been modeled.

Compared to the No Action Alternative, there could be a slight increase in average flow of the American River Parkway in December through May and again in August; a decrease in flow is anticipated to occur in June, July, and September (approximately 100-300 cfs on average), as shown in Figure S.2-8. Seasonal fluctuations would be similar under Alternative 4 and the No Action Alternative; the highest monthly flows are expected to occur in February and lowest in September and October. Increased flows in winter and spring would make the river more accessible to boating activities, including advanced whitewater rafting. Decreases in average flow in June, July, and September could decrease the opportunities for advanced boaters but increase the opportunities for less advanced boaters. Day use activities along the river would not be substantively affected by changes in flows. No impacts to camping would occur, as there are no camping opportunities along the river.

There are no anticipated changes to average water levels or seasonal fluctuations at Rancho Seco Park and Lake under Alternative 4. Therefore, boating, camping, day use activities, and recreational fishing access would not be affected.

Stanislaus River

Under Alternative 4, average water elevations and seasonal fluctuations at New Melones Reservoir (see Figure S.2-9) and average flows in the lower Stanislaus River (see Figure S.2-10) would change compared to the No Action Alternative by the same amount as under Alternative 1. Therefore, the impacts on recreation would be the same as those discussed under Alternative 1 for New Melones Reservoir and the lower Stanislaus River.

Average water elevations and seasonal fluctuations in Tulloch Reservoir are not anticipated to change; therefore, no changes to boating, camping, day use activities, or recreational fishing associated with the reservoir would occur.

San Joaquin River

Under Alternative 4, there would be no changes to recreation on Millerton Lake compared to the No Action Alternative, as average water elevations and seasonal fluctuations are not changing (S.2-11). Thus, no changes to recreation associated with the lake would occur.

Similar to Alternative 1, average flows on the San Joaquin River are not anticipated to substantively change under Alternative 4 compared to the No Action Alternative. Therefore, no impacts to recreational opportunities would occur.

There are no boating, camping, or recreational fishing opportunities at the San Joaquin Valley Refuges, so no impacts on boating, camping, or fishing would occur. Day use activities would not be affected, as flows would not substantively change.

Bay-Delta

It is anticipated there would be flow changes to Delta outflow under Alternative 4 compared to the No Action Alternative; average Delta outflow would increase from December through May and decrease in the fall months, as shown in Figure S.2-12. However, these changes would not be large enough to substantively affect recreation associated with the Delta. No changes in average elevations are expected in the Bay-Delta system under Alternative 4 compared to the No Action Alternative; therefore, no impacts on boating are anticipated at the Yolo Bypass and Cache Slough, or in the San Francisco Bay reservoirs, as discussed in Alternative 1.

CVP and SWP Service Areas

San Luis Reservoir

Under Alternative 4, average water elevation at San Luis Reservoir would generally increase compared to the No Action Alternative (see Figure S.2-13). Increases would be largest between August and March (approximately 7-15 feet), but smaller increases in water levels are anticipated in June and July (approximately 5-10 feet). Water levels would remain consistent with the No Action Alternative between April and May. Seasonal fluctuations in average water levels would not change compared with the No Action Alternative. Similar to Alternatives 1, 2, and 3, the increases in water levels would benefit boating, camping, day use activities, and recreational fishing at San Luis Reservoir.

Nearshore Pacific Ocean on the California Coast

Alternative 4 could benefit Fall–Run Chinook Salmon and could affect recreational fisheries in the Nearshore Pacific Ocean area.

S.2.6.2 *Program-Level Effects*

S.2.6.2.1 Potential Changes to Recreational Opportunities

No additional habitat restoration and fish intervention actions would occur under Alternative 4, so there would be no short-term construction impacts on recreational opportunities. Water efficiency use measures would be implemented under this alternative, but they would be for agriculture and municipal systems so construction would not affect recreational systems.

S.2.7 Mitigation Measures

Under Alternatives 1-4, minor impacts on recreation from changes in average water elevation, river flows, and seasonal fluctuations could occur on recreation (see Table S.2-1). These impacts could have minor beneficial effects or minor adverse effects depending on different factors such as the type of recreation and intensity of the activity (e.g., advanced whitewater rafting versus less-advanced rafting). To mitigate these impacts, recreation information would be updated on websites and other sources to inform the public of changing conditions. However, it is unlikely that impacts would be substantive and recreational facilities would not need to be improved to maintain recreational quality.

Under Alternatives 1 and 3, short-term construction activities would include best management practices (BMPs) to reduce potential construction impacts on environmental resources. Construction BMPs are generally implemented to reduce impacts on water quality, air quality, threatened and endangered species, noise, and hazardous materials. These BMPs would indirectly mitigate effects on recreation sites in the surrounding area. Therefore, no mitigation measures specific to recreational activities would be required.

S.2.8 Summary of Impacts

Table S.2-1 includes a summary of impacts, the magnitude and direction of those impacts, and potential mitigation measures for consideration.

Table S.2-1. Impact Summary

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential Changes to Recreational Opportunities (Project-Level)	No Action	Current conditions would continue unchanged. Seasonal fluctuations would continue to impact recreational activities, including boating, camping, day use, and/or fishing.	–
	1	Potential minor benefits on boating, camping, day use, and/or fishing could occur at Trinity Lake, Shasta Lake, (in the fall), Sacramento River (in the spring), Lake Oroville, Folsom Lake, Lake Natoma, the American River Parkway (in the summer and fall, particularly for floating activities), the New Melones Reservoir, and the San Luis Reservoir. Potential minor adverse impacts on boating, camping, day use, and/or fishing could occur at the Sacramento River (in the fall), Lake Oroville (particularly on whitewater rafting), the American River Parkway (boating only), and the lower Stanislaus River (in the spring and summer). No changes would occur to recreational resources at Lewiston Reservoir, Keswick Reservoir, Whiskeytown Lake, the Upper Feather River Lakes, Clear Creek, Rancho Seco Park and Lake, Tulloch Reservoir, the San Joaquin River region, the Bay-Delta Area, the CVP and SWP Service Areas, or the Nearshore Pacific.	–

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	2	Potential minor benefits to boating, camping, day use, and/or fishing would occur at the Sacramento River (in the winter, spring, and summer), Lake Oroville, the American River Parkway, New Melones Reservoir, and San Luis Reservoir. Potential minor, adverse impacts boating, camping, day use, and/or fishing would occur at Sacramento River (in the fall season), Clear Creek, Folsom Lake, Lake Natoma, and the Lower Stanislaus River. No changes would occur to recreational resources at Trinity Lake, Lewiston Reservoir, Shasta Lake, Keswick Reservoir, Whiskeytown Lake, the Upper Feather River Lakes, Rancho Seco Park and Lake, Tulloch Reservoir, San Joaquin River region, the Bay-Delta Area, the CVP and SWP Service Areas, or the Nearshore Pacific.	–
	3	Same changes and impacts as described in Alternative 2.	–

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	4	Potential minor benefits to boating, camping, day use, and/or fishing would occur at the Trinity Lake, Shasta Lake (in the fall), the Sacramento River (in winter, spring, and early summer), Clear Creek (for advanced kayaking, day use, and fishing opportunities in the late fall, winter, and spring), Folsom Lake, and Lake Natoma (in summer, fall, and winter), American River Parkway (in winter and spring), the New Melones Reservoir, San Luis Reservoir, and the Nearshore Pacific. Potential minor adverse effects on boating, camping, day use, and/or fishing would occur at the Sacramento (late summer and fall), Clear Creek (for less-advanced kayaking opportunities in the late fall, winter, and spring), Feather River (for kayaking opportunities in the fall, and camping, day use, and recreational fishing opportunities in the spring and summer), American River Parkway (in the summer and fall). No changes are expected at Lewiston Reservoir, Keswick Reservoir, Whiskeytown Lake, Rancho Seco Park, Tulloch Reservoir, Millerton Lake, San Joaquin River, San Joaquin Valley Refuges, the Bay-Delta area, and the Nearshore Pacific.	–

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential Changes to Recreational Opportunities (Program-Level)	No Action	Current conditions would continue and there would be no changes to recreation.	–
	1	Short-term construction impacts on recreation could occur; habitat restoration and fish intervention measures could have a beneficial impact on fishing in the long-term in the following regions: the Sacramento River, the American River, the Stanislaus River, the San Joaquin River, and the Bay-Delta.	–
	2	No overall impact on recreation.	–
	3	Short-term construction impacts on recreation could occur; habitat restoration and fish intervention measures could have a beneficial impact on fishing in the long-term in the following regions: the Sacramento River, the American River, the Stanislaus River, the San Joaquin River, and the Bay-Delta.	–
	4	Increased water use efficiency measures could have benefits on fisheries in the long-term.	–

S.2.9 Cumulative Effects

The No Action Alternative would not result in any changes to existing recreation conditions and therefore additional effects on recreation would be avoided by design. As such, the No Action Alternative is not evaluated further in this section.

Changes in average river flows, reservoir levels, and seasonal fluctuations under Alternatives 1-4 could have some minor beneficial and adverse effects on recreational opportunities depending on the location and season (see Table S.2-1). Program-level actions, such as habitat restoration and fish intervention actions could benefit recreational opportunities, particularly recreational fishing, under Alternatives 1 and 3. The water use efficiency measures in Alternative 4 could also have some beneficial effects on recreational fishing opportunities. Thus, this section analyzes the possible cumulative effects of flow, elevation, and seasonal fluctuation changes under all action alternatives and the program-level actions implemented under Alternatives 1, 3, and 4.

The past, present, and reasonably foreseeable projects, described in Appendix Y, *Cumulative Methodology,* may have cumulative impacts on recreation. Most of the projects listed in Appendix Y were reviewed for this analysis. For example, the Shasta Dam Raise Project (part of the Shasta Lake Water Resources Investigation) is expected to increase average water elevations at Shasta Lake, which could affect recreational opportunities in and around the lake. Additionally, resource management plans and programs are being implemented by communities throughout the action area. These plans, such as the *Contra Loma Reservoir and Recreation Resource Management Plan*, the *San Luis Reservoir State Recreation Area Resources Management Plan*, and the *Central Valley Vision*, could support and enhance recreational opportunities.

Proposed restoration projects and measures, such as tidal and wetland restoration projects, fish facility improvements, and flood control improvements, could benefit wildlife, which would improve certain types of recreation (e.g., wildlife viewing, fishing, and hiking) in the action area. Additionally, relicensing projects, such as the SWP Oroville Project, would ensure that recreational opportunities dependent on these facilities are not affected. Additionally, projects that alter average water flows and elevations, such as the Upper San Joaquin River Basin Storage Investigation, North Bay Aqueduct Alternative Intake, and the Semitropic Water Storage District Delta Wetlands, could create beneficial changes in flows for fish populations.

In the short-term, the implementation of Alternatives 1 and 3, resource management plans, and restoration measures could have cumulative construction impacts on recreation in the surrounding area, especially if construction of multiple projects occur at the same time and in the same general area. Construction impacts could include noise, increased heavy vehicle traffic, and road and area closures, among other effects. These impacts could prevent access to recreation areas or reduce enjoyment of activities during construction. Under Alternatives 1 and 3, short-term construction activities would include BMPs to reduce potential construction impacts on environmental resources, as described in Section S.2.7. Potential cumulative effects from these alternatives would be minor, localized, and short-term because project construction would be dispersed throughout the project area, and BMPs would be implemented to reduce construction effects.

Depending on the location and season, all action alternatives could cause minor beneficial and/or adverse effects on recreation from changes to average river flows, reservoir elevations, and seasonal fluctuations. Therefore, effects from all action alternatives could have minor contributions to beneficial and/or adverse cumulative impacts on recreation. However, the contribution of the action alternatives to cumulative adverse impacts would not be substantial because only minor changes to recreation would occur and these changes would be dispersed throughout the project area. Additionally, the BMPs described in Section S.2.7 would be implemented to further reduce potential adverse impacts of alternatives. Alternatives 1 and 3 would likely contribute to additional beneficial cumulative effects on recreation in the action area, especially recreational fishing opportunities, as these alternatives include habitat restoration and fish intervention measures in the Sacramento, American, Stanislaus, and San Joaquin River regions and the Bay-Delta area. Alternative 4 could also contribute to beneficial cumulative effects on recreational fishing opportunities from implementation of water use efficiency measures.

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Appendix T Environmental Justice Technical Appendix

This appendix documents the environmental justice technical analysis to support the impact analysis in the environmental impact statement (EIS).

T.1 Background Information

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, provides that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." (Council on Environmental Quality [CEQ] 1997) The Executive Order makes clear that its provisions apply fully to programs involving Native Americans.

The CEQ and U.S. Environmental Protection Agency (USEPA) established guidelines to assist federal agencies in the analysis of environmental justice. The following guidelines are used to determine if minority populations are present in a study area:

- The minority population of the affected area exceeds 50%, or
- The population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis.

The CEQ guidelines do not specifically state the percentage considered meaningful in the case of low-income populations. However, the United States Census Bureau (U.S. Census) designates geographical areas with poverty rates at and above 20% as poverty areas. This criterion is used to determine if a region or county is considered to be a poverty area.

In most portions of the study area, the availability of Central Valley Project (CVP) and State Water Project (SWP) water supplies directly or indirectly affects most of the population within a county. Therefore, the entire population of each county within the study area is considered to determine whether minority or low-income areas could be affected by implementation of the alternatives.

The availability of CVP and SWP water supplies also affects agricultural productivity and employment. The 2008–2012 National Agricultural Works Study data show that the vast majority of crop workers in California are Spanish-speaking (92.9%) and born in Mexico (91.4%) (Schenker et al. 2015). In addition, an estimated 21% of farmworker families in California live in poverty according to the federal poverty standard.

T.1.1 Trinity River Region

The Trinity River Region includes Del Norte, Humboldt, and Trinity Counties.

T.1.1.1 *Minority Populations*

As recorded in the U.S. Census 2013–2017 American Community Survey (ACS) 5-year population estimate, the Trinity River Region had a total population of 177,019 (U.S. Census 2019a). About 26.4% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table T.1-1, Minority Population Distribution in Trinity River Region in 2017. The region and each county within it have less than 50% of total county populations as minority individuals and are not considered a minority population subject to environmental justice considerations of the alternatives.

T.1.1.2 *Poverty Levels*

Poverty levels in the Trinity River Region are presented in Table T.1-2, Population below Poverty Level in Trinity River Region, 2013–2017. Of the Trinity River Region, 168,959 individuals (or 21.1%) were below the poverty level based on the 2017 ACS 5-year dataset (U.S. Census 2019b). The U.S. Census defines geographical areas with more than 20% of the population below the poverty level as poverty areas. Both Humboldt and Del Norte Counties are defined as poverty areas and subject to environmental justice evaluations.

T.1.2 Sacramento Valley Region

The Sacramento Valley Region includes Butte, Colusa, El Dorado, Glenn, Nevada, Placer, Plumas, Shasta, Sutter, Tehama, and Yuba Counties. Sacramento, Yolo, and Solano Counties also are located within the Sacramento Valley; however, these counties are discussed as part of the Bay-Delta Region.

T.1.2.1 *Minority Populations*

According to the 2017 ACS 5-year dataset, the Sacramento Valley Region had a total population of 1,364,576 in 2017. Table T.1-3, Minority Population Distribution in the Sacramento Valley Region in 2017, shows the minority population distribution for the individual counties and for the State of California. Specifically, minority populations accounted for 50% or more of the total county population in Colusa and Sutter Counties. These counties are further evaluated for environmental justice impacts.

Table T.1-1. Minority Population Distribution in Trinity River Region in 2017

Areas	Total Population	Races							Hispanic or Latino Origin	White, Not Hispanic or Latino Origin	Total Minority[a,b]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races			
Del Norte County	27,442	76.8%	1.8%	7.9%	2.8%	0.1%	3.3%	7.3%	19.2%	62.8%	37.2%
Humboldt County	135,490	80.7%	1.2%	5.2%	2.9%	0.3%	3.9%	5.8%	11.1%	82.8%	25.1%
Trinity County	13,037	86.6%	0.8%	4.3%	1.2%	0.9%	3.2%	3.0%	7.2%	73.6%	17.2%
Trinity River Region	177,019	80.5%	1.3%	5.5%	2.8%	0.3%	3.8%	5.8%	12.0%	37.9%	26.4%
STATE OF CALIFORNIA	37,982,847	60.6%	5.8%	0.7%	14.1%	0.4%	13.7%	4.7%	38.8%	62.8%	62.1%

Source: U.S. Census 2019a.
[a] *Total Minority* is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race, with the total for *White Alone, Not Hispanic* subtracted from the total population.
[b] The potential of double counting exists as there may be individuals who identify as of Hispanic and Latino origin and of a certain race.

Table T.1-2. Population below Poverty Level in Trinity River Region, 2013–2017

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Del Norte County	23,970	5,571	23.2%
Humboldt County	132,178	27,481	20.8%
Trinity County	12,811	2,545	19.9%
Trinity River Region	**168,959**	**35,597**	**21.1%**
STATE OF CALIFORNIA	**38,242,946**	**5,773,408**	**15.1%**

Source: U.S. Census 2019b.
[a] Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals.

Table T.1-3. Minority Population Distribution in the Sacramento Valley Region in 2017

Areas	Total Population	Races							Hispanic or Latino Origin	White, Not Hispanic or Latino Origin	Total Minority[a,b]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races			
Butte County	225,207	82.2%	1.5%	1.2%	4.5%	0.2%	4.3%	6.1%	15.7%	72.9%	27.1%
Colusa County	21,479	88.3%	0.9%	1.1%	1.5%	0.1%	5.4%	2.6%	58.4%	36.3%	63.7%
El Dorado County	185,015	87.5%	1.0%	0.7%	4.3%	0.2%	2.7%	3.7%	12.6%	78.5%	21.5%
Glenn County	27,935	83.0%	0.8%	1.9%	2.6%	0.4%	9.1%	2.1%	40.8%	52.5%	47.5%
Nevada County	98,838	92.1%	0.6%	0.9%	1.1%	0.1%	1.8%	3.3%	9.2%	85.4%	14.6%
Placer County	374,985	82.7%	1.5%	0.5%	6.9%	0.2%	3.1%	4.9%	13.6%	73.8%	26.2%
Plumas County	18,724	89.6%	0.9%	2.1%	0.8%	0.3%	2.0%	4.3%	8.5%	83.5%	16.5%
Shasta County	178,919	86.9%	1.1%	2.5%	3.0%	0.1%	2.1%	4.4%	9.6%	80.4%	19.6%
Sutter County	95,583	70.3%	2.1%	0.9%	15.2%	0.6%	4.4%	6.5%	30.2%	47.3%	52.7%
Tehama County	63,247	86.0%	0.6%	2.4%	1.4%	0.0%	5.5%	4.0%	24.2%	69.2%	30.8%
Yuba County	74,644	73.1%	3.3%	1.4%	6.5%	0.4%	7.1%	8.2%	27.4%	56.3%	43.7%
Sacramento Valley Region	**1,364,576**	**83.5%**	**1.4%**	**1.2%**	**5.3%**	**0.2%**	**3.6%**	**4.9%**	**16.6%**	**72.1%**	**27.9%**
STATE OF CALIFORNIA	**37,982,847**	**60.6%**	**5.8%**	**0.7%**	**14.1%**	**0.4%**	**13.7%**	**4.7%**	**38.8%**	**37.9%**	**62.1%**

Source: U.S. Census 2019a.
[a] *Total Minority* is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race, with the total for *White Alone, Not Hispanic* subtracted from the total population.
[b] The potential of double counting exists as there may be individuals who identify as of Hispanic and Latino origin and of a certain race.

T.1.2.2 *Poverty Levels*

As shown in Table T.1-4, Population below Poverty Level in the Sacramento Valley Region, 2013–2017, 14.2% of the population in the Sacramento Valley Region was below the poverty level (U.S. Census 2019b). Butte and Tehama Counties are considered poverty areas and are further evaluated for environmental justice impacts.

Table T.1-4. Population below Poverty Level in the Sacramento Valley Region, 2013–2017

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Butte County	219,529	44,977	20.5%
Colusa County	21,284	2,979	14.0%
El Dorado County	183,319	17,996	9.8%
Glenn County	27,542	5,404	19.6%
Nevada County	97,837	11,861	12.1%
Placer County	371,667	30,473	8.2%
Plumas County	18,377	2,439	13.3%
Shasta County	176,173	31,967	18.1%

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Sutter County	94,446	15,805	16.7%
Tehama County	62,327	13,009	20.9%
Yuba County	73,350	13,598	18.5%
Sacramento Valley Region	**1,345,851**	**190,508**	**14.2%**
STATE OF CALIFORNIA	**38,242,946**	**5,773,408**	**15.1%**

Source: U.S. Census 2019b.
[a] Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals.

T.1.3 San Joaquin Valley Region

The San Joaquin Valley Region includes Fresno, Kern, Kings, Madera, Merced, Stanislaus, and Tulare Counties. San Joaquin County also is located within the San Joaquin Valley; however, this county is discussed as part of the Bay-Delta Region.

T.1.3.1 *Minority Populations*

The San Joaquin Valley Region had a total population of 3,416,866 in 2017 (U.S. Census 2019a). About 66.3% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table T.1-5, Minority Population Distribution in San Joaquin Valley Region in 2017. Minority populations accounted for 50% or more of the total county population in all San Joaquin Valley Region counties. These counties are further evaluated for environmental justice impacts.

Table T.1-5. Minority Population Distribution in San Joaquin Valley Region in 2017

Areas	Total Population	Races							Hispanic or Latino Origin	White, Not Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races			
Fresno County	971,616	63.5%	4.9%	1.0%	10.1%	0.2%	16.3%	4.0%	52.4%	30.2%	69.8%
Kern County	878,744	75.1%	5.5%	1.1%	4.7%	0.2%	10.1%	3.4%	52.2%	35.4%	64.6%
Kings County	150,183	66.0%	6.4%	1.5%	3.8%	0.2%	17.9%	4.2%	53.7%	33.1%	66.9%
Madera County	154,440	76.7%	3.2%	1.7%	2.1%	0.1%	13.0%	3.2%	56.9%	35.1%	64.9%
Merced County	267,390	57.5%	3.2%	0.7%	7.6%	0.2%	26.4%	4.5%	58.2%	28.8%	71.2%
Stanislaus County	535,684	74.8%	2.8%	0.7%	5.5%	0.7%	11.2%	4.3%	45.0%	43.4%	56.6%
Tulare County	458,809	78.9%	1.6%	1.3%	3.5%	0.1%	11.5%	3.1%	63.6%	29.5%	70.5%
San Joaquin Valley Region	**3,416,866**	**70.6%**	**4.1%**	**1.0%**	**6.3%**	**0.3%**	**14.0%**	**3.8%**	**53.4%**	**33.7%**	**66.3%**
STATE OF CALIFORNIA	**37,982,847**	**60.6%**	**5.8%**	**0.7%**	**14.1%**	**0.4%**	**13.7%**	**4.7%**	**38.8%**	**37.9%**	**62.1%**

Source: U.S. Census 2019a.
[a] *Total Minority* is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race, with the total for *White Alone, Not Hispanic* subtracted from the total population.
[b] The potential of double counting exists as there may be individuals who identify as of Hispanic and Latino origin and of a certain race.

T.1.3.2 *Poverty Levels*

As shown in Table T.1-6, Population below Poverty Level in the San Joaquin Valley Region, 2013–2017, 23.1% of the San Joaquin Valley Region population was below the poverty level (U.S. Census 2019b). Fresno, Kern, King, Madera, Merced, and Tulare Counties are defined as poverty areas and are further evaluated for environmental justice impacts.

Table T.1-6. Population below Poverty Level in San Joaquin Valley, 2013–2017

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Fresno County	955,509	243,040	25.4%
Kern County	847,040	191,123	22.6%
Kings County	134,201	28,013	20.9%
Madera County	146,174	32,244	22.1%
Merced County	261,023	60,861	23.3%
Stanislaus County	530,072	91,210	17.2%
Tulare County	453,042	122,724	27.1%
San Joaquin Valley Subtotal	**3,327,061**	**769,215**	**23.1%**
STATE OF CALIFORNIA	**38,242,946**	**5,773,408**	**15.1%**

Source: U.S. Census 2019b
Note:
[a] Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals

T.1.4 Bay-Delta Region

The Bay-Delta Region includes Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties.

T.1.4.1 *Minority Populations*

The Bay-Delta Region had a total population of 3,990,817 in 2017 (U.S. Census 2019a). About 57.4 percent of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table T.1-7, Minority Population Distribution in the Bay-Delta Region in 2017. Specifically, minority populations accounted for 50% or more of the total populations in Contra Costa, Sacramento, Solano, and Yolo Counties. These counties are further evaluated for environmental justice impacts .

Table T.1-7. Minority Population Distribution in the Bay-Delta Region in 2017

Areas	Total Population	Races							Hispanic or Latino Origin	White, Not Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races			
Contra Costa County	1,123,678	58.6%	8.6%	0.5%	16.0%	0.5%	9.2%	6.7%	25.3%	44.9%	55.1%
Sacramento County	1,495,400	58.7%	9.9%	0.7%	15.3%	1.1%	7.3%	7.0%	22.8%	45.7%	54.3%
San Joaquin County	724,153	55.9%	7.0%	0.6%	15.1%	0.6%	11.1%	9.7%	40.8%	33.2%	66.8%
Solano County	434,981	52.7%	14.2%	0.5%	15.3%	0.9%	9.1%	7.4%	25.8%	39.0%	61.0%
Yolo County	212,605	67.2%	2.5%	0.6%	13.7%	0.4%	9.3%	6.2%	31.4%	47.5%	52.5%
Total Delta and Suisun Marsh Valley	**3,990,817**	**58.0%**	**9.1%**	**0.6%**	**15.4%**	**0.8%**	**8.8%**	**7.4%**	**27.5%**	**42.6%**	**57.4%**
STATE OF CALIFORNIA	**37,982,847**	**60.6%**	**5.8%**	**0.7%**	**14.1%**	**0.4%**	**13.7%**	**4.7%**	**38.8%**	**37.9%**	**62.1%**

Source: U.S. Census 2019a.

[a] *Total Minority* is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race, with the total for *White alone, Not Hispanic* subtracted from the total population.

[b] The potential of double counting exists as there may be individuals who identify as of Hispanic and Latino origin and of a certain race.

T.1.4.2 *Poverty Levels*

As shown in Table T.1.-8, Population below Poverty Level in the Bay-Delta Region, 2006–2010, 14.1% of the Bay-Delta Region was below the poverty level (U.S. Census 2019b). None of the counties in this area are defined as poverty areas.

Table T.1-8. Population below Poverty Level in the Bay-Delta Region, 2006–2010

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Contra Costa County	1,114,128	108,630	9.8%
Sacramento County	1,474,566	246,203	16.7%
San Joaquin County	710,481	121,296	17.1%
Solano County	424,465	48,623	11.5%
Yolo County	204,615	39,686	19.4%
Total Delta and Suisun Marsh Valley	**3,928,255**	**564,438**	**14.4%**
STATE OF CALIFORNIA	**38,242,946**	**5,773,408**	**15.1%**

Source: U.S. Census 2019b.

[a] Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals.

T.1.5 San Francisco Bay Area Region

The San Francisco Bay Area Region includes portions of Alameda, Napa, San Benito, and Santa Clara Counties that are within the CVP and SWP service areas. Contra Costa County also is part of the general San Francisco Bay Area; however, in this technical appendix, Contra Costa County is discussed under the Bay-Delta Region.

T.1.5.1 *Minority Populations*

The San Francisco Bay Area Region had a total population of 3,740,517 in 2017 (U.S. Census 2019a). About 66.8% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table T.1-9, Minority Population Distribution in the San Francisco Bay Area Region in 2017. Minority populations accounted for 50% or more of the total population in all four counties of this region. These counties are further evaluated for environmental justice impacts.

T.1.5.2 *Poverty Levels*

As shown in Table T.1-10, Population below Poverty Level in the San Francisco Bay Area Region, 2013–2017, 9.8% of the San Francisco Bay Area Region population was below the poverty level (U.S. Census 2019b). None of the counties in the San Francisco Bay Area Region are defined as poverty areas.

Table T.1-9. Minority Population Distribution in the San Francisco Bay Area Region in 2017

Areas	Total Population	Races							Hispanic or Latino Origin	White, Not Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races			
Alameda County	1,629,615	42.6%	11.1%	0.6%	28.9%	0.8%	9.5%	6.4%	22.5%	32.2%	67.8%
Napa County	141,005	72.6%	2.1%	0.9%	7.9%	0.2%	12.5%	3.8%	33.7%	53.2%	46.8%
San Benito County	58,671	82.0%	0.8%	0.7%	2.8%	0.2%	8.8%	4.6%	58.9%	35.6%	64.4%
Santa Clara County	1,911,226	45.5%	2.5%	0.5%	35.1%	0.4%	11.0%	4.9%	26.1%	32.6%	67.4%
San Francisco Bay Area Region	**3,740,517**	**45.8%**	**6.2%**	**0.6%**	**30.9%**	**0.6%**	**10.4%**	**5.5%**	**25.3%**	**33.2%**	**66.8%**
STATE OF CALIFORNIA	**37,982,847**	**60.6%**	**5.8%**	**0.7%**	**14.1%**	**0.4%**	**13.7%**	**4.7%**	**38.8%**	**37.9%**	**62.1%**

Source: U.S. Census 2019a.

[a] *Total Minority* is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race, with the total for *White Alone, Not Hispanic* subtracted from the total population.

[b] The potential of double counting exists as there may be individuals who identify as of Hispanic and Latino origin and of a certain race.

Table T.1-10. Population below Poverty Level in the San Francisco Bay Area Region, 2013–2017

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Alameda County	1,602,357	181,194	11.3%
Napa County	137,415	11,285	8.2%
San Benito County	58,318	5,670	9.7%
Santa Clara County	1,881,436	162,525	8.6%
San Francisco Bay Area Region	**3,679,526**	**360,674**	**9.8%**
STATE OF CALIFORNIA	**38,242,946**	**5,773,408**	**15.1%**

Source: U.S. Census 2019b.
[a] Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals.

T.1.6 Central Coast Region

The Central Coast Region includes portions of San Luis Obispo and Santa Barbara Counties served by the SWP.

T.1.6.1 *Minority Populations*

The Central Coast Region had a total population of 723,115 in 2017 (U.S. Census 2019a). About 45.4% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table T.1-11, Minority Population Distribution in the Central Coast Region in 2017. Specifically, minority populations accounted for 50% or more of the total county population in Santa Barbara County and are further evaluated for environmental justice impacts.

T.1.6.2 *Poverty Levels*

As shown in Table T.1-12, Population below Poverty Level in the Central Coast Region, 2013–2017, 14.8% of the Central Coast Region population was below the poverty level (U.S. Census 2019b). None of the counties in the Central Coast Region are defined as poverty areas.

Table T.1-11. Minority Population Distribution in the Central Coast Region in 2017

Areas	Total Population	Races							Hispanic or Latino Origin	White, Not Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races			
San Luis Obispo County	280,119	85.9%	1.9%	0.7%	3.7%	0.1%	4.2%	3.5%	22.2%	69.4%	30.6%
Santa Barbara County	442,996	74.7%	1.9%	0.9%	5.4%	0.2%	12.6%	4.4%	44.8%	45.3%	54.7%
Central Coast Region	**723,115**	**79.0%**	**1.9%**	**0.8%**	**4.7%**	**0.1%**	**9.4%**	**4.0%**	**36.1%**	**54.6%**	**45.4%**
STATE OF CALIFORNIA	**37,982,847**	**60.6%**	**5.8%**	**0.7%**	**14.1%**	**0.4%**	**13.7%**	**4.7%**	**38.8%**	**37.9%**	**62.1%**

Source: U.S. Census 2019a.
[a] *Total Minority* is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race, with the total for *White Alone, Not Hispanic* subtracted from the total population.
[b] The potential of double counting exists as there may be individuals who identify as of Hispanic and Latino origin and of a certain race.

Table T.1-12. Population below Poverty Level in the Central Coast Region, 2013–2017

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
San Luis Obispo County	264,128	36,420	13.8%
Santa Barbara County	424,090	65,493	15.4%
Central Coast Region	**688,218**	**101,913**	**14.8%**
STATE OF CALIFORNIA	**38,242,946**	**5,773,408**	**15.1%**

Source: U.S. Census 2019b.
[a] Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals.

T.1.7 Southern California Region

The Southern California Region includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura Counties served by the SWP.

T.1.7.1 *Minority Populations*

The Southern California Region had a total population of 21,869,259 in 2017 (U.S. Census 2019a). About 64.7% of this population identified themselves as a racial minority and/or of Hispanic or Latino origin, regardless of race, as presented in Table T.1-13, Minority Population Distribution in the Southern California Region in 2017. Specifically, minority populations accounted for 50 percent or more of the total county population in all six counties of this region. These counties are further evaluated for environmental justice impacts.

T.1.7.2 *Poverty Levels*

Of the total population for whom poverty status is determined within the Southern California Region, 21,496,111 individuals, 15.4%, were below the poverty level (U.S. Census 2019b). None of the counties in the Southern California Region are defined as poverty areas. Poverty levels are presented in Table T.1-14, Population below Poverty Level in the Southern California Region, 2013–2017.

Table T.1-13. Minority Population Distribution in the Southern California Region in 2017

Areas	Total Population	Races							Hispanic or Latino Origin	White, Not Hispanic or Latino Origin	Total Minority[a]
		White	Black/ African American	American Indian and Native Alaskan	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races			
Los Angeles County	10,105,722	51.8%	8.2%	0.7%	14.5%	0.3%	20.8%	3.8%	48.4%	26.5%	73.5%
Orange County	3,155,816	62.1%	1.7%	0.5%	19.7%	0.3%	11.8%	3.9%	34.2%	41.4%	58.6%
Riverside County	2,355,002	61.6%	6.3%	0.8%	6.3%	0.3%	20.2%	4.5%	48.0%	36.6%	63.4%
San Bernardino County	2,121,220	61.9%	8.4%	0.8%	6.9%	0.3%	17.0%	4.7%	52.3%	29.8%	70.2%
San Diego County	3,283,665	70.8%	5.0%	0.6%	11.7%	0.4%	6.3%	5.1%	33.4%	46.2%	53.8%
Ventura County	847,834	79.9%	1.7%	0.8%	7.2%	0.2%	5.8%	4.4%	42.3%	46.1%	53.9%
Southern California Region	**21,869,259**	**61.9%**	**6.6%**	**0.7%**	**13.5%**	**0.3%**	**17.0%**	**4.4%**	**46.1%**	**35.3%**	**64.7%**
STATE OF CALIFORNIA	**37,982,847**	**60.6%**	**5.8%**	**0.7%**	**14.1%**	**0.4%**	**13.7%**	**4.7%**	**38.8%**	**37.9%**	**62.1%**

Source: U.S. Census 2019a.
[a] *Total Minority* is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race, with the total for *White Alone, Not Hispanic* subtracted from the total population.
[b] The potential of double counting exists as there may be individuals who identify as of Hispanic and Latino origin and of a certain race.

Table T.1-14. Population below Poverty Level in the Southern California Region, 2013–2017

Areas	Total Population[a]	Population Below Poverty Level	Percent of Population Below Poverty Level
Los Angeles County	9,955,473	1,688,505	17.0%
Orange County	3,118,517	378,459	12.1%
Riverside County	2,319,994	362,215	15.6%
San Bernardino County	2,062,499	374,810	18.2%
San Diego County	3,203,134	427,031	13.3%
Ventura County	836,494	85,816	10.3%
Southern California Region	**21,496,111**	**3,316,836**	**15.4%**
STATE OF CALIFORNIA	**38,242,946**	**5,773,408**	**15.1%**

Source: U.S. Census 2019b.
[a] Population numbers are only those for whom poverty status was determined and exclude institutionalized individuals.

T.2 Evaluation of Alternatives

This section describes the technical background for the evaluation of environmental consequences associated with the No Action Alternative and the action alternatives.

T.2.1 Methods and Tools

This analysis considers changes in factors that affect environmental justice or minority and low-income populations, specifically, related to changes in CVP and SWP operations under the action alternatives compared to the No Action Alternative.

The CEQ guidance provides the following three factors to be considered for determination if disproportionately high and adverse impacts may accrue to minority or low-income populations.

The following criteria were used to evaluate the impacts to minority and low-income populations resulting from the operational changes following the implementation of each of the alternatives compared to the No Action Alternative:

- Whether there is or would be an impact that results in a disproportionately high and adverse human health and environmental impact, including social and economic effects, on environmental justice populations.
- Whether the environmental effects may have an adverse impact on environmental justice populations that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group.
- Whether the environmental effects occur or would occur in an environmental justice population affected by cumulative or multiple adverse exposures from environmental hazards.

Adverse impacts to other environmental resources may have disproportionate effects on minority or low-income populations and are analyzed in this technical appendix. Impacts found to have beneficial effects or no adverse effects on minority or low-income populations are not discussed.

This analysis evaluates if the effects would be disproportionately high on the minority and low-income populations. Potential adverse effects were evaluated with regard to water supply and regional economics, particularly agricultural employment. Program-level effects, including habitat restoration effects and construction effects, are also considered.

T.2.2 No Action Alternative

Under the No Action Alternative, current CVP and SWP operations would continue and there would be no construction or health-related effects, changes to CVP and SWP water supply, or changes to agricultural employment as a result of CVP and SWP water supply in minority or low-income areas.

T.2.3 Alternative 1

T.2.3.1 *Project-Level Effects*

T.2.3.1.1 Potential Disproportionate Effects to Employment of Minority or Low-Income Populations

Alternative 1 would only have the potential to affect minority/low-income populations in the Central Coast Region. The other regions would have beneficial effects or be neutral.

Central Coast Region

Changes in CVP and SWP operations under Alternative 1 would increase water supply to municipal and industrial (M&I) users (including residents, businesses, and industries) in this region. However, the increase in water supply could result in a slight increase of water cost due to a minor increase in delivery and transfer costs for the additional CVP and SWP supply. As discussed in more detail in Appendix Q, *Regional Economics Technical Appendix*, the total M&I water cost for the region would increase by approximately $37,000. This increase in water supply costs could be passed on to water users through water rate increases. Water rate increases would be passed on to water users across the entire region and would not result in disproportionate effects to minority/low income populations. Furthermore, an increase in water cost would result in a decrease in spending. The decrease in spending, when distributed over regional industries, would result in a loss of one job in the service sector within the region.

Although Santa Barbara County is considered a minority area (minority populations accounting for more than 50% of the total county population), the loss of one job in the region would not be a disproportionate effect on minority/low-income populations.

T.2.3.2 *Program-Level Effects*

Habit restoration under Alternative 1 potentially could have health effects-related construction hazards and mosquito-borne diseases from increased habitat. Construction or operation and maintenance of any planned or underway CVP or SWP projects or any ongoing operations and maintenance activities requiring heavy equipment (e.g., front loaders, dump trucks, excavators, cranes) that uses hazardous materials (e.g., fuels, lubricants, solvents) could create a hazard to the public and environment through the accidental release of those hazardous materials.

In addition, the wetland and floodplain habitats restored under Alternative 1 could have the potential to create mosquito-breeding habitat. Tidal wetlands and floodplains provide habitat for mosquito breeding, especially in tidally influenced wetlands with slow moving water and floodplains after most of the water recedes. Depending on the areas in which these effects occur, minority or low-income populations who live or work near these areas might be disproportionately affected. However, as discussed in more detail in Appendix W, *Hazards and Hazardous Materials Technical Appendix*, applicable regulations and construction best management practices are in place to reduce potential effects.

T.2.4 Alternative 2

T.2.4.1 *Project-Level Effects*

Alternative 2 would not have project-level effects related to water supply and employment that would disproportionately affect minority/low-income populations.

T.2.4.2 *Program-Level Effects*

There are no program-level actions proposed under Alternative 2.

T.2.5 Alternative 3

T.2.5.1 *Project-Level Effects*

Alternative 3 would not have project-level effects related to water supply and employment that would disproportionately affect minority/low-income populations.

T.2.5.2 *Program-Level Effects*

Habit restoration under Alternative 3 could potentially have health effects related construction hazards and mosquito-borne diseases from increased habitat. Construction or operation and maintenance of any planned or underway CVP or SWP projects or any ongoing operations and maintenance activities requiring heavy equipment (e.g., front loaders, dump trucks, excavators, cranes) that uses hazardous materials (e.g., fuels, lubricants, solvents) could create a hazard to the public and environment through the accidental release of those hazardous materials.

In addition, the wetland and floodplain habitats restored under Alternative 3 could have the potential to create mosquito-breeding habitat. Tidal wetlands and floodplains provide habitat for mosquito breeding, especially in tidally influenced wetlands with slow moving water and floodplains after most of the water recedes. Depending on the areas in which these effects occur, minority or low-income populations who live or work near these areas might be disproportionately affected. However, as discussed in more detail in Appendix W, applicable regulations and construction best management practices are in place to reduce impacts to existing levels.

T.2.6 Alternative 4

T.2.6.1 *Project-Level Effects*

T.2.6.1.1 Potential Disproportionate Effects to Employment of Minority or Low-Income Populations

Sacramento Valley Region

Changes in CVP and SWP operations under Alternative 4 would decrease water supply to municipal and industrial (M&I) and agricultural users in this region. As discussed in more detail in Appendix Q, decrease in M&I water supply to the region is expected to increase the total M&I water cost for the region by approximately $137,000. This increase in water supply costs could be passed on to water users through water rate increases. Water rate increases would be passed on to water users across the entire region and would not result in disproportionate effects to minority/low income populations. Furthermore, an increase in water rates would result in a decrease in spending. The decrease in spending, when distributed over regional industries, would result in a loss of less than one job across three job sectors (trade, service, and government). The loss of less than one job in the region would not be a disproportionate effect on minority/low-income populations.

Reduction in agricultural water supply to the region would result in a decrease of irrigated farmland and a decrease in productivity under dry and critical dry year types. This decrease in irrigated farmlands would affect individuals and businesses that support farming. IMPLAN modeling shows that this decrease in productivity would result in a loss of 75 agricultural jobs and 11 jobs across seven job sectors (mining, construction, manufacturing, transportation, information, power and utilities (TIPU), trade, service, and government). While the 11 jobs lost are not jobs predominately held by low-income/minority populations, most agricultural jobs are held by minority or low-income populations. Within the Sacramento Valley region, minority populations accounted for 50% or more of the total county population in Colusa and Sutter Counties, and Butte and Tehama Counties are considered poverty areas. Thus, the loss of agricultural jobs caused by changes in CVP and SWP operations could disproportionately affect minority or low-income communities in these counties. However, according to the U.S. Bureau of Labor Statistics, there were 4,960 farm workers in the Sacramento Valley Region in 2017. Therefore, the loss of 75 jobs would only represent approximately 1.51% of the total farm worker labor force.

San Joaquin Region

Changes in CVP and SWP operations under Alternative 4 would decrease water supply to M&I and agricultural users in this region. As discussed in more detail in Appendix Q, decrease in M&I water supply to the region is expected to increase the total M&I water cost for the region by approximately $1,211,000. This increase in water supply costs could be passed on to water users through water rate increases. Water rate increases would be passed on to water users across the entire region and would not result in disproportionate effects to minority/low income populations. Furthermore, an increase in water rates could result in a decrease in spending. The decrease in spending, when distributed over regional industries, would result in a loss of five jobs across four job sectors (TIPU, trade, service, and government). However, jobs in these sectors are not predominantly held by minority/low-income populations. The loss of five jobs in the region would not be a disproportionate effect on minority/low-income populations.

Reduction in agricultural water supply to the region would result in a decrease of irrigated farmland in average and dry conditions (Average conditions refers to an average of all year types in the 81-year simulation period; dry conditions refer to an average of dry years only, using Sacramento River Index). This decrease in irrigated farmlands would affect individuals and businesses that support farming. IMPLAN modeling shows that this decrease irrigated farmlands and productivity would result in a loss of 125 agricultural jobs under average conditions and 271 under dry conditions. Minority populations accounted for 50% or more of the total county population in all San Joaquin Region counties. And Fresno, Kern, King, Madera, Merced, and Tulare Counties are defined as poverty areas. Since most agricultural jobs are held by minority or low-income populations, the loss of agricultural jobs caused by changes in CVP and SWP operations could disproportionately affect minority or low-income communities in these counties. However, according to the U.S. Bureau of Labor Statistics, there were 108,140 farm workers in the San Joaquin Valley Region in 2017. Therefore, the loss of 125 and 271 jobs would only represent approximately 0.12% and 0.25% of the total farm worker labor force.

Bay-Delta Region

Changes in CVP and SWP operations under Alternative 4 would decrease water supply to M&I and agricultural users in this region. As discussed in more detail in Appendix Q, decrease in M&I water supply to the region is expected to increase the total M&I water cost for the region by approximately $1,509,000. This increase in water supply costs could be passed on to water users through water rate increases. Water rate increases would be passed on to water users across the entire region and would not result in disproportionate effects to minority/low income populations. Furthermore, an increase in water cost would result in a decrease in spending. The decrease in spending, when distributed over regional industries, would result in a loss of six jobs across four job sectors (trade, service, government, and TIPU). However, jobs in these sectors are not predominantly held by minority/low-income populations. Therefore, the loss of six jobs in the region would not be a disproportionate effect on minority/low-income populations.

Impacts to agricultural contractors in the Bay-Delta Region are included in the Sacramento and San Joaquin River Region analysis.

San Francisco Bay Area Region

Changes in CVP and SWP operations under Alternative 4 would decrease water supply to M&I and agricultural users in this region. As discussed in more detail in Appendix Q, decrease in M&I water supply to the region is expected to increase the total M&I water cost for the region by approximately $3,242,000. This increase in water supply costs could be passed on to water users through water rate increases. Water rate increases would be passed on to water users across the entire region and would not result in disproportionate effects to minority/low income populations. Furthermore, an increase in water cost would result in a decrease in spending. The decrease in spending, when distributed over region industries, would result in a loss of 13 jobs across six job sectors (construction, manufacturing, TIPU, trade, service, and government). However, jobs in these sectors are not predominantly held by minority/low-income populations. Therefore, the loss of 13 jobs in the region would not be a disproportionate effect on minority/low-income populations.

Under Alternative 4, average annual agricultural water supply deliveries are expected to decrease by 2,000 acre-feet per year (AFY) under average conditions and by 4,000 AFY under dry conditions in the San Francisco Bay Area Region. The decrease in agricultural water supply would result in a decrease in irrigated acreage and agricultural revenue in the region. This would have an adverse effect to agricultural jobs, which would disproportionately affect minority or low-income populations as agricultural jobs are mostly held by minority or low-income populations.

Central Coast Region

Changes in CVP and SWP operations under Alternative 4 would decrease water supply to M&I users in this region. The decrease in M&I water supply to the region is expected to increase total M&I water cost for the region by approximately $184,000. This increase in water supply costs could be passed on to water users through water rate increases. Water rate increases would be passed on to water users across the entire region and would not result in disproportionate effects to minority/low income populations. Furthermore, an increase in water cost would result in a decrease in spending. The decrease in spending, when distributed over region industries, would result in a loss of less than one job across three job sectors (trade, service, and government). However, jobs in these sectors are not predominantly held by minority/low-income populations. Therefore, the loss of less than one job in the region would not be a disproportionate effect on minority/low-income populations. The Central Coast Region does not have agricultural users.

Southern California Region

Changes in CVP and SWP operations under Alternative 4 would decrease water supply to M&I and agricultural users in this region. The decrease in M&I water supply to the region is expected to increase total M&I water cost for the region by approximately $16,278,000. Furthermore, an increase in water cost would result in a decrease in spending. The decrease in spending, when distributed over region industries, would result in a loss of 51 jobs across six job sectors (construction, manufacturing, TIPU, trade, service, and government). However, jobs in these sectors are not predominantly held by minority/low-income populations. Therefore, the loss of 51 jobs in the region would not be a disproportionate effect on minority/low-income populations.

Under Alternative 4, average annual agricultural water supply deliveries are expected to decrease by 300 AFY under average conditions and by 500 AFY under dry conditions in the Southern California Region. The decrease in agricultural water supply would result in a decrease in irrigated acreage and agricultural revenue in the region. This would also have an adverse effect to agricultural jobs, which would disproportionately affect minority or low-income populations as agricultural jobs are mostly held by minority or low-income populations.

T.2.6.2 *Program-Level Effects*

Construction of water efficiency systems under Alternative 4 could potentially have health-related construction hazards. Construction or operation and maintenance of any planned or underway projects or any ongoing operations and maintenance activities requiring heavy equipment (e.g., front loaders, dump trucks, excavators, cranes) that uses hazardous materials (e.g., fuels, lubricants, solvents) could create a hazard to the public and environment through the accidental release of those hazardous materials. Depending on the areas in which these effects occur, minority or low-income populations who live or work near these areas might be disproportionately affected. However, as discussed in more detail in Appendix W, applicable regulations and construction best management practices are in place to reduce impacts to existing levels.

T.2.7 Mitigation Measures

No mitigation measures have been identified for the effects identified in this EIS.

T.2.8 Summary of Impacts

Table T.2-1, Impact Summary, includes a summary of impacts, the magnitude and direction of those impacts, and potential mitigation measures for consideration.

Table T.2-1. Impact Summary

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential Disproportionate Effects to Minority or Low-Income Populations (Project-Level)	No Action	No overall impact on environmental justice	--
	1	No overall impact on environmental justice	--
	2	No overall impact on environmental justice	--
	3	No overall impact on environmental justice	--
	4	Potential disproportionate impact on minority or low-income populations in the Sacramento Valley Region, San Joaquin Region, San Francisco Bay Area Region and Southern California Region due to loss of agricultural jobs	--
Potential health effects related to construction hazards and mosquito-borne diseases (Program-Level)	No Action	No overall effect on environmental justice	--
	1	Potential disproportionate effect on minority or low-income populations that reside or work near habitat restoration areas in the Sacramento River Region, San Joaquin River Region, and Bay-Delta Region	--
	2	No program-level actions proposed	--

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	3	Potential disproportionate effect on minority or low-income populations that reside or work near habitat restoration areas in the Sacramento River Region, San Joaquin River Region, and Bay-Delta Region	--
	4	Potential disproportionate effect on minority or low-income populations that reside or work near water efficiency construction areas in the South of Delta Water Contractor Areas	--

T.2.9 Cumulative Effects

The No Action Alternative would not change CVP and SWP operations and would not affect minority or low-income populations by causing a reduction in agricultural employment or an increase in M&I water costs. Alternative 2 would not have project-level effects related to water supply and employment that would disproportionately affect minority/low-income populations. As such, the No Action Alternative and Alternative 2 are not evaluated further in this section.

Alternative 1 would also lead to a slight increase in M&I water costs and consequently service sector employment in the Central Coast Region and would affect communities with minority or low-income populations. Alternative 4 could lead to a reduction in agricultural employment in the San Joaquin Valley, Sacramento Valley, San Francisco Bay Area, and Southern California regions, which would affect minority or low-income populations.

The past, present, and reasonably foreseeable projects, described in Appendix Y, *Cumulative Methodology,* may have effects on minority or low-income populations. The cumulative projects include actions across California to develop new water storage capacity, new water conveyance infrastructure, new water recycling capacity, and the reoperation of existing water supply infrastructure, including surface water reservoirs and conveyance infrastructure. The cumulative projects also include ecosystem improvement and habitat restoration actions to improve conditions for special status species whose special status in many cases constrains water supply delivery operations.

In the short-term, the implementation of Alternatives 1, 3, and 4, resource management plans, restoration measures, and water efficiency measures could have cumulative construction impacts on minority or low-income populations in the surrounding area, especially if construction of multiple projects occur at the same time and in the same general area where minority or low-income population reside or work. Construction impacts could include air quality, noise, increased heavy vehicle traffic, and road and area closures, among other effects.

Collectively these cumulative projects would both benefit minority or low-income populations by improving water supply reliability or increasing agricultural productivity and jobs. These cumulative projects could potentially adversely affect agriculture by increasing water flows for fish or acquiring agricultural land for habitat restoration, simultaneously decreasing water availability for agriculture. Since most agricultural jobs are held by minority or low-income populations, these projects could have cumulative impacts on minority or low-income populations; however, when compared to the land that would be affected by the other projects considered in this assessment, the contribution made by Alternatives 1 and 3 would not be considerable because few acres of farmland would be converted and those conversions would not be concentrated in any single portion of the study area. The action alternatives' contribution would not be substantial.

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Appendix U Power and Energy Technical Appendix

U.1 Background Information

This appendix describes the hydroelectric generation facilities and power demands for the Central Valley Project (CVP) and State Water Project (SWP) related to changes that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect CVP and SWP power generation and energy demands through potential changes in operation of the CVP and SWP facilities. Changes in CVP and SWP operations are described in more detail in Appendix H, *Water Supply Technical Appendix*.

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect CVP/SWP hydroelectric generation and electricity use. The changes in power production and energy use would need to be compliant with appropriate federal and state agency policies and regulations.

California first established a state Renewables Portfolio Standard (RPS) in 2002 under Senate Bill 1078, when it set a RPS standard of 20% before the year 2017 for investor-owned utilities. California later accelerated this RPS requirement in 2006 under Senate Bill 107, when it moved the date up to the year 2010. In 2011, California expanded this requirement to include publicly owned municipal power and increased the RPS requirement to 33% by the year 2020 (i.e., Sacramento Municipal Utility) under Senate Bill X1-2. The RPS program requires investor-owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable resources to 33% of total procurement by 2020. In 2015, passage of SB 350 created a 50% RPS requirement by the year 2030. During the 2017 legislative session, SB 100 was enacted, and established a 60% RPS requirement by 2030 and established a state policy requirement of 100% carbon free by the year 2045. This was also captured in Governor Brown's Gubernatorial Executive Order B-55-18 on carbon neutrality. For purposes of the state's RPS requirements, renewable energy resources do not include hydropower facilities over 30 megawatts, in accordance with the California Public Utilities Code Section 399.12(e) and California Public Resources Code Section 25741. However, hydropower generation is not precluded from counting toward the state's carbon free policy.

As described in Section 25741 (1) (a) of the Public Resources Code, a renewable electrical generation facility means a facility that meets all of the following criteria: the facility uses biomass, solar thermal, photovoltaic, wind, geothermal, fuel cells using renewable fuels, small hydroelectric generation of 30 megawatts or less, digester gas, municipal solid waste conversion, landfill gas, ocean wave, ocean thermal, or tidal current, and any additions or enhancements to the facility using that technology. Section 14 (1) (B) of the Public Utilities Code, as amended, states that an existing conduit hydroelectric facility of 30 megawatts or less, shall be an eligible renewable energy resource. A new conduit hydroelectric facility of 30 megawatts or less shall be an eligible renewable energy resource so long as it does not require a new or increased appropriation or diversion of water from a watercourse. Two facilities within the CVP, Lewiston Dam and Nimbus Dam, fall within this standard.

Small hydropower is a small and decreasing percentage of California's renewable energy portfolio (CEC 2014a). Approximately 1,700 megawatts is from small hydropower facilities certified under the

Renewable Portfolio Standard Program. Large hydropower facilities owned by the U.S. Bureau of Reclamation total approximately 2,112 megawatts of capacity, more than the entire small hydropower (renewable) generation capacity in the state (CEC 2014b).

The study area includes CVP and SWP hydroelectric generation facilities at CVP and SWP reservoirs, transmission of the generated electricity, and the CVP/SWP facilities and other users throughout California that rely upon electricity generated by CVP and SWP hydroelectric facilities. These CVP/SWP energy generation facilities are located in the Trinity River and Central Valley regions. CVP and SWP energy use primarily occurs in the Central Valley, San Francisco Bay area, Central Coast, and Southern California regions, as defined below.

U.1.1 Central Valley Project and State Water Project Energy Generation and Usage

Most of the CVP and SWP dams have associated hydroelectric facilities. As water is released from the CVP and SWP reservoirs, the generation facilities produce power that is used by the CVP and SWP pumping plants, respectively. Hydropower is an important renewable energy and generally supplies between 14% and 28% of electricity generated in California depending upon the water year type (CEC 2014a). In 2015, at the end of the 2012–2015 drought, hydropower (both small hydro facilities, with less than 30 megawatts of generating capacity, and large hydro facilities, with more than 30 megawatts of generating capacity) provided approximately 7% of the electricity generated in California (CEC 2015). However, in 2017, one of the wettest years on record, hydropower provided approximately 21% of electricity generated in California (CEC 2018a).

U.1.1.1 *CVP Power and Energy Resources*

Power generated by the CVP is transmitted by Western Area Power Administration (WAPA) to CVP facilities. CVP facilities generally use around 25% to 30% of the power generated by the CVP. Under existing laws, WAPA markets the remaining power to Preference Customers, which includes four first preference customers (Calaveras Public Power Agency, California Department of Corrections: Sierra Conservation Center, Trinity Public Utilities District, and Tuolumne Public Power Agency), Indian tribes, federal agencies, military bases, municipalities, public utilities districts, irrigation and water districts, and state agencies (Reclamation 2012).

Central Valley Project plant-in-service costs are assigned to water users and power customers for repayment in accordance with their benefits resulting from Reclamation’s cost allocation study. Reclamation’s customers have requested a final CVP cost allocation, and Reclamation currently has a study underway to review and update CVP cost allocation factors as appropriate (Reclamation 2019l). In accordance with Reclamation’s most recent plant-in-service cost allocation (for fiscal year 2017), 22.3% of CVP plant-in-service costs, excluding CVPIA costs, are allocated to commercial power customers, and are repaid annually through the power revenue requirement methodology established by WAPA. Power customers pay their percentage share of total WAPA and Reclamation’s costs (including the power allocation of CVP plant-in-service, annual costs, and interest) for the right to receive a percentage share of the daily net (of project use) CVP power generation.

Consequently as CVP annual and plant-in-service power costs increase (including Central Valley Project Improvement Act [CVPIA] Environmental Restoration Funds), and available energy for sale decreases, the net unit cost of CVP power will increase. Alternatively, California renewable energy mandates and other factors have eroded the market price for power, thus decreasing its attractiveness as the price competitiveness of the federal hydropower product is affected.

On December 31, 2024, all of the WAPA's Sierra Nevada Region's long-term power sales contracts will expire. Power customers also have an opportunity to cancel their contracts as part of the rate filing/rate adjustment due on September 30, 2019, and before the start of the new marketing plan. These include all of the contracts outside of project loads. Given the increasing renewable portfolio standard, large hydropower is becoming less desirable, as energy utilities are required to have increasing percentages of their portfolios from renewable sources. CVP power customers may choose not to renew power sales contracts in 2024, which would cause WAPA to market CVP power in the California Independent System Operator (ISO) market, and may or may not allow for recovery of CVP power costs, including the CVPIA. This could lead to financial issues for the Central Valley Project, increased costs for either federal taxpayers or water users, and wasted hydropower resources from California's existing large dams and hydropower facilities.

The CVP power facilities include 11 hydroelectric powerplants and have a total maximum generating capacity of 2,076 megawatts, as shown in Table U.1-1, *Central Valley Project Hydroelectric Powerplants*. Hydrology can vary substantially from year to year, which then affects the hydropower production. Typically, in an average water year, approximately 4,500 gigawatt-hours of energy is produced (Reclamation 2017b). Major factors that influence powerplant operations include required downstream water releases, electric system needs, and project use demand. The power generated from CVP powerplants is dedicated to first meeting the requirements of CVP facilities, then for water supply delivery and pumping. The remaining energy is marketed by WAPA to preference power customers in Northern California.

Table U.1-1. Central Valley Project Hydroelectric Powerplants

Facility	Installed Capacity (Megawatts)
Trinity Powerplant	140
Lewiston Powerplant	0.3
Judge Francis Carr Powerplant	154
Shasta Powerplant	710
Spring Creek Powerplant	180
Keswick Powerplant	117
Folsom Powerplant	207
Nimbus Powerplant	13.5
New Melones Powerplant	300
O'Neill Pump-Generating Plant	25
San Luis Powerplant (CVP portion of the William R. Gianelli/ San Luis Pump-Generating Plant)	202

Source: CEC 2018b.

Power generation at CVP and SWP hydropower facilities fluctuates in response to reservoir releases and conveyance flows. Reservoir releases are affected by hydrologic conditions, minimum stream flow requirements, flow fluctuation restrictions, water quality requirements, and non-CVP and non-SWP water rights, which must be met prior to releases for CVP water service contractors and SWP entitlement holders.

The CVP power generation facilities were developed to meet CVP energy use loads. Most of the energy used by the CVP is needed for pumping plants in the Sacramento–San Joaquin Delta (Delta), at San Luis Reservoir, and along the Delta-Mendota Canal and San Luis Canal portion of the California Aqueduct.

Table U.1-2, *Central Valley Project Facility Pumping Loads*, shows the pump load for each CVP pumping plant.

Table U.1-2. Central Valley Project Facility Pumping Loads

Facility	Pumping Load (Megawatts)
C.W. "Bill" Jones Pumping Plant	101
O'Neil Pumping-Generating Plant	27

Sources: Reclamation 2016a, 2019j.

Table U.1-3, *Hydropower Generation and Energy Use by Central Valley Project*, presents historical average annual CVP hydropower generation and use. Monthly power generation pattern follows seasonal reservoir releases, with peaks during the irrigation season. The hydropower generation between January and June decreases after 2007 because the potential to convey CVP water across the Delta during this period was reduced after 2007 to reduce reverse flows in Old and Middle River (OMR), in accordance with legal decisions and subsequently through implementation of the biological opinions.

Table U.1-3. Hydropower Generation and Energy Use by Central Valley Project

Calendar Year	Water Year Type[1]	Net CVP Hydropower Generation (Gigawatt-hours)[2]	CVP Facility Energy Used (Gigawatt-hours)
2000	Above normal	5,701	–
2001	Dry	4,169	957
2002	Dry	4,378	1,090
2003	Above normal	5,484	1,170
2004	Below normal	5,187	1,172
2005	Above normal	4,599	1,150
2006	Wet	7,285	1,037
2007	Dry	4,276	1,064
2008	Critically dry	3,673	923
2009	Dry	3,392	803
2010	Below normal	4,118	1,001
2011	Wet	5,629	1,276
2012	Below normal	4,423	990
2013	Dry	4,314	NA
2014	Critically dry	2,751	NA
2015	Critically dry	2,471	NA
2016	Below normal	3,605	NA
2017	Wet	6,253	NA
2018	Dry	3,939	NA

Sources: Reclamation 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016b, 2017a, 2018.

[1] Water year types are based on Sacramento Valley 40-30-30 Index, as described in Appendix H. Surface Water Technical Appendix.

[2] After station service. Includes federal share of San Luis.

NA = Not Available

The California Public Utilities Commission (CPUC) evaluated the “energy intensity” of several types of water supplies (CPUC 2010). The energy intensity is defined as the average amount of energy required to convey and/or treat water on a unit basis, such as per 1 acre-foot (AF). Substantial quantities of energy are required by the CVP pumping plants to convey large amounts of water over long distances with significant changes in elevation. The study indicated that the energy intensity of CVP water delivered to users downstream of San Luis Reservoir ranged from 0.292 megawatt-hours/AF for users along the Delta-Mendota Canal to 0.428 megawatt-hours/AF for users along the San Luis Canal/California Aqueduct to 0.870 megawatt-hours/AF in San Benito and Santa Clara Counties.

U.1.1.2 *State Water Project Power and Energy Resources*

The SWP also generates hydroelectricity along the California Aqueduct at energy recovery plants (DWR 2017). Power generated by the SWP is transmitted by Pacific Gas and Electric Company (PG&E), Southern California Edison, and California Independent System Operator through other facilities (DWR 2013a, 2013b). The SWP also markets energy in excess of the SWP demands to a utility and members of the Western Systems Power Pool.

The SWP power facilities are operated primarily to provide power for the SWP facilities (DWR 2017). The SWP power facilities and capacities are summarized in Table U.1-4, *State Water Project Hydroelectric Powerplants*. The SWP has power contracts with electric utilities and the California ISO that act as exchange agreements with utility companies for transmission and power sales and purchases. Each year, the SWP must purchase additional power to meet pumping requirements.

Table U.1-4. State Water Project Hydroelectric Powerplants

Facility	**Installed Capacity (Megawatts)**
Oroville Facilities	–
Hyatt Pumping-Generating Plant	645
Thermalito Diversion Dam Powerplant	3
Thermalito Pumping-Generating Plant	114
William R. Gianelli (San Luis) Pumping-Generating Plant (SWP share)	222
Alamo Powerplant	17
Mojave Siphon Powerplant	30
Devil Canyon Powerplant	276
Warne Powerplant	74
Total	1,381

Source: DWR 2017.
SWP = State Water Project

The SWP power generation facilities were developed to meet SWP energy use loads. The majority of the energy used by the SWP is needed for pumping plants located in the Delta, at the San Luis Reservoir, and along the California Aqueduct. Table U.1-5, *State Water Project Pumping Plant Loads*, shows the pump load for each of the SWP pumping plants.

Table U.1-5. State Water Project Pumping Plant Loads

Facility	Pumping Load (Megawatts)
Hyatt Pumping-Generating Plant	387
Barker Slough Pumping Plant	4
Cordelia Pumping Plant	NA
South Bay Pumping Plant	21
Del Valle Pumping Plant	1
Harvey O. Banks Pumping Plant	248
William R. Gianelli Pumping Plant	276
Dos Amigos Pumping Plant	179
Buena Vista Pumping Plant	108
John R. Teerink Pumping Plant	112
Ira J. Chrisman Pumping Plant	246
A.D. Edmonston Pumping Plant	836
Oso Pumping Plant	70
Alamo Pumping Plant	17
Pearblossom Pumping Plant	152
Las Perillas Pumping Plant	3
Badger Hill Pumping Plant	9
Devil’s Den Pumping Plant	8
Bluestone Pumping Plant	8
Polonio Pass Pumping Plant	8
Greenspot Pump Station	3
Crafton Hills Pump Station	3
Cherry Valley Pump Station	0.2
Total	2,699

Source: DWR 2017.
NA = not available

Table U.1-6, *Hydropower Generation and Energy Use by the State Water Project*, presents historical average annual SWP hydropower generation and use for the period 2001–2018. Monthly power generation pattern follows seasonal reservoir releases, with peaks during the irrigation season. SWP power use and generation values indicate the SWP generates approximately 63% of the energy needed for deliveries (DWR 2002, 2004a, 2004b, 2005, 2006, 2007, 2008, 2012a, 2012b, 2013a, 2013b, 2014, 2015a, 2015b, 2016, 2017). The energy generation and purchases and energy use decreases after 2007 because the potential to convey SWP water across the Delta was reduced in accordance with legal decisions and subsequently through implementation of the biological opinions.

Table U.1-6. Hydropower Generation and Energy Use by the State Water Project

Calendar Year	Water Year Type[1]	State Water Project Hydropower Generation (Gigawatt- hour)	Energy Acquired through Long-Term Agreements and Purchases (Gigawatt-hour)	Energy Used by State Water Project Facilities (Gigawatt-hour)
2000	Above normal	6,372	5,741	9,190
2001	Dry	4,295	4,660	6,656
2002	Dry	4,953	4,610	8,394
2003	Above normal	5,511	4,668	9,175
2004	Below normal	6,056	4,429	9,860
2005	Above normal	5,151	5,367	8,308
2006	Wet	7,056	5,811	9,158
2007	Dry	5,577	6,642	9,773
2008	Critically dry	3,541	4,603	5,745
2009	Dry	4,650	3,970	6,089
2010	Below normal	3,920	5,081	7,187
2011	Wet	4,846	4,895	8,549
2012	Below normal	4,198	3,741	7,406
2013	Dry	3,069	3,604	5,736
2014	Critically dry	1,133	1,691	2,791
2015	Critically dry	1,275	2,781	3,488
2016	Below normal	NA	NA	NA
2017	Wet	NA	NA	NA
2018	Dry	NA	NA	NA

Sources: DWR 2002, 2004a, 2004b, 2005, 2006, 2007, 2008, 2012a, 2012b, 2013a, 2013b, 2014, 2015a, 2015b, 2016, 2017.
[1] Water year types are based on Sacramento Valley 40-30-30 Index, as described in Appendix H, Surface Water Technical Appendix.
NA = not available

The energy intensity values calculated by CPUC for the SWP ranged from 1.128 megawatt-hours/AF for water users along the South Bay Aqueduct to 1.157 megawatt-hours/AF for water users in Kern County to 4.644 megawatt-hours/AF for water users at the terminal end of the East Branch Extension of the California Aqueduct (CPUC 2010).

U.1.2 Trinity River

The Trinity Powerplant is on the Trinity River (Reclamation 2019a). Primary releases of Trinity Dam are made through the powerplant. Trinity County has first preference to the power from this plant.

The Lewiston Powerplant is at the Lewiston Dam along the Trinity River (Reclamation 2019b). It is operated in conjunction with the spillway gates to maintain the minimum flow in the Trinity River downstream. Because the turbine capacity is less than the Trinity River minimum flow criteria, the turbine is usually set at maximum output with the spillway gates adjusted to regulate river flow. The Lewiston Powerplant provides power to the adjacent fish hatchery. Adjacent to Lewiston Dam is an intake to the Clear Creek Tunnel, which diverts Trinity River water to Carr Powerplant, where it discharges into Whiskeytown Reservoir.

U.1.3 Sacramento River

The Shasta Powerplant is a peaking powerplant located downstream of Shasta Dam along the Sacramento River (Reclamation 2019d). Until early 1990s, concerns with downstream temperatures resulted in the bypasses of outflows around the powerplant and lost hydropower generation. Installation of the Shasta Temperature Control Device enabled operators to decide the depth of the reservoir from which the water feeding into the penstocks originates. The system has shown success in controlling the water temperature of powerplant releases through Shasta Dam. The Shasta Powerplant also provides water supply for the Livingston Stone National Fish Hatchery.

The Spring Creek Powerplant is a peaking plant along Spring Creek (Reclamation 2019e) Water discharged via the Judge Francis Carr Powerplant flows into the Whiskeytown Reservoir and then provides the source of water for the Spring Creek Powerplant generation. Trinity County has first preference to the power benefits from Spring Creek Powerplant. Water from Spring Creek Powerplant is discharged into Keswick Reservoir. Releases from Spring Creek Powerplant also are operated to maintain water quality in the Spring Creek arm of Keswick Reservoir.

The Keswick Powerplant is located at Keswick Dam along the Sacramento River downstream of Shasta Dam. The powerplant regulates the flows into the Sacramento River from both Shasta Lake and Spring Creek releases; with minimal storage capacity, Keswick Dam is operated to allow for peaking operations at Shasta Dam and the Spring Creek powerhouse while maintaining relatively consistent flows to the Sacramento River below Keswick Dam (Reclamation 2019f).

U.1.4 Clear Creek

The Judge Francis Carr Powerplant is a peaking powerplant located on the Clear Creek Tunnel (Reclamation 2019c). It generates power from water exported from the Trinity River Basin via the intake to the Clear Creek Tunnel adjacent to Lewiston Dam. The plant discharges into Whiskeytown Reservoir. Similar to Trinity Powerplant, Trinity County has first preference to the power benefit from this facility.

U.1.5 Feather River

The Hyatt Pumping-Generating Plant is on the channel between Lake Oroville and the Thermalito Diversion Pool (DWR 2007). Water in the Thermalito Diversion Pool can be pumped back to Lake Oroville to be released through the Hyatt Pumping-Generating Plant and generate more electricity, released through the Thermalito Diversion Dam Powerplant for delivery to the low flow channel upstream of Thermalito Forebay, or conveyed to Thermalito Forebay for subsequent release through the Thermalito Pumping-Generating Plant. The combined Hyatt Pumping-Generating Plant and Thermalito Pumping-Generating Plant generate approximately 2,200 gigawatt-hours of energy in a average water year, while the 3 megawatts generated by Thermalito Diversion Dam Powerplant adds another 24 gigawatt-hours per year (DWR 2017).

U.1.6 American River

The Folsom Powerplant is a peaking powerplant at Folsom Dam along the American River (Reclamation 2019g). The Folsom Powerplant is operated in an integrated manner with flood control and storage management operations at Folsom Reservoir. One of the integrated operations is related to coordinating early flood control releases with power generation. It also provides power for the pumping plant that supplies the multiple local municipal water systems. Folsom Powerplant supports voltage regulation for the Sacramento region during summer heavy load times.

The Nimbus Powerplant is located at Nimbus Dam along the American River, downstream of Folsom Dam (Reclamation 2019h). The Nimbus Powerplant regulates releases from Folsom Dam into the American River and can be considered a run-of-the river powerplant.

U.1.7 Stanislaus River

The New Melones Powerplant is a peaking powerplant located along the Stanislaus River (Reclamation 2019i). Primary reservoir releases are made through the powerplant. This plant provides substantial voltage support to the PG&E system during summer heavy load periods.

U.1.8 San Joaquin River

This analysis does not include powerplants along the San Joaquin River. Their operations would be expected to be consistent between all action alternatives.

U.1.9 Central Valley Project and State Water Project Service Areas (South to Diamond Valley)

U.1.9.1 *San Luis Reservoir Powerplants (Federal Share)*

The O’Neill Pump-Generating Plant is on a channel that conveys water between the Delta-Mendota Canal and the O’Neill Forebay (Reclamation 2019j). This pump-generating plant only generates power when water is released from the O’Neill Reservoir to the Delta-Mendota Canal. When water is conveyed from the Delta-Mendota Canal to O’Neill Forebay, the units serve as pumps, not hydroelectric generators. The generated power is used to support CVP pumping and irrigation actions of the CVP.

The William R. Gianelli (San Luis) Pump-Generating Plant is along the along the western boundary of the O’Neill Forebay at the San Luis Dam (Reclamation 2019k). This pump-generating plant is owned by the federal government but is operated as a joint federal-state facility that is shared by the CVP and SWP. Energy is generated when water is needed to be conveyed from San Luis Reservoir back into O’Neill Forebay for continued conveyance to the Delta-Mendota Canal. The plant is operated in pumping mode when water is moved from O’Neill Forebay to San Luis Reservoir for storage until heavier water demands develop. The generated power is used to offset CVP and SWP pumping loads. The powerplant can generate up to 424 megawatts, with the CVP share of the total capacity being 202 megawatts. This facility is operated and maintained by the State of California under an operation and maintenance agreement with the U.S. Department of the Interior, Bureau of Reclamation (Reclamation).

U.1.9.2 *San Luis Reservoir Powerplant (State Share)*

As described above, the William R. Gianelli (San Luis) Pump-Generating Plant is owned by the federal government and is operated as a joint federal-state facility shared by the CVP and SWP. The SWP water flows from the California Aqueduct into O’Neill Forebay downstream of the CVP’s O’Neill Pump-Generating Plant. The pump-generating plant is located along the western boundary of the O’Neill Forebay at the San Luis Dam (DWR 2013a, 2013b). Electricity is generated when water is transferred from San Luis Reservoir back to O’Neill Forebay for continued conveyance in the California Aqueduct. The plant acts as a pumping plant when water is transferred from O’Neill Forebay to San Luis Reservoir. The generated power is used to offset CVP and SWP pumping loads. The powerplant can generate up to 424 megawatts, with the SWP share of the total capacity being 222 megawatts. This facility is operated and maintained by the State of California under an operation and maintenance agreement with Reclamation.

U.1.9.3 *East Branch and West Branch Powerplants*

Downstream of the Antelope Valley, the California Aqueduct divides into the East Branch and West Branch. The Alamo Powerplant, Mojave Powerplant, and Devil Canyon Powerplant are located along the East Branch, which conveys water into San Bernardino County (DWR 2017). The Warne Powerplant is located along the West Branch, which conveys water into Los Angeles County. The generation rates vary at these powerplants depending upon the amount of water conveyed.

U.1.9.4 *Other Energy Resources for the State Water Project*

Other energy supplies have been obtained by California Department of Water Resources (DWR) from other utilities and energy marketers under agreements that allow DWR to buy, sell, or exchange energy on a short-term hourly basis or a long-term multiyear basis (DWR 2017).

For example, DWR jointly developed the 1,254-megawatt Castaic Powerplant on the West Branch with the Los Angeles Department of Water and Power (DWR 2017). The power is available to DWR at the Sylmar Substation.

DWR has a long-term purchase agreement with the Kings River Conservation District for the approximately 400 million kilowatt-hours of energy from the 165-megawatt hydroelectric Pine Flat Powerplant (DWR 2017). DWR also purchases energy from five hydroelectric plants with 30 megawatts of installed capacity that are owned and operated by Metropolitan Water District of Southern California (DWR 2017).

DWR also purchases energy under short-term purchase agreements from utilities and energy marketers of the WSPP (DWR 2017). In addition, the 1988 Coordination Agreement between DWR and Metropolitan Water District of Southern Californian enables DWR to purchase and exchange energy (DWR 2017) from Metropolitan’s Colorado River Aqueduct System.

U.1.10 Other Hydroelectric Generation Facilities

Hydroelectric facilities in addition to CVP and SWP hydroelectric facilities in the study area are owned by investor-owned utility companies, such as PG&E and Southern California Edison; municipal agencies, such as Sacramento Municipal Utility District (SMUD); and by local and regional water agencies. Some of the larger facilities outside the CVP and SWP systems and within or adjacent to the study area include (CEC 2014b; YCWA 2012):

- PG&E
  - Helms Pumped Storage (1,200 megawatts) in Fresno County.
  - Pit System (320 megawatts) and McCloud-Pit System (370 megawatts, total) in Shasta County.
  - Upper North Fork Feather River System (360 megawatts) in Plumas County.
- SMUD Upper American River Project System (688 megawatts) in El Dorado County.
- City and County of San Francisco Hetch Hetchy Power System (390 megawatts) in Tuolumne County.
- Southern California Edison
  - Big Creek System and Eastwood Pump Storage (approximately 1,000 megawatts) in Fresno and Madera Counties.

   - Mammoth Pool Project (187 megawatts) in Fresno and Madera Counties.
- Turlock Irrigation District and Modesto Irrigation District New Don Pedro Project (203 megawatts) in Tuolumne County.
- Yuba Water Agency Yuba River Development Project (390 megawatts) in Yuba County.

U.1.11 Energy Demands for Groundwater Pumping

Groundwater provided approximately 38% of the state's agricultural, municipal, and industrial water supply of the average water needs between 2005 and 2010, or over 16 million acre-feet/year (AFY) of groundwater (DWR 2015c). The use of groundwater varies regionally throughout the state.

The amount of energy used statewide to pump groundwater is not well quantified (CPUC 2010). CPUC estimated groundwater energy use by hydrologic region and by type of use to evaluate the water and energy relationships. Groundwater pumping estimates were calculated in each DWR Planning Area for agricultural and municipal water demands. Groundwater energy use was estimated based upon assumptions of well depths and pump efficiencies. Some wells use natural gas for individual engines instead of electricity; however, the amount of natural gas pumping versus electric pumping is generally unknown. Between 2005 and 2010, average groundwater use in the state was approximately 16.5 million AF, or 38% of total agricultural, municipal, and industrial water supplies (DWR 2015c). In 2010, CPUC estimated that, statewide groundwater pumping accounted for more electricity use between May and August than the total electricity use by CVP and SWP during that same time period (CPUC 2010). Over the entire year, it was estimated that groundwater pumping used approximately 10% more electricity than the SWP and approximately 5% less than CVP and SWP combined.

U.2 Evaluation of Alternatives

This section describes the potential mechanisms for change in energy generation and analytical methods, results of the impact analyses, potential mitigation measures, and cumulative effects.

U.2.1 Methods and Tools

The environmental consequences assessment considers changes in energy resources conditions related to changes in CVP and SWP operations under the alternatives compared to the No Action Alternative.

U.2.1.1 *Changes in Energy Resources Related to Central Valley Project and State Water Project Water Users*

Energy generation is limited on a monthly basis by the average power capacity of each generation facility based upon reservoir elevations and water release patterns. The majority of the CVP and SWP energy use is for the conveyance facilities located in the Delta and south of the Delta. Energy use would change with changes in CVP and SWP deliveries.

Reservoir elevations and flow patterns through pumping facilities output from the CalSim II model (Appendix F, *Model Documentation*) are used with LTGen and SWP power tools, as described in Appendix U Attachment 1, *Power Model Documentation*. These tools estimate average annual peaking power capacity, energy use, and energy generation at CVP and SWP facilities, respectively. The tools estimate average monthly and annual energy generation and use and net generation. (Net generation is the difference between energy generation and use; a negative net generation means more energy is used than generated.) When net generation values are negative, the CVP or SWP would purchase power from other generation facilities. Because California's energy system must always be balanced, purchasing power from other generation facilities would imply that additional generation is needed. This additional generation could come from reduced curtailments of renewable generation, existing thermal generation, or increased import of energy from out of state (primarily from the Pacific Northwest or from Arizona and Nevada). When net generation values are positive, power would be available for use by both CVP preferential power customers (for available CVP power) and non-CVP and SWP electricity users for available SWP power, and would allow for either less generation from thermal generating plants, or less imported power from outside the state.

When CVP and SWP water deliveries change, water users are anticipated to change their use of groundwater, recycled water, and/or desalinated water, as described in Appendix H, *Water Supply Technical Appendix*, and Appendix I, *Groundwater Technical Appendix*. Specific responses by water users to changes in CVP and SWP water deliveries are not known; therefore, energy use for the alternate water supplies cannot be quantified in this analysis. It is not known whether the net change in energy use for the CVP and SWP would or would not be similar to the net change in energy use for alternate water supplies (e.g., groundwater pumping, water treatment, water conveyance).

U.2.2 No Action Alternative

Due to the climate change, sea-level rise, and increased water demands in the Sacramento Valley, CVP and SWP energy generation may be less in the summer months, and therefore less generation is available for sale to CVP preference power customers, when energy demand is high for water conveyance and air conditioning equipment throughout the state. Water deliveries could also change in 2030, which could result in less energy use for CVP and SWP water conveyance facilities.

U.2.3 Alternative 1

Alternative 1 is compared to the No Action Alternative to evaluate changes in both CVP and SWP net generation.

U.2.3.1 *Project-Level Effects*

Potential changes in Central Valley Project net generation

Changes in CVP operations under Alternative 1 compared to the No Action Alternative would result in an increase of CVP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in CVP energy resources, as summarized in Table U.2-1, *Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative*. The CVP net generation over the long-term would be slightly lower by 3% and 2% higher in dry and critically dry years, under Alternative 1 compared to the No Action Alternative.

Table U.2-1. Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative

Water Year		Alternative 1 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 1 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	1,322	1,207	115 (10%)
	Generation	4,539	4,533	6 (0%)
	Net Generation	3,217	3,326	-109 (-3%)
Dry and Critically Dry Water Years[1]	Energy Use	1,070	974	96 (10%)
	Generation	3,515	3,377	138 (4%)
	Net Generation	2,445	2,403	42 (2%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 1 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-2, *Simulated Monthly CVP Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative*, shows the breakdown of the monthly energy use, generation, and net generation, by long-term average and for dry and critically dry years, for the CVP facilities. The model output shows that there is an average decrease in net generation under Alternative 1 compared to the No Action Alternative in October through December, and April and May for all years, and a decrease in October, and February through May for dry and critically dry years. The decreases in net generation tend to be a result of both increase in energy use and decreases in generation in those months.

Table U.2-2. Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	82	112	127	132	115	109	44	52	93	125	121	96
		Generation	287	266	258	313	316	329	308	474	489	622	476	396
		Net Generation	205	154	131	181	201	220	264	422	397	498	355	299
	Alt 1	Energy Use	96	103	119	135	125	116	77	85	102	128	130	105
		Generation	281	218	282	337	333	347	303	474	517	641	490	316
		Net Generation	184	115	163	201	208	231	225	390	415	513	361	212
	Change from NAA (percent change)[2]	Energy Use	15	-10	-8	3	11	7	33	33	10	3	9	8
		Generation	-6	-48	24	24	18	18	-6	0	28	18	14	-79
		Net Generation	-21 (-10%)	-38 (-25%)	31 (24%)	21 (11%)	7 (3%)	11 (5%)	-39 (-15%)	-32 (-8%)	18 (5%)	15 (3%)	6 (2%)	-87 (-29%)
Dry and Critically Dry Years1	NAA	Energy Use	70	80	106	122	105	85	35	40	57	103	92	79
		Generation	198	155	213	248	270	168	216	363	429	517	383	217
		Net Generation	128	75	107	126	165	83	180	323	372	414	291	138
	Alt 1	Energy Use	73	77	104	129	122	107	47	58	71	101	98	82
		Generation	198	165	219	257	279	183	218	377	451	543	398	228
		Net Generation	125	88	115	128	157	76	171	319	380	442	300	146
	Change from NAA (percent change)[2]	Energy Use	3	-3	-2	7	17	22	12	18	14	-2	6	3
		Generation	0	10	6	9	9	15	2	14	22	26	15	11
		Net Generation	-4 (-3%)	13 (17%)	8 (7%)	2 (1%)	-8 (-5%)	-7 (-9%)	-10 (-5%)	-4 (-1%)	8 (2%)	28 (7%)	8 (3%)	8 (6%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting No Action Alternative value from Alternative 1 value. Percent change is the change divided by No Action Alternative value.
GWh = Gigawatt-hours; Alt 1 = Alternative 1; NAA = No Action Alternative

Under Alternative 1, annual energy generation would be higher for both long-term average and in dry and critically dry years, but the energy required to move the water would also be higher for both long-term average and in dry and critically dry years, compared to the No Action Alternative for the CVP. The trend is also maintained at a monthly level; the CVP would expect increased generation under Alternative 1 compared to the No Action Alternative, but similarly would expect increases in energy usage. While decreases in monthly net generation would occasionally be relatively small (reductions in CVP net generation in dry and critically dry years in October and May would both be less than 5%), monthly reductions in net generation would likely require alternative sources of energy; increases in net generation in one month would not necessarily benefit a month with a reduction in net generation because no opportunities for large-scale energy storage are available.

Potential changes in State Water Project net generation

Changes in SWP operations under Alternative 1 compared to the No Action Alternative would result in an increase SWP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in SWP energy resources, as summarized in Table U.2-3, *Simulated Annual State Water*

Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative. The changes to SWP net generation would be much greater under Alternative 1, relative to the No Action Alternative; long-term average net generation would be 25% lower, and dry and critically dry year net generation would be 19% lower.

Table U.2-3. Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative

Water Year		Alternative 1 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 1 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	8,377	7,304	1,073 (15%)
	Generation	4,349	4,074	275 (7%)
	Net Generation	-4,028	-3,230	-798 (25%)
Dry and Critically Dry Water Years[1]	Energy Use	5,217	4,685	532 (11%)
	Generation	2,670	2,489	182 (7%)
	Net Generation	-2,547	-2,197	-350 (16%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 1 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-3, *Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative*, shows the monthly energy use, generation, and resulting net generation for SWP facilities for No Action Alternative and Alternative 1, both as long-term average of all years, and as an average for dry and critically dry years. Simulated SWP net generation would be decreased in all months for both the average of all years and for dry and critically dry years. For both timeframes, the decrease in net generation is a result of increased energy use; the average generation of all years and dry and critically dry years would also increase, but not by as much.

Table U.2-3. Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	696	635	683	301	334	424	453	593	666	846	833	841
		Generation	312	268	278	198	235	284	306	396	407	537	433	419
		Net Generation	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
	Alt 1	Energy Use	767	774	759	366	419	539	608	733	727	907	898	880
		Generation	318	300	320	227	274	332	330	431	447	558	457	356
		Net Generation	-449	-474	-439	-139	-144	-207	-279	-303	-280	-349	-441	-524
	Change from NAA (percent change)[2]	Energy Use	71	139	76	65	85	115	156	140	60	61	65	39
		Generation	6	32	42	28	39	49	23	34	40	21	24	-64
		Net Generation	-65 (17%)	-108 (29%)	-34 (8%)	-37 (36%)	-45 (46%)	-66 (47%)	-133 (91%)	-106 (54%)	-20 (8%)	-40 (13%)	-41 (10%)	-103 (24%)
Dry and Critically Dry Years[1]	NAA	Energy Use	433	446	474	179	231	159	211	380	489	604	512	567
		Generation	180	166	193	124	162	73	146	247	344	383	249	221
		Net Generation	-253	-280	-280	-56	-68	-86	-65	-133	-145	-222	-264	-346
	Alt 1	Energy Use	457	468	507	248	291	196	270	428	535	637	585	596
		Generation	188	175	203	142	180	77	156	263	380	390	279	237
		Net Generation	-269	-293	-304	-106	-111	-119	-114	-165	-155	-247	-306	-359
	Change from NAA (percent change)[2]	Energy Use	23	22	33	69	61	37	59	48	46	33	73	29
		Generation	7	9	10	19	18	3	10	16	36	7	30	16
		Net Generation	-16 (6%)	-13 (5%)	-23 (8%)	-50 (91%)	-43 (63%)	-33 (38%)	-49 (76%)	-32 (24%)	-10 (7%)	-26 (12%)	-42 (16%)	-13 (4%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).

[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 1 value. Percent change is the change divided by the No Action Alternative value.

GWh = Gigawatt-hours; Alt 1 = Alternative 1; NAA = No Action Alternative

Under Alternative 1, annual energy generation would be 7% higher for both long-term average and in dry and critically dry years, but the energy required to move the water would also be higher for both long-term average and in dry and critically dry years, compared to the No Action Alternative for the SWP, resulting in a reduction in net generation. The trend is also maintained at a monthly level; the SWP would expect increased generation under Alternative 1 compared to the No Action alternative, but similarly would expect increases in energy usage. Alternative sources of energy would be needed in response to the decreased net generation in most months.

U.2.3.2 *Program-Level Effects*

Construction-related actions that are analyzed at a program level would not affect power or energy resources.

U.2.4 Alternative 2

Alternative 2 is compared to the No Action Alternative to evaluate changes in both CVP and SWP net generation.

U.2.4.1 *Project-Level Effects*

Potential changes in Central Valley Project net generation

Changes in CVP operations under Alternative 2 compared to the No Action Alternative would result in an increase of CVP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in CVP energy resources, as summarized in Table U.2-4, *Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative*. The CVP annual net generation over the long-term conditions would be slightly lower by 4%, but there would be no change in the dry and critically dry year net generation under Alternative 2 compared to the No Action Alternative.

Table U.2-4. Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative

Water Year		Alternative 2 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 2 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	1,420	1,207	213 (18%)
	Generation	4,609	4,533	75 (2%)
	Net Generation	3,189	3,326	-137 (-4%)
Dry and Critically Dry Water Years[1]	Energy Use	1,139	974	165 (17%)
	Generation	3,542	3,377	165 (5%)
	Net Generation	2,402	2,403	0 (0%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 2 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-5, *Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative*, shows the breakdown of the monthly energy use, generation, and net generation, by long-term average and for dry and critically dry years, for the CVP facilities. The model output shows that there is an average decrease in net generation under Alternative 2 compared to the No Action Alternative in September, October, November, and February through May for all years, and a decrease in November through April for dry and critically dry years. The decreases in net generation tend to be a result of both increase in energy use and decreases in generation in those months.

Table U.2-5. Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	82	112	127	132	115	109	44	52	93	125	121	96
		Generation	287	266	258	313	316	329	308	474	489	622	476	396
		Net Generation	205	154	131	181	201	220	264	422	397	498	355	299
	Alt 2	Energy Use	98	111	137	146	137	119	73	90	114	146	139	109
		Generation	278	212	270	332	338	337	299	485	558	660	512	329
		Net Generation	180	100	133	185	200	217	226	395	445	514	374	219
	Change from NAA (percent change)[2]	Energy Use	16	-1	10	14	23	11	30	38	21	21	18	13
		Generation	-9	-54	11	19	22	8	-9	11	69	37	37	-67
		Net Generation	-25 (-12%)	-53 (-35%)	1 (1%)	5 (3%)	-1 (0%)	-3 (-1%)	-39 (-15%)	-27 (-6%)	48 (12%)	16 (3%)	19 (5%)	-80 (-27%)
Dry and Critically Dry Years[1]	NAA	Energy Use	70	80	106	122	105	85	35	40	57	103	92	79
		Generation	198	155	213	248	270	168	216	363	429	517	383	217
		Net Generation	128	75	107	126	165	83	180	323	372	414	291	138
	Alt 2	Energy Use	59	88	122	137	131	112	50	65	74	116	95	90
		Generation	191	159	211	245	274	171	222	392	474	558	406	239
		Net Generation	132	72	90	107	142	58	173	327	400	443	310	149
	Change from NAA (percent Change)[2]	Energy Use	-10	8	16	15	26	28	14	25	17	13	4	11
		Generation	-7	4	-2	-4	4	3	7	29	45	42	23	22
		Net Generation	3 (3%)	-4 (-5%)	-17 (-16%)	-19 (-15%)	-22 (-14%)	-25 (-30%)	-8 (-4%)	4 (1%)	28 (8%)	29 (7%)	19 (7%)	11 (8%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).

[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 2 value. Percent change is the change divided by the No Action Alternative value.

GWh = Gigawatt-hours; Alt 2 = Alternative 2; NAA = No Action Alternative

Under Alternative 2, annual energy generation would be higher for both long-term average and in dry and critically dry years, but the energy required to move the water would also be higher for both long-term average and in dry and critically dry years, relative to the No Action Alternative for the CVP. This would result in a reduction in annual net generation for the average of all years, but no change in annual generation for dry and critically dry years. At a monthly level, the CVP would similarly expect increased generation under Alternative 2 compared to the No Action Alternative, but also increases in energy usage, resulting in decreases in monthly net generation in multiple months. While decreases in monthly net generation would occasionally be relatively small (reductions in CVP net generation for all years in February and March, and in dry and critically dry years in April would be less than 5%), alternative sources of energy would be needed in response to the decreased net generation in many months.

Potential changes in State Water Project net generation

Changes in SWP operations under Alternative 2 compared to the No Action Alternative would result in an increase of SWP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in SWP energy resources, as summarized in Table U.2-6, *Simulated Annual State Water*

Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative. The changes to SWP net generation would be much greater under Alternative 2, relative to the No Action Alternative; long-term average net generation would be 53% lower, and dry and critically dry year net generation would be 61% lower.

Table U.2-6. Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative.

Water Year		Alternative 2 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 2 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	9,630	7,304	2,326 (32%)
	Generation	4,679	4,074	605 (15%)
	Net Generation	-4,951	-3,230	-1,721 (53%)
Dry and Critically Dry Water Years[1]	Energy Use	6,596	4,685	1,910 (41%)
	Generation	3,064	2,489	575 (23%)
	Net Generation	-3,532	-2,197	-1,336 (61%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 2 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-7, *Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative*, shows the monthly energy use, generation, and resulting net generation for SWP facilities for No Action Alternative and Alternative 2, both as long-term average of all years, and as an average for dry and critically dry years. Simulated SWP net generation would be decreased in all months for both the average of all years and for dry and critically dry years. For both timeframes, the decrease in net generation is a result of increased energy use; the average generation of all years and dry and critically dry years would also increase, but not by as much.

Table U.2-7. Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	696	635	683	301	334	424	453	593	666	846	833	841
		Generation	312	268	278	198	235	284	306	396	407	537	433	419
		Net Generation	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
	Alt 2	Energy Use	819	845	865	596	625	746	666	799	828	953	952	936
		Generation	340	321	334	276	322	395	340	455	508	559	458	372
		Net Generation	-479	-524	-531	-320	-304	-351	-325	-344	-320	-394	-494	-564
	Change from NAA (percent change)[2]	Energy Use	123	210	182	296	291	322	213	206	161	107	119	95
		Generation	27	53	56	77	87	111	34	59	101	22	26	-48
		Net Generation	-95 (25%)	-158 (43%)	-125 (31%)	-218 (214%)	-205 (207%)	-211 (150%)	-179 (123%)	-147 (75%)	-60 (23%)	-85 (28%)	-94 (23%)	-143 (34%)
Dry and Critically Dry Years[1]	NAA	Energy Use	433	446	474	179	231	159	211	380	489	604	512	567
		Generation	180	166	193	124	162	73	146	247	344	383	249	221
		Net Generation	-253	-280	-280	-56	-68	-86	-65	-133	-145	-222	-264	-346
	Alt 2	Energy Use	486	581	675	384	443	367	338	488	618	740	760	716
		Generation	201	207	237	155	212	128	175	289	424	419	341	275
		Net Generation	-285	-375	-438	-229	-231	-239	-163	-199	-194	-321	-418	-441
	Change from NAA (percent change)[2]	Energy Use	53	135	201	205	212	207	127	109	129	136	247	150
		Generation	21	41	43	31	49	55	29	43	80	37	93	54
		Net Generation	-32 (13%)	-94 (34%)	-158 (56%)	-173 (312%)	-163 (238%)	-153 (177%)	-98 (151%)	-66 (50%)	-49 (34%)	-99 (45%)	-155 (59%)	-96 (28%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 2 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; Alt 2 = Alternative 2; NAA = No Action Alternative

Under Alternative 2, annual energy generation would be higher for both long-term average and in dry and critically dry years, but the energy required by the SWP to move the water would also be higher for both long-term average and in dry and critically dry years, relative to the No Action Alternative. The trend is also maintained at a monthly level; the SWP would expect increased generation under Alternative 2 compared to the No Action alternative in all months, but greater increases in energy usage resulting in reductions in net generation in all months. Alternative sources of energy would be needed in response to the decreased net generation because increased net generation in one month would not generally benefit a different month.

U.1.1.1 Program-Level Effects

Construction-related actions that are analyzed at a program level would not affect power or energy resources.

U.2.5 Alternative 3

Alternative 3 is compared to the No Action Alternative to evaluate changes in both CVP and SWP net generation.

U.2.5.1 *Project-Level Effects*

Potential changes in Central Valley Project net generation

Changes in CVP operations under Alternative 3 compared to the No Action Alternative would result in an increase of CVP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in CVP energy resources, as summarized in Table U.2-8, *Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative*. Similar to Alternative 2, the CVP annual net generation over the long-term conditions would be slightly lower by 4%, but there would be no change in the dry and critically dry year net generation under Alternative 3 compared to the No Action Alternative.

Table U.2-8. Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative

Water Year		Alternative 3 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 3 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	1,415	1,207	208 (17%)
	Generation	4,610	4,533	77 (2%)
	Net Generation	3,195	3,326	-131 (-4%)
Dry and Critically Dry Water Years[1]	Energy Use	1,135	974	161 (17%)
	Generation	3,538	3,377	161 (5%)
	Net Generation	2,403	2,403	0 (0%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 3 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-9, *Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative*, shows the breakdown of the monthly energy use, generation, and net generation, by long-term average and for dry and critically dry years, for the CVP facilities. The model output shows that there is an average decrease in net generation under Alternative 3 compared to the No Action Alternative in September, October, November, and February through May for all years, and a decrease in November through April for dry and critically dry years. The decreases in net generation tend to be a result of both increase in energy use and decreases in generation in those months.

Table U.2-9. Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	82	112	127	132	115	109	44	52	93	125	121	96
		Generation	287	266	258	313	316	329	308	474	489	622	476	396
		Net Generation	205	154	131	181	201	220	264	422	397	498	355	299
	Alt 3	Energy Use	97	112	139	146	139	117	72	89	113	144	139	109
		Generation	287	213	275	330	336	335	299	483	554	659	511	327
		Net Generation	191	101	136	184	197	218	227	394	441	515	373	218
	Change from NAA (percent change)[2]	Energy Use	15	0	12	14	24	8	28	37	20	19	18	13
		Generation	1	-53	16	18	21	7	-9	9	65	37	36	-68
		Net Generation	-14 (-7%)	-53 (-34%)	4 (3%)	3 (2%)	-4 (-2%)	-2 (-1%)	-37 (-14%)	-28 (-7%)	44 (11%)	18 (4%)	18 (5%)	-81 (-27%)
Dry and Critically Dry Years[1]	NAA	Energy Use	70	80	106	122	105	85	35	40	57	103	92	79
		Generation	198	155	213	248	270	168	216	363	429	517	383	217
		Net Generation	128	75	107	126	165	83	180	323	372	414	291	138
	Alt 3	Energy Use	60	85	124	140	133	108	49	64	74	113	95	91
		Generation	205	154	212	243	272	169	223	392	471	554	403	240
		Net Generation	145	70	87	103	139	61	174	328	397	441	309	149
	Change from NAA (percent change)[2]	Energy Use	-10	5	18	18	28	23	14	24	17	10	3	12
		Generation	7	-1	-2	-6	1	1	8	29	42	38	21	23
		Net Generation	17 (13%)	-6 (-8%)	-20 (-18%)	-23 (-18%)	-26 (-16%)	-22 (-27%)	-6 (-3%)	5 (2%)	25 (7%)	27 (7%)	17 (6%)	11 (8%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 3 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; Alt 3 = Alternative 3; NAA = No Action Alternative

Under Alternative 3, annual CVP energy generation would be higher for both long-term average and in dry and critically dry years, but the energy required by the CVP to move the water would also be higher for both long-term average and in dry and critically dry years, relative to the No Action Alternative. At a monthly level, the CVP would similarly expect increased generation under Alternative 3 compared to the No Action Alternative, but also increases in energy usage. While decreases in monthly net generation would occasionally be relatively small (reductions in CVP net generation for all years in February and March, and in dry and critically dry years in April, would be less than 5%), alternative sources of energy would be needed in response to the decreased net generation in many months.

Potential changes in State Water Project net generation

Changes in SWP operations under Alternative 3 compared to the No Action Alternative would result in an increase of SWP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in SWP energy resources, as summarized in Table U.2-10, *Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative*. The decreases to SWP net generation would be much greater under Alternative 3, relative to the No Action Alternative; long-term average net generation would be 52% lower, and dry and critically dry year net generation would be 58% lower.

Table U.2-10. Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative

Water Year		Alternative 3 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 3 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	9,557	7,304	2,253 (31%)
	Generation	4,658	4,074	584 (14%)
	Net Generation	-4,898	-3,230	-1,668 (52%)
Dry and Critically Dry Water Years[1]	Energy Use	6,507	4,685	1,821 (39%)
	Generation	3,038	2,489	549 (22%)
	Net Generation	-3,469	-2,197	-1,272 (58%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 3 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-11, *Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative*, shows the monthly energy use, generation, and resulting net generation for SWP facilities for No Action Alternative and Alternative 3, both as long-term average of all years, and as an average for dry and critically dry years. Simulated SWP net generation would be decreased in all months but October for both the average of all years and for dry and critically dry years. For both timeframes, decreases in net generation is a result of increased energy use; the average monthly generation of all years and dry and critically dry years would also increase, but not by as much, except in October, when the increase in October generation exceeds the increase in energy use.

Table U.2-11. Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	696	635	683	301	334	424	453	593	666	846	833	841
		Generation	312	268	278	198	235	284	306	396	407	537	433	419
		Net Generation	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
	Alt 3	Energy Use	796	839	871	588	620	744	656	793	818	946	951	932
		Generation	335	320	338	275	321	396	338	450	501	557	456	371
		Net Generation	-461	-520	-534	-313	-299	-348	-318	-343	-317	-388	-495	-560
	Change from NAA (percent change)[2]	Energy Use	100	205	188	288	286	321	204	200	152	100	118	90
		Generation	23	51	60	77	86	113	31	54	95	20	24	-48
		Net Generation	-77 (20%)	-154 (42%)	-128 (32%)	-211 (207%)	-200 (202%)	-208 (148%)	-172 (118%)	-146 (74%)	-57 (22%)	-80 (26%)	-95 (24%)	-139 (33%)
Dry and Critically Dry Years[1]	NAA	Energy Use	433	446	474	179	231	159	211	380	489	604	512	567
		Generation	180	166	193	124	162	73	146	247	344	383	249	221
		Net Generation	-253	-280	-280	-56	-68	-86	-65	-133	-145	-222	-264	-346
	Alt 3	Energy Use	445	574	683	365	447	355	332	484	612	734	755	721
		Generation	193	206	239	148	211	123	172	289	420	416	343	276
		Net Generation	-251	-369	-444	-217	-236	-232	-160	-194	-192	-317	-412	-445
	Change from NAA (percent change)[2]	Energy Use	11	128	210	185	217	196	122	104	124	129	242	154
		Generation	13	40	46	24	49	50	26	43	76	34	94	55
		Net Generation	2 (-1%)	-88 (32%)	-163 (58%)	-161 (289%)	-167 (245%)	-146 (169%)	-96 (147%)	-61 (46%)	-48 (33%)	-96 (43%)	-148 (56%)	-99 (29%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 3 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; Alt 3 = Alternative 3; NAA = No Action Alternative

Under Alternative 3, annual SWP energy generation would be higher for both long-term average and in dry and critically dry years, but the energy required by the SWP to move the water would also be higher for both long-term average and in dry and critically dry years, relative to the No Action Alternative. The trend is also maintained at a monthly level; the SWP would expect increased generation under Alternative 3 compared to the No Action Alternative in all months for both the average of all years and for the average of dry and critically dry years, but larger increases in energy usage, resulting in reductions in net generation for all months except October of dry and critically dry years. Alternative sources of energy would be needed in response to the decreased net generation in most months.

U.2.5.2 *Program-Level Effects*

Construction-related actions that are analyzed at a program level would not affect power or energy resources.

U.2.6 Alternative 4

Alternative 4 is compared to the No Action Alternative to evaluate changes in both CVP and SWP net generation.

U.2.6.1 *Project-Level Effects*

Potential changes in Central Valley Project net generation

Changes in CVP operations under Alternative 4 compared to the No Action Alternative would result in an decrease of CVP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in CVP energy resources, as summarized in Table U.2-12, *Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative*. The CVP annual net generation over the long-term conditions would be slightly higher by 1%, and there would be a 8% increase in the dry and critically dry year net generation under Alternative 4 compared to the No Action Alternative.

Table U.2-12. Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative

Water Year		**Alternative 4 (GWh)**	**No Action Alternative (NAA) (GWh)**	**Changes between Alternative 4 and NAA (percent change)[2] (GWh)**
Long-Term Average	Energy Use	1,117	1,207	-90 (-7%)
	Generation	4,489	4,533	-45 (-1%)
	Net Generation	3,372	3,326	46 (1%)
Dry and Critically Dry Water Years[1]	Energy Use	848	974	-126 (-13%)
	Generation	3,453	3,377	76 (2%)
	Net Generation	2,605	2,403	202 (8%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 4 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-13, *Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative*, shows the breakdown of the monthly energy use, generation, and net generation, by long-term average and for dry and critically dry years, for the CVP facilities. The model output shows that there is an average decrease in net generation under Alternative 4 compared to the No Action Alternative in September, October, and November for the average of all years, and a decrease in January for dry and critically dry years. The decreases in net generation tend to be a result of decreases in generation in those months.

Table U.2-13. Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	82	112	127	132	115	109	44	52	93	125	121	96
		Generation	287	266	258	313	316	329	308	474	489	622	476	396
		Net Generation	205	154	131	181	201	220	264	422	397	498	355	299
	Alt 4	Energy Use	94	98	119	134	115	49	46	51	91	111	111	96
		Generation	280	212	280	327	327	353	323	474	494	629	479	310
		Net Generation	186	114	161	193	212	304	276	423	403	518	368	214
	Change from NAA (percent change)[2]	Energy Use	12	-14	-8	2	0	-60	2	-1	-1	-13	-10	-1
		Generation	-6	-54	21	14	11	24	14	0	5	7	4	-85
		Net Generation	-19 (-9%)	-40 (-26%)	29 (22%)	12 (7%)	11 (5%)	84 (38%)	12 (5%)	1 (%)	6 (2%)	20 (4%)	14 (4%)	-85 (-28%)
Dry and Critically Dry Years[1]	NAA	Energy Use	70	80	106	122	105	85	35	40	57	103	92	79
		Generation	198	155	213	248	270	168	216	363	429	517	383	217
		Net Generation	128	75	107	126	165	83	180	323	372	414	291	138
	Alt 4	Energy Use	67	76	102	130	98	30	25	30	59	80	77	73
		Generation	206	160	221	246	273	185	227	374	433	514	388	225
		Net Generation	139	84	119	116	174	155	202	344	374	434	311	151
	Change from NAA (percent change)[2]	Energy Use	-3	-4	-5	8	-7	-55	-10	-10	2	-23	-14	-6
		Generation	8	5	7	-2	3	18	12	11	4	-3	6	8
		Net Generation	11 (8%)	9 (11%)	12 (11%)	-10 (-8%)	10 (6%)	72 (87%)	22 (12%)	21 (7%)	3 (1%)	20 (5%)	20 (7%)	14 (10%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 4 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; Alt 4 = Alternative 4; NAA = No Action Alternative

Under Alternative 4, annual CVP energy generation would be lower for long-term average and higher in dry and critically dry years, but the energy required by the CVP to move the water would also be lower for both long-term average and in dry and critically dry years, relative to the No Action Alternative, resulting in increased net generation for both long-term average and dry and critically dry years. At a monthly level, the CVP would similarly expect decreased generation for long-term average under Alternative 4 compared to the No Action Alternative in most months, but also small decreases in energy usage. Decreases in monthly net generation would occasionally be relatively small, alternative sources of energy would be needed in response to the decreased net generation in a few months.

Potential changes in State Water Project net generation

Changes in SWP operations under Alternative 4 compared to the No Action Alternative would result in a decrease in SWP water deliveries to areas south of the Delta and also lower average annual generation, resulting in changes to SWP power and energy resources, as summarized in Table U.2-14, *Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative*. The decreases to SWP net generation would be reduced under

Alternative 4, relative to the No Action Alternative; long-term average net generation would be 7% higher, and dry and critically dry year net generation would be 16% higher.

Table U.2-14. Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative

Water Year		Alternative 4 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 4 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	6,972	7,304	-332 (-5%)
	Generation	3,971	4,074	-103 (-3%)
	Net Generation	-3,001	-3,230	229 (-7%)
Dry and Critically Dry Water Years[1]	Energy Use	4,197	4,685	-488 (-10%)
	Generation	2,344	2,489	-145 (-6%)
	Net Generation	-1,853	-2,197	343 (-16%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 4 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-15, *Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative*, shows the monthly energy use, generation, and resulting net generation for SWP facilities for No Action Alternative and Alternative 4, both as long-term average of all years, and as an average for dry and critically dry years. Simulated average annual SWP net generation would be decreased in October, November, January, February, and September months, and in January and February for dry and critically dry years. For long-term average of all years, decreases in net generation is a result of decreased generation in September, October and November, and increased energy usage in January and February; in dry and critical the average monthly generation for January and February would be increased, but the increase in energy use in those months would exceed the increase in generation.

Table U.2-15. Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	696	635	683	301	334	424	453	593	666	846	833	841
		Generation	312	268	278	198	235	284	306	396	407	537	433	419
		Net Generation	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
	Alt 3	Energy Use	673	625	615	348	401	349	399	546	634	791	811	781
		Generation	284	255	272	221	265	304	332	399	399	508	418	314
		Net Generation	-389	-371	-343	-127	-137	-44	-66	-147	-235	-283	-392	-466
	Change from NAA (percent change)[2]	Energy Use	-23	-9	-68	47	67	-75	-54	-47	-33	-55	-22	-60
		Generation	-29	-14	-5	22	30	21	26	3	-8	-29	-14	-105
		Net Generation	-5 (1%)	-5 (1%)	63 (-16%)	-25 (25%)	-38 (38%)	96 (-68%)	80 (-55%)	50 (-25%)	25 (-9%)	26 (-8%)	8 (-2%)	-45 (11%)
Dry and Critically Dry Years[1]	NAA	Energy Use	433	446	474	179	231	159	211	380	489	604	512	567
		Generation	180	166	193	124	162	73	146	247	344	383	249	221
		Net Generation	-253	-280	-280	-56	-68	-86	-65	-133	-145	-222	-264	-346
	Alt 3	Energy Use	371	359	425	241	304	105	126	331	448	517	500	471
		Generation	159	144	174	135	182	79	124	237	332	341	249	187
		Net Generation	-212	-215	-251	-106	-122	-25	-2	-94	-116	-176	-251	-283
	Change from NAA (percent change)[2]	Energy Use	-62	-87	-49	62	73	-55	-85	-49	-41	-87	-12	-96
		Generation	-21	-22	-19	12	19	6	-22	-10	-12	-42	0	-34
		Net Generation	41 (-16%)	65 (-23%)	29 (-10%)	-50 (90%)	-54 (79%)	61 (-71%)	63 (-97%)	39 (-29%)	29 (-20%)	45 (-20%)	13 (-5%)	62 (-18%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).

[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 4 value. Percent change is the change divided by the No Action Alternative value.

GWh = Gigawatt-hours; Alt 4 = Alternative 4; NAA = No Action Alternative

Under Alternative 4, annual SWP energy generation would be lower for both long-term average and in dry and critically dry years, but the energy required by the SWP to move the water would also be lower for both long-term average and in dry and critically dry years, relative to the No Action Alternative. The trend is also maintained at a monthly level; the SWP would expect decreased generation under Alternative 4 compared to the No Action Alternative in most months for both the average of all years and for the average of dry and critically dry years, but also decreases in energy usage, resulting in reductions in net generation for several months. Alternative sources of energy would be needed in response to the decreased net generation in certain months.

U.2.6.2 *Program-Level Effects*

Construction-related actions that are analyzed at a program level would not affect power or energy resources.

U.2.7 Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 3 compared to the No Action Alternative.

Changes under Alternatives 1 through 4 compared to the No Action Alternative would result in decreased net energy generation, and increased potential energy use by CVP and SWP water users for alternate water supplies. Therefore, there could be adverse impacts to energy resources compared to the No Action Alternative, and mitigation measures could be applicable. There are several opportunities to reduce the effect of the action alternatives on net generation. If generating plants' efficiencies were improved, additional generation could be made at each of the plants. Similarly, improvements to the CVP and SWP pumping plants' efficiencies would reduce the energy needed to move water throughout the state. However, as the CVP and SWP plants' equipment is replaced through normal operations and maintenance, improvements in performance and efficiency are a primary consideration. The capital expense associated with making performance upgrades outside of normal operations and maintenance would make the upgrades infeasible.

There may be some opportunities for the CVP and SWP to increase generation through operational modifications, such as reducing the bypass of powerplants for fall temperature management. However, these modifications would not be of sufficient magnitude to address all of the potential effects on net generation associated with Alternatives 1 through 3, as indicated by the modeling. Changes in timing of the CVP generation, whether weekly, daily, or hourly, were not modeled and are important, and may require analysis.

Unlike the SWP, which requires significantly more generation than the SWP generates, CVP generation is sold to CVP preference power customers only after project use needs are met (approximately 25%). As CVP use needs increase from the No Action Alternative, CVP preference power customers receive less generation at a higher cost. CVP preference power customers incur additional costs from (1) the cost of replacement generation, and (2) if replacement generation has a difference emission factor, an emission charge.

Additionally, CVP preference power's effective rate also increases not only due to less generation but also because Reclamation requires that the CVPIA power restoration fund charges be paid by preference power customers and not project use power. It will be important to recognize and monitor the change in project use consumption as a share of the CVP resource when allocating CVP capital and annual costs.

U.2.8 Summary of Impacts

The results of the environmental consequences of implementation of Alternatives 1 through 4 compared to the No Action Alternative are presented in Table U.2-16, *Comparison of Alternatives 1 through 4 to No Action Alternative*.

Table U.2-16. Comparison of Alternatives 1 through 4 to No Action Alternative

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential changes in Central Valley Project net generation (Project-Level)	No Action Alternative	Potential for less energy available for CVP and SWP operation	--
	Alternative 1	3% reduction in annual net generation for the average of all years for CVP facilities and a 2% increase in net generation in dry and critically dry years would occur. At a monthly level, reductions of greater than 5% in average CVP net generation would occur in September (29%), October (10%), November (25%), April (15%), and May (8%). In dry and critically dry years, there would be monthly average reductions greater than 5% in net CVP generation in February (5%), March (9%), and April (5%).	--
	Alternative 2	4% reduction in annual net generation for both the average of all years for CVP facilities and no change in dry and critically dry year average annual generation would occur. At a monthly level, reductions in average CVP net generation greater than 5% would occur in September (27%), October (12%), November (35%), April (15%), and May (6%). In dry and critically dry years, there would be monthly average reductions greater than 5% in November (5%), December (16%), January (15%), February (14%), and March (30%).	--
	Alternative 3	4% reduction in annual net generation for both the average of all years and no change for dry and critically dry years for CVP facilities would occur. At a monthly level, reductions in average CVP net generation greater than 5% would occur in September (27%), October (7%), November (34%), April (14%), and May (7%). In dry and critically dry years, there would be monthly average reductions greater than 5% in November (8%), December (18%), January (18%), February (16%), and March (27%).	--

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	Alternative 4	1% increase in annual net generation for the average of all years and 8% increase for dry and critically dry years for CVP facilities would occur. At a monthly level, reductions in average CVP net generation greater than 5% would occur in September (28%), October (9%), November (26%), and November (34%) In dry and critically dry years, there would be monthly average reductions greater than 5% in January (8%).	--
Potential changes in State Water Project net generation (Project-Level)	No Action Alternative	Potential for less energy available for CVP and SWP operation	--
	Alternative 1	25% reduction in annual net generation for both the average of all years and 16% reduction annual net generation in dry and critically dry years for SWP facilities would occur. Average monthly SWP monthly net generation would be reduced for the average of all years from 8% in June to 47% in March, and dry and critically dry years from 4% in September to 91% in January.	--
	Alternative 2	53% reduction in annual net generation for the average of all years and 16% reduction in annual net generation for dry and critically dry years for SWP facilities would occur. Average monthly SWP net generation would be reduced by 23% in August to 214% in January for the average of all years, and in dry and critically dry years from 13% in October to 312 in January.	--
	Alternative 3	52% reduction in annual net generation for the average of all years and 58% reduction in net generation for dry and critically dry years for SWP facilities. Average monthly SWP net generation would be reduced by 22% in June to 207% in January for the average of all years, and in all months but October for dry and critically dry years, ranging from 29% in September to 289% in January.	--

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	Alternative 4	7% reduction in annual net generation for the average of all years and 16% reduction annual net generation in dry and critically dry years for SWP facilities would occur. Average monthly SWP monthly net generation would be reduced by more than 5% for the average of all years in January (25%), February (38%), and September (11%); and in dry and critically dry years in January (90%) and February (79%).	--

Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of less than 5% between action alternatives and the No Action Alternative are considered to be "similar."

U.2.9 Cumulative Effects Analysis

As described in Appendix Y, *Cumulative Methodology*, the cumulative effects analysis considers projects, programs, and policies that are not speculative, and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable. Not all cumulative projects in Appendix Y would result in effects related to power and energy that are related to the types of impacts from the action alternatives. The projects that have the potential to result in cumulative impacts with the action alternatives include:

- Bay-Delta Water Quality Control Plan Update
- FERC Relicensing Projects
- Bay Delta Conservation Plan (including the California WaterFix alternative)
- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations
- El Dorado Water and Power Authority Supplemental Water Rights Project
- Sacramento River Water Reliability Project
- Semitropic Water Storage District Delta Wetlands
- North Bay Aqueduct Alternative Intake
- Irrigated Lands Regulatory Program
- San Luis Reservoir Low Point Improvement Project
- Westlands Water District v. United States Settlement
- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)

The cumulative effects of these projects would be the same under all action alternatives.

Most of the future reasonably foreseeable actions are anticipated to improve water supplies in California to reduce impacts due to climate change, sea-level rise, increased water allocated to improve habitat conditions, and future growth. If CVP and SWP water supply reliability increases, energy use for conveyance of CVP and SWP water supplies also would increase.

Some of the future reasonably foreseeable actions are anticipated to potentially reduce CVP and SWP water supply reliability (e.g., Water Quality Control Plan Update and FERC Relicensing Projects).

Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. It is anticipated that some of these projects could increase energy use, such as implementation of desalination projects.

However, other projects, such as water recycling, would not substantially increase energy use because most of the energy use was previously required for wastewater treatment. It is anticipated that energy required for water treatment of alternative water supplies would be similar to treatment for CVP and SWP water supplies. Increased use of groundwater pumps would increase energy use; however, this energy use would be similar or less than the energy used for CVP and SWP water conveyance.

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Appendix U, Attachment 1 - Power Model Documentation

This Attachment describes the power model assumptions, methods, and models used for the Re-initiation of Consultation on long-term operations of the Central Valley Project (CVP) and State Water Project (SWP) (ROC on LTO). This Attachment also provides model results processing and interpretation methods used for the impacts analysis and descriptions.

1 Power Modeling Methodology & Assumptions

Energy generation can be quantified by estimating hydropower generation, at a monthly level, over a sequence of years representing varying hydrologic conditions. This kind of analysis is based on input hydrology and reservoir operations information. Energy generation capability will be based on the reservoir storage and flow through the turbines. Energy consumption will be based on pumping requirements to meet the operating criteria. These inputs are fed into two spreadsheet-based models, Long-Term Generation (LTGen) and SWP Power, which compute energy generation at each CVP and SWP pumping facility through a series of computations.

1.1 Power Models

LTGEN and SWP_Power are two commonly used, publicly available models developed by Reclamation and DWR. These models calculate a facility's long-term power generation capacity and pumping energy consumption for CVP and SWP facilities (Reclamation 2015). To calculate long-term power generation, the models use reservoir storage and release data from the CalSim II model along with user-specified generation characteristics, such as the number of units and transmission loss, to calculate a monthly average energy generation at all CVP and SWP reservoirs with power plants.

The models compute energy generation requirements using flow and storage data from CalSim II and user- specified characteristics, such as percentage of on-peak and off-peak pumping and transmission losses to calculate the monthly average energy consumption of all CVP and SWP pumping plants under the assumed CalSim II scenarios. Flows and storages from the entire CalSim II simulation period (October 1921 to September 2003) are used as inputs to the models. Climate change and sea level rise are inherently represented through CalSim II outputs.

Metrics for quantifying hydropower generation are displayed in terms of energy units generated (such as megawatts). Calculating energy generation annually, monthly, and by water year type can help in evaluating the overall hydropower performance under a variety of energy demand and hydrologic conditions.

For this analysis, the energy capacity, energy generation, energy use, and net energy generation of CVP and SWP facilities for No Action Alternative and four proposed action alternatives are compared against each other using exceedance tables, exceedance charts, and monthly pattern charts. Using LTGen and SWP_Power, the following parameters have been computed for each CVP and SWP facility:

- Facility Capacity (megawatts; MW)

- Energy Generation (gigawatt hours; GWh)
- Energy Use (gigawatt hours; GWh)
- Net Energy Generation (gigawatt hours; GWh)

1.2 Energy Generation Calculations

Energy generation is computed using empirical energy factors provided by the Western Area Power Authority (WAPA) for CVP facilities and by the DWR Operations Control Office (OCO) for SWP facilities. Energy generation can be calculated using Equation 1.

$$\text{Energy\_Generation } (MWh) = Energy\_Factor_G * Q\frac{ft^3}{s} \qquad \text{Eq. 1}$$

1.3 Average Monthly Power Capacity Calculations

Energy generation is limited on a monthly basis by an average power capacity at each facility. Power capacity fluctuates with varying reservoir levels and scheduled water releases. Generally, power production is higher during summer months when reservoir levels are higher and water is released to satisfy delivery requirements.

For CVP facilities, average monthly power capacity is estimated using empirical equations provided by WAPA. For SWP facilities, average monthly power capacity is computed using Equation 2, where the peak capacity is assumed to be a function of total head and average power plant flow.

$$\text{Power\_Capacity } (MW) = 0.7457\,\frac{kW}{hp} * 62.4\,\frac{lbs}{ft^3} * \frac{1MW}{1{,}000kW} * \frac{1hp}{550\frac{lb*ft}{s}} * \frac{1}{\eta} * head(ft) * Avg.powerplant\_flot\_rate\left(\frac{ft^3}{s}\right) \qquad \text{Eq. 2}$$

1.4 Energy Use Calculations

Energy use is computed using empirical energy factors provided by WAPA for CVP facilities and by the OCO for SWP facilities. Energy use can be calculated using Equation 3.

$$\text{Energy\_Use } (MWh) = Energy\_Factor_U * Q\frac{ft^3}{s} \qquad \text{Eq. 3}$$

In addition, the power models determine whether user-specified off-peak energy use targets can be satisfied under given power and flow capacity limits. Moreover, the tools determine the feasibility of requiring a certain percentage of pumping energy use to occur during off-peak hours for a particular month.

1.5 Transmission Losses

Transmission losses are estimated to determine energy use and generation at load centers, as percentages of energy use or generation.

1.6 Assumption Tables

Tables T.1 and T.2 show the assumptions used to estimate energy use and transmission losses at CVP and SWP pumping facilities. Tables T.3 and T.4 show the assumptions used to estimate energy generation, power capacity, and transmission losses at CVP and SWP generation facilities.

Table T.1. Central Valley Project Pumping Plant Characteristics.

Jones Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5
# Units	6	6	6	6	6	6	6	6	6	6	6	6
Capacity/Unit (MW)	16	16	16	16	16	16	16	16	16	16	16	16
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	42.9%	42.9%	42.9%	42.9%	42.9%	42.9%	42.9%	42.9%	42.9%	42.9%	42.9%	42.9%
On Peak Cap Adj Factor	1.05	1.05	1.05	1.50	1.20	2.20	1.60	2.30	1.50	1.05	1.05	1.05
Off Peak Cap Adj Factor	1.05	1.05	1.05	1.50	1.20	2.20	1.60	2.30	1.50	1.05	1.05	1.05

CVP Banks Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	297	297	297	297	297	297	297	297	297	297	297	297
# Units	0	0	0	0	0	0	0	0	0	0	0	0
Capacity/Unit (MW)	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	53.7%	53.7%	53.7%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	53.7%	53.7%	53.7%
On Peak Cap Adj Factor	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Off Peak Cap Adj Factor	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Contra Costa Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	164.8	164.8	164.8	164.8	164.8	164.8	164.8	164.8	164.8	164.8	164.8	164.8
# Units	6	6	6	6	6	6	6	6	6	6	6	6
Capacity/Unit (MW)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Transmission Loss (%)	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Percent Eng Off Peak (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
On Peak Cap Adj Factor	2.00	2.00	2.00	2.00	2.00	2.00	1.20	1.20	1.20	1.20	2.00	2.00
Off Peak Cap Adj Factor	2.00	2.00	2.00	2.00	2.00	2.00	1.20	1.20	1.20	1.20	2.00	2.00

O'Neill Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	59.2	59.2	59.2	59.2	59.2	59.2	59.2	59.2	59.2	59.2	59.2	59.2
# Units	6	6	6	6	6	6	6	6	6	6	6	6
Capacity/Unit (MW)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	48.5%	48.5%	48.5%	48.5%	48.5%	48.5%	48.5%	48.5%	48.5%	48.5%	48.5%	48.5%
On Peak Cap Adj Factor	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Off Peak Cap Adj Factor	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

CVP San Luis Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	function	function	function	function	function	function	function	function	function	function	function	function
# Units	8	8	8	8	8	8	8	8	8	8	8	8
Capacity/Unit (MW)	function	function	function	function	function	function	function	function	function	function	function	function
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%
On Peak Cap Adj Factor	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Off Peak Cap Adj Factor	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50

San Felipe Pumping Plant (Pacheco)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	function	function	function	function	function	function	function	function	function	function	function	function
# Units	12	12	12	12	12	12	12	12	12	12	12	12
Capacity/Unit (MW)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
On Peak Cap Adj Factor	2.00	2.00	2.00	1.50	1.50	1.50	1.50	1.20	1.20	1.20	1.20	1.20
Off Peak Cap Adj Factor	2.00	2.00	2.00	1.50	1.50	1.50	1.50	1.20	1.20	1.20	1.20	1.20

CVP Dos Amigos Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	137.9	137.9	137.9	137.9	137.9	137.9	137.9	137.9	137.9	137.9	137.9	137.9
# Units	6	6	6	6	6	6	6	6	6	6	6	6
Capacity/Unit (MW)	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	76.6%	76.6%	76.6%	76.6%	76.6%	76.6%	76.6%	76.6%	56.6%	56.6%	56.6%	76.6%
On Peak Cap Adj Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Off Peak Cap Adj Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Folsom Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	function	function	function	function	function	function	function	function	function	function	function	function
# Units	6	6	6	6	6	6	6	6	6	6	6	6
Capacity/Unit (MW)	5	5	5	5	5	5	5	5	5	5	5	5
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
On Peak Cap Adj Factor	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Off Peak Cap Adj Factor	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50

Table T.1. Central Valley Project Pumping Plant Characteristics (cont.).

Corning Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	190	190	190	190	190	190	190	190	190	190	190	190
# Units	0	0	0	0	0	0	0	0	0	0	0	0
Capacity/Unit (MW)	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Loss (%)	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Percent Eng Off Peak (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
On Peak Cap Adj Factor	3.00	4.00	4.00	4.00	4.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00
Off Peak Cap Adj Factor	3.00	4.00	4.00	4.00	4.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00

Red Bluff Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	12	12	12	12	12	12	0	0	0	0	0	12
# Units	0	0	0	0	0	0	0	0	0	0	0	0
Capacity/Unit (MW)	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
On Peak Adj Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Off Peak Adj Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

San Luis Other	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	93.5	93.5	93.5	93.5	93.5	93.5	93.5	93.5	93.5	93.5	93.5	93.5
# Units	0	0	0	0	0	0	0	0	0	0	0	0
Capacity/Unit (MW)	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Loss (%)	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Percent Eng Off Peak (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
On Peak Cap Adj Factor	2.00	2.00	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50	1.50	2.00
Off Peak Cap Adj Factor	2.00	2.00	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50	1.50	2.00

DMC Other	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
# Units	0	0	0	0	0	0	0	0	0	0	0	0
Capacity/Unit (MW)	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Loss (%)	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Percent Eng Off Peak (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
On Peak Cap Adj Factor	3.00	3.00	3.00	3.00	2.50	2.00	2.00	1.50	1.50	1.50	1.50	1.50
Off Peak Cap Adj Factor	3.00	3.00	3.00	3.00	2.50	2.00	2.00	1.50	1.50	1.50	1.50	1.50

Tehama Other	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2
# Units	0	0	0	0	0	0	0	0	0	0	0	0
Capacity/Unit (MW)	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
On Peak Cap Adj Factor	2.00	3.00	3.00	3.00	3.00	3.00	1.50	1.50	1.50	1.50	1.50	1.50
Off Peak Cap Adj Factor	2.00	3.00	3.00	3.00	3.00	3.00	1.50	1.50	1.50	1.50	1.50	1.50

Miscellaneous Project Use	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
MW	7	5	6	6	9	11	4	5	15	23	33	9
Transmission Loss (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GWH	5.1	3.4	4.6	4.5	6.1	8.5	2.5	3.7	10.6	16.8	24.8	6.2
Percent Eng Off Peak (%)	59.1%	61.6%	67.3%	64.3%	62.0%	59.0%	52.2%	52.9%	49.1%	50.3%	49.8%	61.3%

DMC Intertie	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3
# Units	8	8	8	8	8	8	8	8	8	8	8	8
Capacity/Unit (MW)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
On Peak Cap Adj Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Off Peak Cap Adj Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table T.2. State Water Project Pumping Plant Characteristics

Banks Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	297	297	297	297	297	297	297	297	297	297	297	297
# Units	0	0	0	0	0	0	0	0	0	0	0	0
Capacity/Unit (MW)	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	53.7%	53.7%	53.7%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	53.7%	53.7%	53.7%

SWP San Luis Pumping Plant (Gianelli Pumping Plant)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	function	function	function	function	function	function	function	function	function	function	function	function
# Units	8	8	8	8	8	8	8	8	8	8	8	8
Capacity/Unit (MW)	function	function	function	function	function	function	function	function	function	function	function	function
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%	89.7%

Dos Amigos Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	137.9	137.9	137.9	137.9	137.9	137.9	137.9	137.9	137.9	137.9	137.9	137.9
# Units	6	6	6	6	6	6	6	6	6	6	6	6
Capacity/Unit (MW)	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Percent Eng Off Peak (%)	76.6%	76.6%	76.6%	76.6%	76.6%	76.6%	76.6%	76.6%	56.6%	56.6%	56.6%	76.6%

Buena Vista Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	242	242	242	242	242	242	242	242	242	242	242	242
Plant Power Rating (MW)	107.797	107.797	107.797	107.797	107.797	107.797	107.797	107.797	107.797	107.797	107.797	107.797
Transmission Loss (%)	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%
Percent Eng Off Peak (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Teerink (Wheeler Ridge) Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	295	295	295	295	295	295	295	295	295	295	295	295
Plant Power Rating (MW)	111.9	111.9	111.9	111.9	111.9	111.9	111.9	111.9	111.9	111.9	111.9	111.9
Transmission Loss (%)	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%
Percent Eng Off Peak (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Chrisman (Wind Gap) Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	639	639	639	639	639	639	639	639	639	639	639	639
Plant Power Rating (MW)	246.18	246.18	246.18	246.18	246.18	246.18	246.18	246.18	246.18	246.18	246.18	246.18
Transmission Loss (%)	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%	1.51%
Percent Eng Off Peak (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Edmonson Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	2,236	2,236	2,236	2,236	2,236	2,236	2,236	2,236	2,236	2,236	2,236	2,236
Plant Power Rating (MW)	775.84	775.84	775.84	775.84	775.84	775.84	775.84	775.84	775.84	775.84	775.84	775.84
Transmission Loss (%)	1.64%	1.64%	1.64%	1.64%	1.64%	1.64%	1.64%	1.64%	1.64%	1.64%	1.64%	1.64%
Percent Eng Off Peak (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Pearblossom Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	703	703	703	703	703	703	703	703	703	703	703	703
Plant Power Rating (MW)	151.588	151.588	151.588	151.588	151.588	151.588	151.588	151.588	151.588	151.588	151.588	151.588
Transmission Loss (%)	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%
Percent Eng Off Peak (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Oso Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	280	280	280	280	280	280	280	280	280	280	280	280
Plant Power Rating (MW)	69.975	69.975	69.975	69.975	69.975	69.975	69.975	69.975	69.975	69.975	69.975	69.975
Transmission Loss (%)	2.34%	2.34%	2.34%	2.34%	2.34%	2.34%	2.34%	2.34%	2.34%	2.34%	2.34%	2.34%
Percent Eng Off Peak (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

South Bay Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	797	797	797	797	797	797	797	797	797	797	797	797
Plant Power Rating (MW)	20.69	20.69	20.69	20.69	20.69	20.69	20.69	20.69	20.69	20.69	20.69	20.69
Transmission Loss (%)	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%
Percent Eng Off Peak (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Del Valle Pumping Plant	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	72	72	72	72	72	72	72	72	72	72	72	72
Plant Power Rating (MW)	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.746
Transmission Loss (%)	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%
Percent Eng Off Peak (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table T.2. State Water Project Pumping Plant Characteristics (cont.).

Las Perillas Pumping Plant												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	77	77	77	77	77	77	77	77	77	77	77	77
Plant Power Rating (MW)	3.021	3.021	3.021	3.021	3.021	3.021	3.021	3.021	3.021	3.021	3.021	3.021
Transmission Loss (%)	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%
Percent Eng Off Peak (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Badger Hill Pumping Plant												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	200	200	200	200	200	200	200	200	200	200	200	200
Plant Power Rating (MW)	8.766	8.766	8.766	8.766	8.766	8.766	8.766	8.766	8.766	8.766	8.766	8.766
Transmission Loss (%)	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%	1.32%
Percent Eng Off Peak (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table T.3. Central Valley Project Powerplant Characteristics.

Trinity Powerplant - Peaking Operation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	2	2	2	2	2	2	2	2	2	2	2	2
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Transmission Loss (%)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%

Lewiston Powerplant - Baseload Operation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	0	0	0	0	0	0	0	0	0	0	0	0
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Transmission Loss (%)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%

Carr Powerplant - Peaking Operation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	2	2	2	2	2	2	2	2	2	2	2	2
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Transmission Loss (%)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%

Spring Creek Powerplant - Peaking Operation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	2	2	2	2	2	2	2	2	2	2	2	2
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Transmission Loss (%)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%

Shasta Powerplant - Peaking Operation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	5	5	5	5	5	5	5	5	5	5	5	5
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Transmission Loss (%)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%

Keswick Powerplant - Baseload Operation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	3	3	3	3	3	3	3	3	3	3	3	3
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Transmission Loss (%)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%

Folsom Powerplant - Peaking Operation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	3	3	3	3	3	3	3	3	3	3	3	3
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Transmission Loss (%)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%

Nimbus Powerplant - Baseload Operation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	2	2	2	2	2	2	2	2	2	2	2	2
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Transmission Loss (%)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%

New Melones Powerplant - Peaking Operation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	2	2	2	2	2	2	2	2	2	2	2	2
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%

CVP San Luis Powerplant - Peaking Operation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	8	8	8	8	8	8	8	8	8	8	8	8
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Share of Total Cap (%)	47.1%	47.1%	47.1%	47.1%	47.1%	47.1%	47.1%	47.1%	47.1%	47.1%	47.1%	47.1%

O'Neill Powerplant - Baseload Operation, flow computation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	6	6	6	6	6	6	6	6	6	6	6	6
Capacity/Unit (MW)	3	3	3	3	3	3	3	3	3	3	3	3
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%

Table T.4. State Water Project Powerplant Characteristics.

Hyatt (Lake Oroville) Power Plant												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Maximum Flow Capacity (cfs)	16,950	16,950	16,950	16,950	16,950	16,950	16,950	16,950	16,950	16,950	16,950	16,950
Plant Power Rating (MW)	812	812	812	812	812	812	812	812	812	812	812	812
Plant Efficiency	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%
Transmission Loss (%)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
Thermalito Power Plant												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Maximum Flow Capacity (cfs)	17,400	17,400	17,400	17,400	17,400	17,400	17,400	17,400	17,400	17,400	17,400	17,400
Plant Power Rating (MW)	120	120	120	120	120	120	120	120	120	120	120	120
Plant Efficiency	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%	87.3%
Transmission Loss (%)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
SWP San Luis (Gianelli Power Plant)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Capacity/Unit (MW)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
# Units	8	8	8	8	8	8	8	8	8	8	8	8
Share of Total Cap (%)	52.9%	52.9%	52.9%	52.9%	52.9%	52.9%	52.9%	52.9%	52.9%	52.9%	52.9%	52.9%
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Alamo Power Plant												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	105	105	105	105	105	105	105	105	105	105	105	105
Maximum Flow Capacity (cfs)	1,740	1,740	1,740	1,740	1,740	1,740	1,740	1,740	1,740	1,740	1,740	1,740
Plant Power Rating (MW)	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6
Plant Efficiency	80.1%	80.1%	80.1%	80.1%	80.1%	80.1%	80.1%	80.1%	80.1%	80.1%	80.1%	80.1%
Transmission Loss (%)	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Mojave Power Plant												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	95	95	95	95	95	95	95	95	95	95	95	95
Maximum Flow Capacity (cfs)	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880
Plant Power Rating (MW)	32.90	32.90	32.90	32.90	32.90	32.90	32.90	32.90	32.90	32.90	32.90	32.90
Plant Efficiency	84.00%	84.00%	84.00%	84.00%	84.00%	84.00%	84.00%	84.00%	84.00%	84.00%	84.00%	84.00%
Transmission Loss (%)	5.93%	5.93%	5.93%	5.93%	5.93%	5.93%	5.93%	5.93%	5.93%	5.93%	5.93%	5.93%
Devil's Canyon Power Plant												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	1,113	1,113	1,113	1,113	1,113	1,113	1,113	1,113	1,113	1,113	1,113	1,113
Maximum Flow Capacity (cfs)	2,940	2,940	2,940	2,940	2,940	2,940	2,940	2,940	2,940	2,940	2,940	2,940
Plant Power Rating (MW)	357.90	357.90	357.90	357.90	357.90	357.90	357.90	357.90	357.90	357.90	357.90	357.90
Plant Efficiency	82.03%	82.03%	82.03%	82.03%	82.03%	82.03%	82.03%	82.03%	82.03%	82.03%	82.03%	82.03%
Transmission Loss (%)	2.23%	2.23%	2.23%	2.23%	2.23%	2.23%	2.23%	2.23%	2.23%	2.23%	2.23%	2.23%
W. E. Warne Power Plant												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	573	573	573	573	573	573	573	573	573	573	573	573
Maximum Flow Capacity (cfs)	1,564	1,564	1,564	1,564	1,564	1,564	1,564	1,564	1,564	1,564	1,564	1,564
Plant Power Rating (MW)	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2
Plant Efficiency	81.4%	81.4%	81.4%	81.4%	81.4%	81.4%	81.4%	81.4%	81.4%	81.4%	81.4%	81.4%
Transmission Loss (%)	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Castaic Power Plant												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Energy Factor (kWh/af)	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function	Function
Maximum Flow Capacity (cfs)	17,840	17,840	17,840	17,840	17,840	17,840	17,840	17,840	17,840	17,840	17,840	17,840
Plant Power Rating (MW)	1,260	1,260	1,260	1,260	1,260	1,260	1,260	1,260	1,260	1,260	1,260	1,260
Plant Efficiency	88.4%	88.4%	88.4%	88.4%	88.4%	88.4%	88.4%	88.4%	88.4%	88.4%	88.4%	88.4%
Transmission Loss (%)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%

2 References

U.S. Department of the Interior, Bureau of Reclamation (Reclamation). 2015. Final Environmental Impact Statement for the Coordinated Long-term Operation of the Central Valley Project and the State Water Project, Appendix 8A: Power Model Documentation.

The following results of the LTGen and SWP Power models are included for energy capacity, energy generation, and energy use at key project locations for the following alternatives:

- No Action Alternative 011319
- Alternative 1 011519
- Alternative 2 021719
- Alternative 3 021719
- Alternative 4 043019

Title	Model Parameter	Table Numbers	Figure Numbers
CVP Total Capacity	CVP_TOTAL	1-1 to 1-4	1-1 to 1-18
CVP Total Generation	CVP_TOTAL	2-1 to 2-4	2-1 to 2-18
CVP Total Energy Use	CVP_TOTAL	3-1 to 3-4	3-1 to 3-18
CVP Net Generation	CVP_TOTAL	4-1 to 4-4	4-1 to 4-18
SWP Total Capacity	SWP_TOTAL	5-1 to 5-4	5-1 to 5-18
SWP Total Generation	SWP_TOTAL	6-1 to 6-4	6-1 to 6-18
SWP Total Energy Use	SWP_TOTAL	7-1 to 7-4	7-1 to 7-18
SWP Net Generation	SWP_TOTAL	8-1 to 8-4	8-1 to 8-18
CVP and SWP Net Generation	CVP_SWP_TOTAL	9-1 to 9-4	9-1 to 9-18

3 Report Formats

- Exceedance tables comparing power modeling results of two scenarios
- Monthly pattern charts including all scenarios
- Monthly exceedance charts including all scenarios

Table 1-1. CVP Total Capacity, Monthly Capacity

No Action Alternative 011319

Statistic	Monthly Capacity (MW) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,683	1,741	1,814	1,858	1,881	1,908	1,869	1,853	1,794	1,758	1,677	1,654
20%	1,635	1,713	1,777	1,828	1,858	1,881	1,839	1,816	1,730	1,700	1,633	1,616
30%	1,597	1,674	1,735	1,798	1,836	1,843	1,820	1,783	1,668	1,628	1,571	1,590
40%	1,575	1,629	1,706	1,773	1,810	1,814	1,793	1,744	1,631	1,580	1,540	1,563
50%	1,549	1,601	1,676	1,737	1,781	1,792	1,759	1,710	1,609	1,554	1,516	1,519
60%	1,517	1,555	1,639	1,713	1,751	1,761	1,730	1,666	1,563	1,494	1,473	1,470
70%	1,450	1,507	1,591	1,670	1,724	1,730	1,695	1,633	1,521	1,448	1,427	1,428
80%	1,389	1,436	1,525	1,599	1,654	1,663	1,652	1,587	1,450	1,364	1,348	1,358
90%	1,168	1,268	1,390	1,483	1,512	1,511	1,468	1,426	1,259	1,128	1,107	1,148
Long Term												
Full Simulation Period[a]	1,482	1,543	1,619	1,690	1,729	1,744	1,711	1,660	1,554	1,485	1,445	1,444
Water Year Types[b,c]												
Wet (32%)	1,627	1,677	1,738	1,828	1,864	1,884	1,858	1,838	1,757	1,721	1,644	1,629
Above Normal (16%)	1,560	1,605	1,668	1,767	1,811	1,818	1,794	1,745	1,630	1,588	1,541	1,540
Below Normal (13%)	1,519	1,571	1,651	1,717	1,755	1,768	1,733	1,669	1,563	1,494	1,481	1,483
Dry (24%)	1,486	1,548	1,632	1,641	1,690	1,716	1,687	1,618	1,510	1,434	1,420	1,434
Critical (15%)	1,043	1,148	1,257	1,365	1,388	1,382	1,324	1,244	1,098	937	918	923

Alternative 1 011519

Statistic	Monthly Capacity (MW) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,719	1,785	1,831	1,862	1,899	1,929	1,915	1,876	1,801	1,748	1,723	1,709
20%	1,702	1,750	1,806	1,841	1,879	1,909	1,896	1,846	1,739	1,684	1,672	1,676
30%	1,665	1,726	1,766	1,820	1,854	1,886	1,862	1,807	1,696	1,645	1,619	1,639
40%	1,638	1,706	1,747	1,801	1,837	1,861	1,836	1,778	1,652	1,594	1,595	1,597
50%	1,612	1,653	1,711	1,785	1,824	1,833	1,806	1,738	1,624	1,554	1,537	1,550
60%	1,580	1,615	1,672	1,745	1,791	1,813	1,788	1,714	1,597	1,526	1,499	1,518
70%	1,506	1,541	1,642	1,705	1,751	1,773	1,739	1,684	1,573	1,494	1,469	1,485
80%	1,455	1,488	1,563	1,657	1,700	1,720	1,689	1,622	1,513	1,435	1,411	1,423
90%	1,166	1,326	1,434	1,569	1,549	1,541	1,543	1,479	1,282	1,146	1,147	1,141
Long Term												
Full Simulation Period[a]	1,544	1,599	1,664	1,727	1,767	1,791	1,762	1,702	1,586	1,512	1,494	1,501
Water Year Types[b,c]												
Wet (32%)	1,709	1,752	1,782	1,829	1,869	1,904	1,890	1,854	1,763	1,708	1,686	1,684
Above Normal (16%)	1,609	1,641	1,692	1,789	1,827	1,846	1,829	1,771	1,644	1,580	1,572	1,571
Below Normal (13%)	1,534	1,578	1,660	1,766	1,803	1,818	1,775	1,713	1,599	1,526	1,495	1,499
Dry (24%)	1,542	1,597	1,675	1,694	1,744	1,779	1,752	1,675	1,568	1,483	1,468	1,485
Critical (15%)	1,131	1,243	1,367	1,456	1,490	1,483	1,420	1,329	1,159	1,052	1,036	1,058

Alternative 1 011519 minus No Action Alternative 011319

Statistic	Monthly Capacity (MW) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	36	43	17	4	17	21	46	22	7	-11	46	55
20%	67	37	29	13	21	28	57	30	9	-15	40	60
30%	68	52	31	22	19	43	42	25	28	17	47	48
40%	63	77	42	29	27	47	43	33	21	14	55	33
50%	63	52	35	48	44	40	47	28	15	-1	21	32
60%	62	60	33	32	40	52	58	47	34	31	26	48
70%	56	34	51	35	27	42	44	51	53	46	41	56
80%	66	53	37	58	47	58	37	35	63	71	63	65
90%	-2	58	44	86	36	30	76	53	24	17	40	-7
Long Term												
Full Simulation Period[a]	62	56	46	36	39	48	51	41	32	27	49	57
Water Year Types[b,c]												
Wet (32%)	82	75	44	1	5	20	32	16	6	-13	42	55
Above Normal (16%)	49	35	24	22	16	29	34	26	15	-8	31	30
Below Normal (13%)	15	7	9	49	48	51	42	44	35	32	14	15
Dry (24%)	55	49	43	53	54	63	66	57	57	49	47	51
Critical (15%)	88	95	110	91	101	100	95	85	61	114	118	135

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 1-2. CVP Total Capacity, Monthly Capacity

No Action Alternative 011319

Statistic	Monthly Capacity (MW)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,683	1,741	1,814	1,858	1,881	1,908	1,869	1,853	1,794	1,758	1,677	1,654
20%	1,635	1,713	1,777	1,828	1,858	1,881	1,839	1,816	1,730	1,700	1,633	1,616
30%	1,597	1,674	1,735	1,798	1,836	1,843	1,820	1,783	1,668	1,628	1,571	1,590
40%	1,575	1,629	1,706	1,773	1,810	1,814	1,793	1,744	1,631	1,580	1,540	1,563
50%	1,549	1,601	1,676	1,737	1,781	1,792	1,759	1,710	1,609	1,554	1,516	1,519
60%	1,517	1,555	1,639	1,713	1,751	1,761	1,730	1,666	1,563	1,494	1,473	1,470
70%	1,450	1,507	1,591	1,670	1,724	1,730	1,695	1,633	1,521	1,448	1,427	1,428
80%	1,389	1,436	1,525	1,599	1,654	1,663	1,652	1,587	1,450	1,364	1,348	1,358
90%	1,168	1,268	1,390	1,483	1,512	1,511	1,468	1,426	1,259	1,128	1,107	1,148
Long Term												
Full Simulation Period[a]	1,482	1,543	1,619	1,690	1,729	1,744	1,711	1,660	1,554	1,485	1,445	1,444
Water Year Types[b,c]												
Wet (32%)	1,627	1,677	1,738	1,828	1,864	1,884	1,858	1,838	1,757	1,721	1,644	1,629
Above Normal (16%)	1,560	1,605	1,668	1,767	1,811	1,818	1,794	1,745	1,630	1,588	1,541	1,540
Below Normal (13%)	1,519	1,571	1,651	1,717	1,755	1,768	1,733	1,669	1,563	1,494	1,481	1,483
Dry (24%)	1,486	1,548	1,632	1,641	1,690	1,716	1,687	1,618	1,510	1,434	1,420	1,434
Critical (15%)	1,043	1,148	1,257	1,365	1,388	1,382	1,324	1,244	1,098	937	918	923

Alternative 2 021719

Statistic	Monthly Capacity (MW)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,796	1,834	1,870	1,900	1,919	1,958	1,949	1,923	1,853	1,797	1,779	1,768
20%	1,743	1,809	1,849	1,883	1,907	1,937	1,931	1,884	1,779	1,699	1,687	1,705
30%	1,698	1,778	1,833	1,868	1,898	1,926	1,921	1,830	1,726	1,644	1,630	1,670
40%	1,653	1,746	1,800	1,850	1,889	1,912	1,885	1,797	1,679	1,613	1,606	1,585
50%	1,621	1,702	1,769	1,825	1,871	1,888	1,858	1,766	1,646	1,580	1,563	1,545
60%	1,560	1,632	1,725	1,784	1,827	1,854	1,816	1,727	1,607	1,541	1,501	1,504
70%	1,503	1,544	1,647	1,726	1,781	1,817	1,783	1,680	1,571	1,480	1,456	1,457
80%	1,406	1,467	1,587	1,684	1,751	1,769	1,736	1,645	1,520	1,414	1,392	1,398
90%	1,267	1,363	1,451	1,558	1,572	1,579	1,558	1,466	1,342	1,225	1,182	1,215
Long Term												
Full Simulation Period[a]	1,559	1,627	1,703	1,763	1,804	1,829	1,801	1,722	1,607	1,528	1,502	1,502
Water Year Types[b,c]												
Wet (32%)	1,749	1,796	1,832	1,871	1,907	1,942	1,932	1,889	1,801	1,740	1,719	1,719
Above Normal (16%)	1,629	1,681	1,747	1,834	1,876	1,905	1,886	1,798	1,672	1,609	1,591	1,574
Below Normal (13%)	1,530	1,607	1,696	1,817	1,852	1,873	1,833	1,736	1,616	1,528	1,499	1,499
Dry (24%)	1,544	1,609	1,696	1,721	1,777	1,807	1,776	1,687	1,568	1,486	1,464	1,474
Critical (15%)	1,125	1,247	1,396	1,473	1,504	1,496	1,442	1,322	1,176	1,050	998	1,001

Alternative 2 021719 minus No Action Alternative 011319

Statistic	Monthly Capacity (MW)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	112	93	56	41	37	50	80	70	59	39	101	114
20%	108	95	72	54	49	56	92	68	50	0	55	89
30%	100	104	98	70	62	82	101	47	58	16	59	80
40%	78	116	94	77	78	98	91	52	47	34	65	21
50%	72	101	93	88	90	95	99	56	36	25	48	26
60%	43	77	86	71	76	93	86	61	43	47	29	34
70%	53	36	55	55	57	87	88	46	51	32	29	29
80%	17	31	62	85	98	107	84	58	70	50	44	40
90%	99	96	61	75	59	69	90	40	84	97	75	67
Long Term												
Full Simulation Period[a]	77	84	84	73	75	85	90	61	53	43	57	57
Water Year Types[b,c]												
Wet (32%)	122	119	94	43	43	57	73	51	44	19	75	90
Above Normal (16%)	69	75	79	67	65	87	92	52	42	21	50	34
Below Normal (13%)	11	36	46	100	98	105	100	67	52	34	19	16
Dry (24%)	58	61	64	80	87	91	89	69	58	52	44	40
Critical (15%)	81	99	139	107	115	114	117	78	78	113	79	78

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 1-3. CVP Total Capacity, Monthly Capacity

No Action Alternative 011319

	Monthly Capacity (MW)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	1,683	1,741	1,814	1,858	1,881	1,908	1,869	1,853	1,794	1,758	1,677	1,654
20%	1,635	1,713	1,777	1,828	1,858	1,881	1,839	1,816	1,730	1,700	1,633	1,616
30%	1,597	1,674	1,735	1,798	1,836	1,843	1,820	1,783	1,668	1,628	1,571	1,590
40%	1,575	1,629	1,706	1,773	1,810	1,814	1,793	1,744	1,631	1,580	1,540	1,563
50%	1,549	1,601	1,676	1,737	1,781	1,792	1,759	1,710	1,609	1,554	1,516	1,519
60%	1,517	1,555	1,639	1,713	1,751	1,761	1,730	1,666	1,563	1,494	1,473	1,470
70%	1,450	1,507	1,591	1,670	1,724	1,730	1,695	1,633	1,521	1,448	1,427	1,428
80%	1,389	1,436	1,525	1,599	1,654	1,663	1,652	1,587	1,450	1,364	1,348	1,358
90%	1,168	1,268	1,390	1,483	1,512	1,511	1,468	1,426	1,259	1,128	1,107	1,148
Long Term												
Full Simulation Period[a]	1,482	1,543	1,619	1,690	1,729	1,744	1,711	1,660	1,554	1,485	1,445	1,444
Water Year Types[b,c]												
Wet (32%)	1,627	1,677	1,738	1,828	1,864	1,884	1,858	1,838	1,757	1,721	1,644	1,629
Above Normal (16%)	1,560	1,605	1,668	1,767	1,811	1,818	1,794	1,745	1,630	1,588	1,541	1,540
Below Normal (13%)	1,519	1,571	1,651	1,717	1,755	1,768	1,733	1,669	1,563	1,494	1,481	1,483
Dry (24%)	1,486	1,548	1,632	1,641	1,690	1,716	1,687	1,618	1,510	1,434	1,420	1,434
Critical (15%)	1,043	1,148	1,257	1,365	1,388	1,382	1,324	1,244	1,098	937	918	923

Alternative 3 021719

	Monthly Capacity (MW)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	1,793	1,829	1,872	1,900	1,919	1,957	1,948	1,923	1,852	1,791	1,778	1,766
20%	1,741	1,809	1,849	1,885	1,907	1,937	1,929	1,882	1,781	1,695	1,696	1,707
30%	1,702	1,778	1,832	1,868	1,897	1,928	1,919	1,843	1,728	1,651	1,646	1,670
40%	1,667	1,746	1,799	1,850	1,887	1,906	1,883	1,799	1,679	1,610	1,598	1,594
50%	1,611	1,699	1,771	1,823	1,866	1,887	1,855	1,767	1,646	1,583	1,553	1,548
60%	1,561	1,635	1,722	1,780	1,827	1,851	1,819	1,735	1,609	1,536	1,499	1,497
70%	1,492	1,546	1,651	1,722	1,781	1,816	1,783	1,683	1,577	1,476	1,459	1,457
80%	1,400	1,466	1,581	1,683	1,746	1,770	1,733	1,640	1,514	1,410	1,397	1,387
90%	1,247	1,355	1,444	1,556	1,576	1,578	1,552	1,452	1,343	1,225	1,191	1,153
Long Term												
Full Simulation Period[a]	1,556	1,625	1,701	1,761	1,803	1,827	1,800	1,721	1,605	1,526	1,499	1,498
Water Year Types[b,c]												
Wet (32%)	1,751	1,796	1,831	1,872	1,907	1,940	1,933	1,892	1,799	1,738	1,721	1,718
Above Normal (16%)	1,625	1,683	1,745	1,834	1,876	1,905	1,885	1,800	1,677	1,607	1,584	1,576
Below Normal (13%)	1,531	1,607	1,697	1,815	1,851	1,872	1,832	1,737	1,618	1,531	1,505	1,501
Dry (24%)	1,535	1,607	1,694	1,719	1,775	1,806	1,775	1,686	1,570	1,483	1,465	1,468
Critical (15%)	1,116	1,240	1,387	1,460	1,499	1,492	1,437	1,309	1,154	1,046	975	980

Alternative 3 021719 minus No Action Alternative 011319

	Monthly Capacity (MW)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	110	88	58	42	37	49	79	70	58	33	101	113
20%	105	95	73	57	49	56	90	66	51	-4	64	91
30%	105	104	97	70	61	85	99	60	61	23	74	79
40%	92	117	94	77	77	92	90	55	47	31	58	31
50%	62	98	95	85	86	95	96	57	37	29	38	29
60%	44	80	83	66	75	90	89	69	45	41	26	27
70%	42	39	59	52	57	86	87	50	57	28	32	28
80%	12	30	56	85	93	108	80	53	64	46	49	30
90%	79	87	54	73	63	67	85	26	84	97	84	5
Long Term												
Full Simulation Period[a]	74	82	82	70	74	84	89	61	51	41	54	53
Water Year Types[b,c]												
Wet (32%)	124	118	93	44	43	56	74	54	42	16	77	90
Above Normal (16%)	66	77	77	67	65	88	90	55	47	19	43	36
Below Normal (13%)	13	36	46	98	96	104	99	68	55	37	25	18
Dry (24%)	49	58	62	78	85	90	88	67	60	49	45	34
Critical (15%)	72	91	130	95	111	110	112	65	56	108	57	57

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 1-4. CVP Total Capacity, Monthly Capacity

No Action Alternative 011319

Statistic	Monthly Capacity (MW) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,683	1,741	1,814	1,858	1,881	1,908	1,869	1,853	1,794	1,758	1,677	1,654
20%	1,635	1,713	1,777	1,828	1,858	1,881	1,839	1,816	1,730	1,700	1,633	1,616
30%	1,597	1,674	1,735	1,798	1,836	1,843	1,820	1,783	1,668	1,628	1,571	1,590
40%	1,575	1,629	1,706	1,773	1,810	1,814	1,793	1,744	1,631	1,580	1,540	1,563
50%	1,549	1,601	1,676	1,737	1,781	1,792	1,759	1,710	1,609	1,554	1,516	1,519
60%	1,517	1,555	1,639	1,713	1,751	1,761	1,730	1,666	1,563	1,494	1,473	1,470
70%	1,450	1,507	1,591	1,670	1,724	1,730	1,695	1,633	1,521	1,448	1,427	1,428
80%	1,389	1,436	1,525	1,599	1,654	1,663	1,652	1,587	1,450	1,364	1,348	1,358
90%	1,168	1,268	1,390	1,483	1,512	1,511	1,468	1,426	1,259	1,128	1,107	1,148
Long Term												
Full Simulation Period[a]	1,482	1,543	1,619	1,690	1,729	1,744	1,711	1,660	1,554	1,485	1,445	1,444
Water Year Types[b,c]												
Wet (32%)	1,627	1,677	1,738	1,828	1,864	1,884	1,858	1,838	1,757	1,721	1,644	1,629
Above Normal (16%)	1,560	1,605	1,668	1,767	1,811	1,818	1,794	1,745	1,630	1,588	1,541	1,540
Below Normal (13%)	1,519	1,571	1,651	1,717	1,755	1,768	1,733	1,669	1,563	1,494	1,481	1,483
Dry (24%)	1,486	1,548	1,632	1,641	1,690	1,716	1,687	1,618	1,510	1,434	1,420	1,434
Critical (15%)	1,043	1,148	1,257	1,365	1,388	1,382	1,324	1,244	1,098	937	918	923

Alternative 4 043019

Statistic	Monthly Capacity (MW) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,754	1,805	1,847	1,870	1,894	1,915	1,896	1,866	1,805	1,749	1,716	1,703
20%	1,708	1,770	1,822	1,853	1,867	1,895	1,863	1,832	1,738	1,690	1,688	1,673
30%	1,680	1,744	1,792	1,828	1,851	1,870	1,843	1,796	1,685	1,635	1,636	1,643
40%	1,641	1,716	1,757	1,808	1,836	1,849	1,821	1,773	1,666	1,605	1,592	1,604
50%	1,615	1,669	1,737	1,789	1,814	1,828	1,789	1,739	1,628	1,568	1,555	1,567
60%	1,589	1,634	1,704	1,769	1,788	1,797	1,766	1,695	1,595	1,526	1,514	1,526
70%	1,522	1,593	1,673	1,722	1,755	1,764	1,737	1,670	1,569	1,496	1,487	1,493
80%	1,468	1,508	1,581	1,662	1,689	1,717	1,671	1,616	1,539	1,447	1,428	1,448
90%	1,258	1,338	1,459	1,514	1,576	1,549	1,539	1,472	1,288	1,240	1,162	1,205
Long Term												
Full Simulation Period[a]	1,558	1,617	1,687	1,737	1,766	1,783	1,753	1,697	1,595	1,527	1,507	1,514
Water Year Types[b,c]												
Wet (32%)	1,712	1,758	1,796	1,842	1,870	1,895	1,876	1,845	1,763	1,713	1,693	1,684
Above Normal (16%)	1,626	1,663	1,724	1,808	1,833	1,842	1,813	1,771	1,650	1,599	1,584	1,585
Below Normal (13%)	1,555	1,615	1,693	1,771	1,793	1,802	1,774	1,713	1,607	1,528	1,516	1,524
Dry (24%)	1,554	1,614	1,692	1,697	1,734	1,760	1,730	1,659	1,567	1,484	1,473	1,493
Critical (15%)	1,159	1,270	1,397	1,470	1,498	1,497	1,443	1,347	1,206	1,116	1,067	1,094

Alternative 4 043019 minus No Action Alternative 011319

Statistic	Monthly Capacity (MW) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	71	64	33	12	13	7	27	12	11	-9	39	49
20%	73	57	45	24	9	14	24	16	9	-10	55	58
30%	82	70	57	29	16	27	23	13	17	7	64	53
40%	66	87	51	36	26	35	28	29	35	25	52	41
50%	66	68	61	52	34	36	30	29	19	13	39	49
60%	72	79	65	55	37	36	36	28	32	32	41	56
70%	72	85	82	52	30	33	42	37	49	48	60	65
80%	80	72	56	63	36	55	19	29	89	84	81	90
90%	90	70	69	30	63	38	72	47	30	112	55	57
Long Term												
Full Simulation Period[a]	76	75	68	47	37	40	42	37	41	42	62	69
Water Year Types[b,c]												
Wet (32%)	85	81	58	13	6	11	17	7	6	-8	49	55
Above Normal (16%)	66	58	56	41	22	25	19	26	20	11	44	45
Below Normal (13%)	36	44	42	54	38	34	41	43	44	34	35	41
Dry (24%)	68	65	60	56	44	44	44	40	56	51	52	59
Critical (15%)	116	122	140	105	110	114	119	103	108	178	149	171

a Based on the 82-year simulation period.

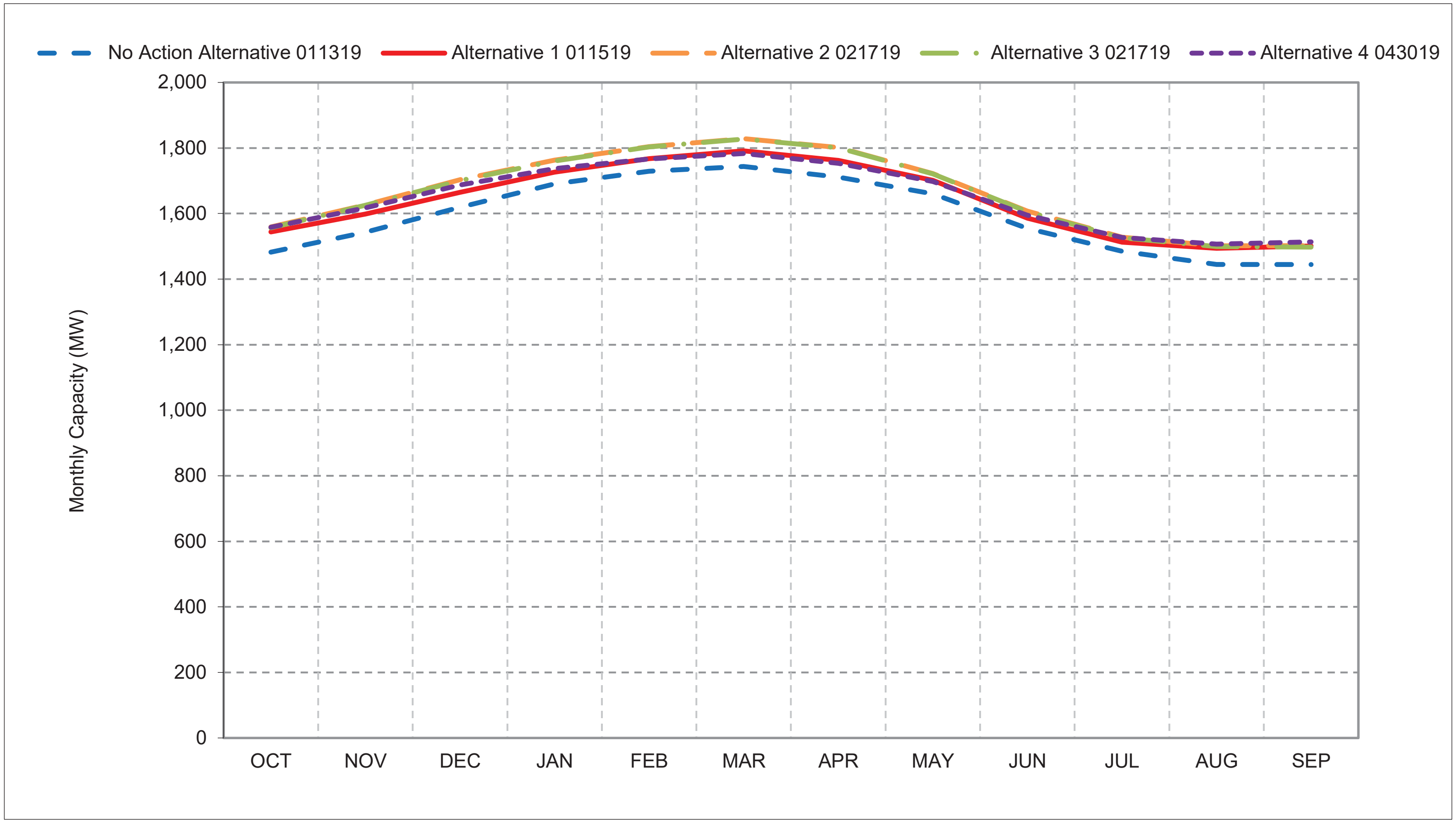
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Figure 1-1. CVP Total Capacity, Long-Term Average Capacity



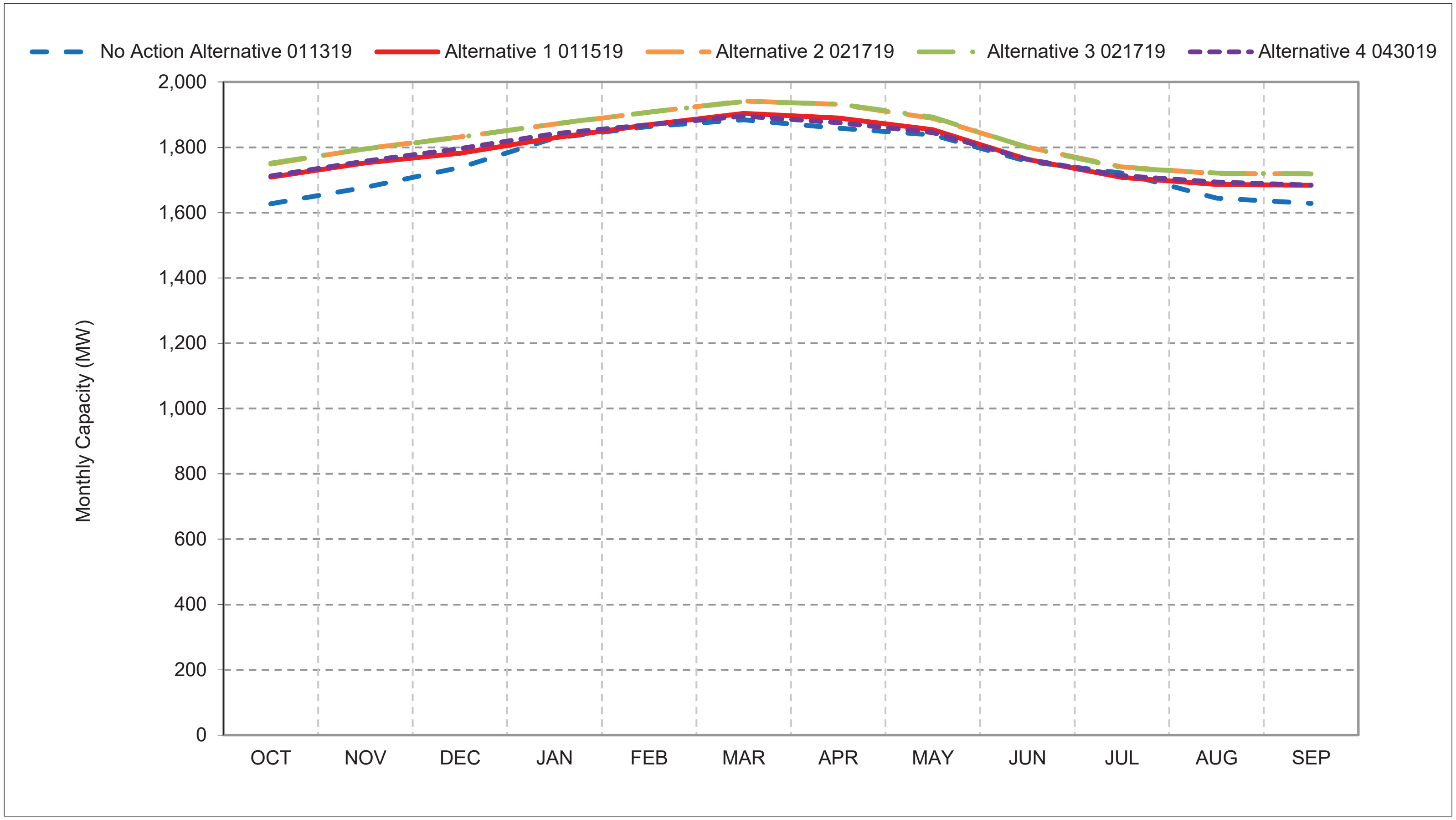
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

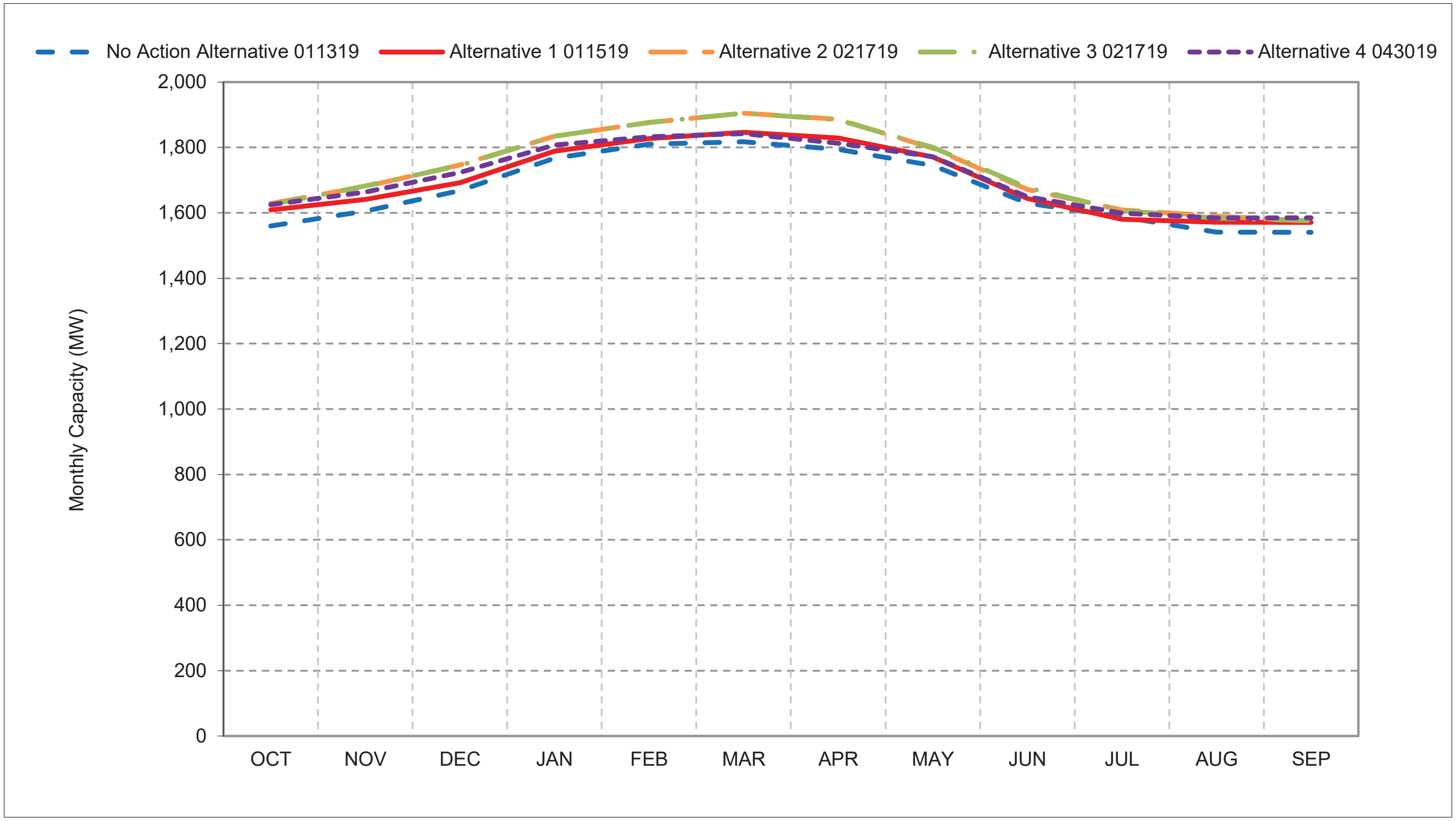
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 1-2. CVP Total Capacity, Wet Year Average Capacity



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 1-3. CVP Total Capacity, Above Normal Year Average Capacity



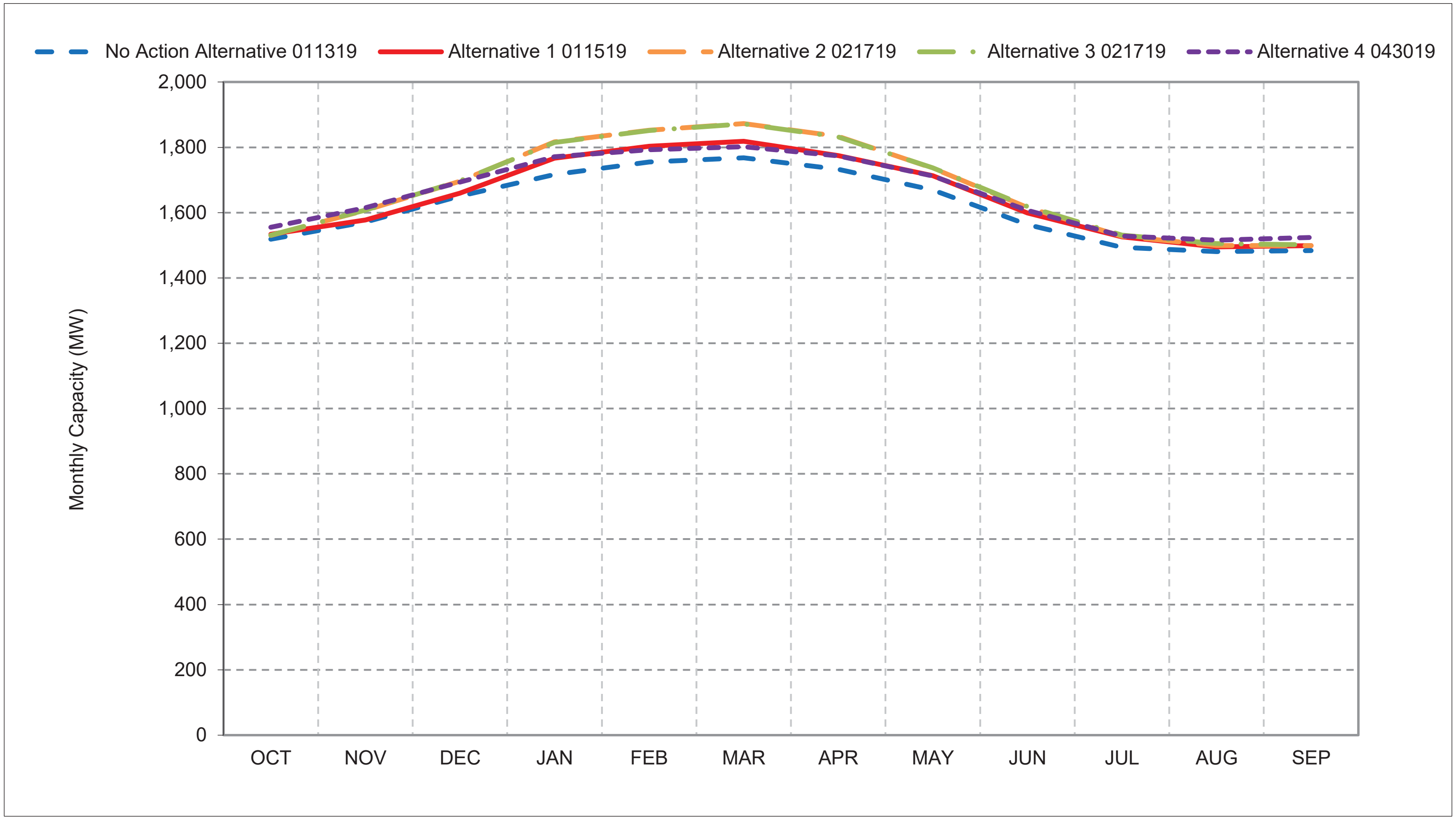
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

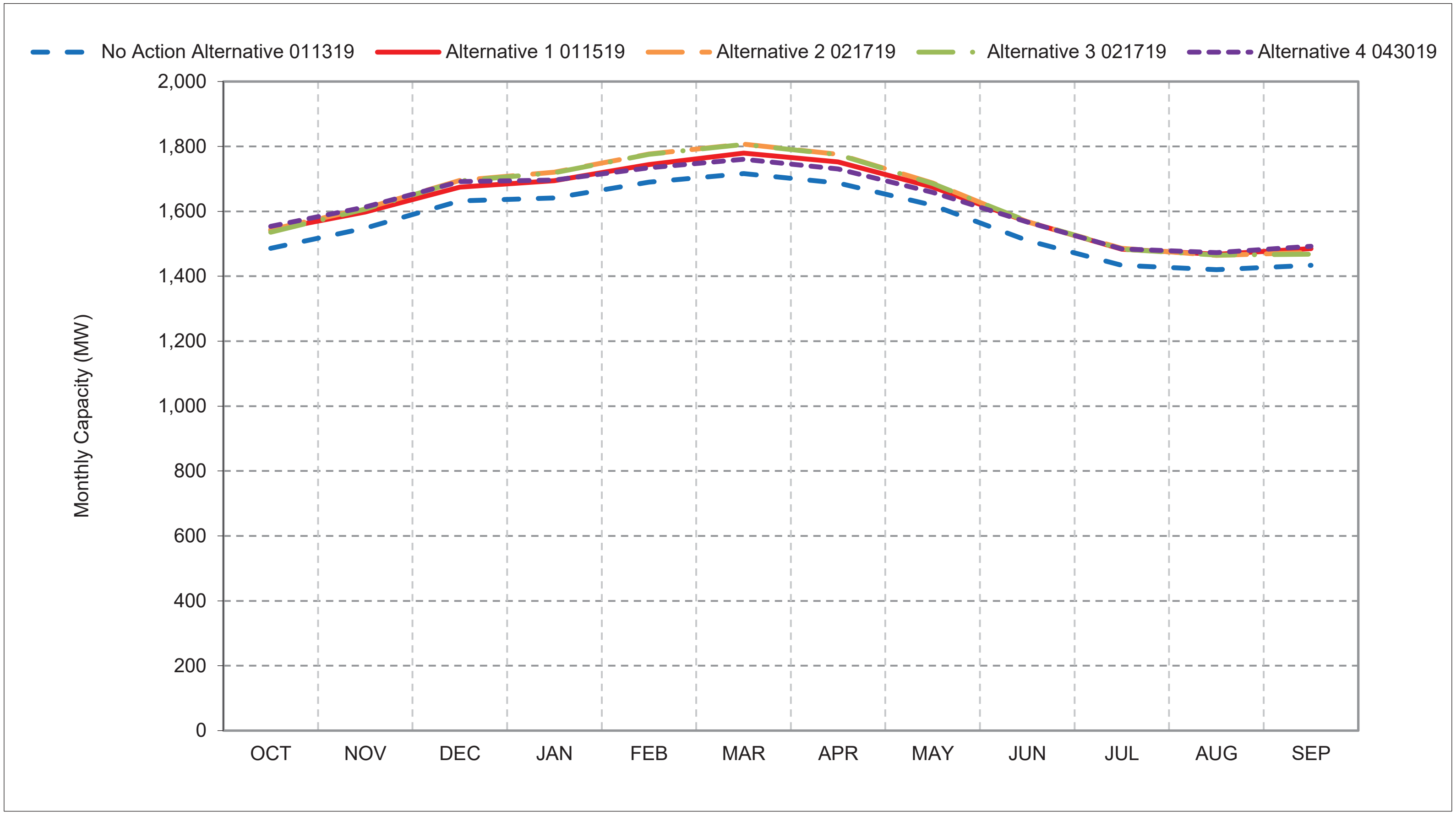
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 1-4. CVP Total Capacity, Below Normal Year Average Capacity



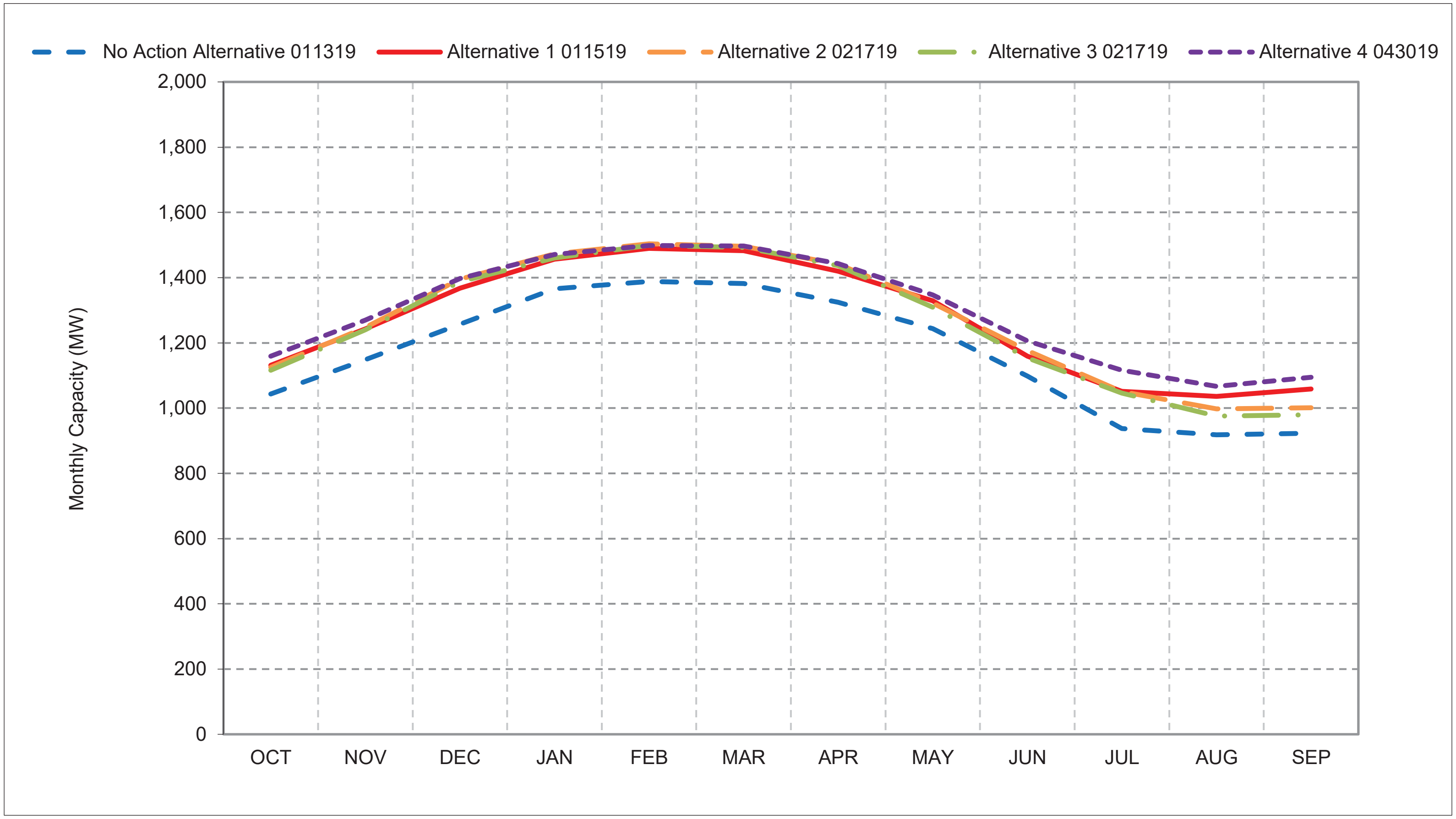
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 1-5. CVP Total Capacity, Dry Year Average Capacity



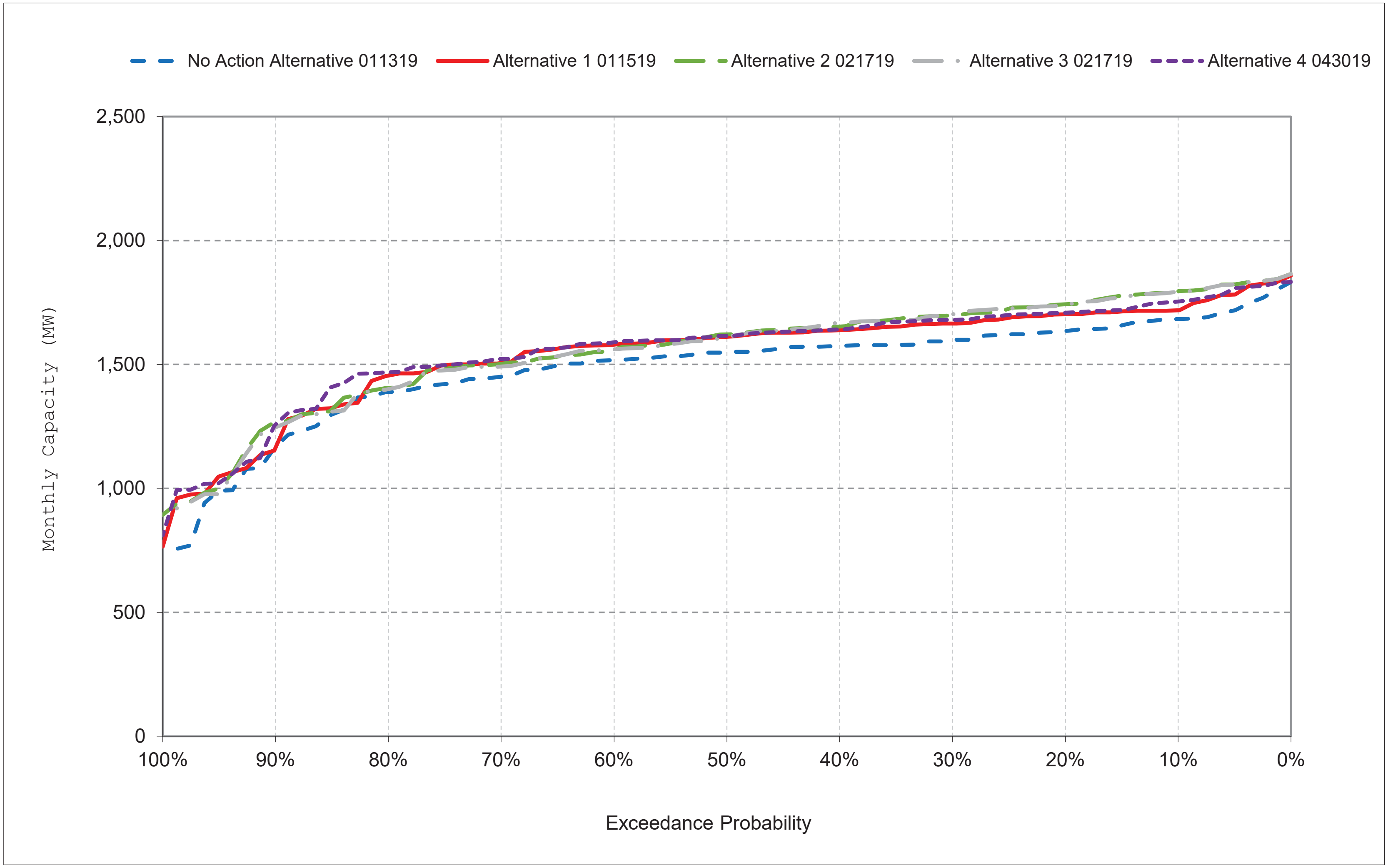
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 1-6. CVP Total Capacity, Critical Year Average Capacity



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

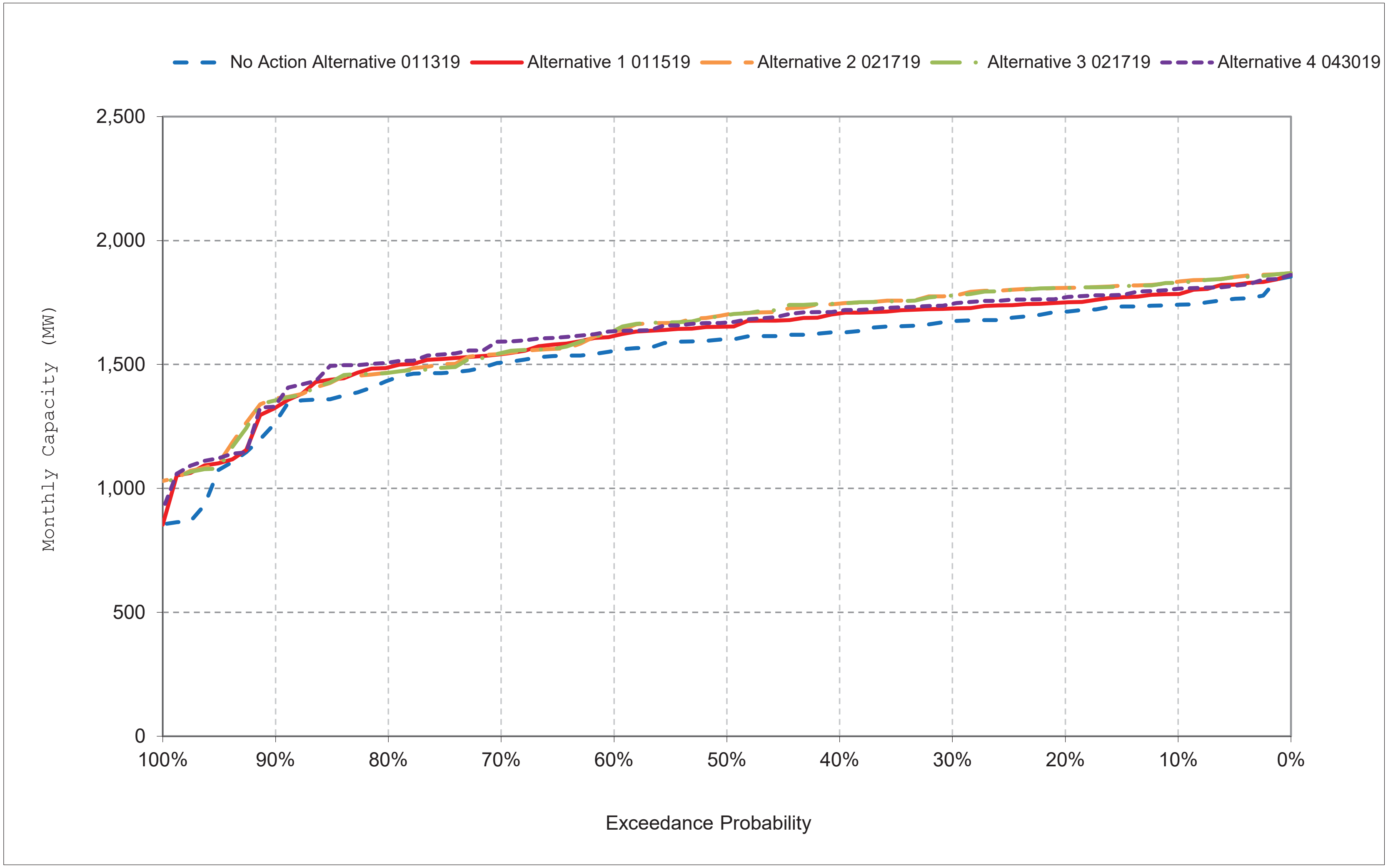
Figure 1-7. CVP Total Capacity, October



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

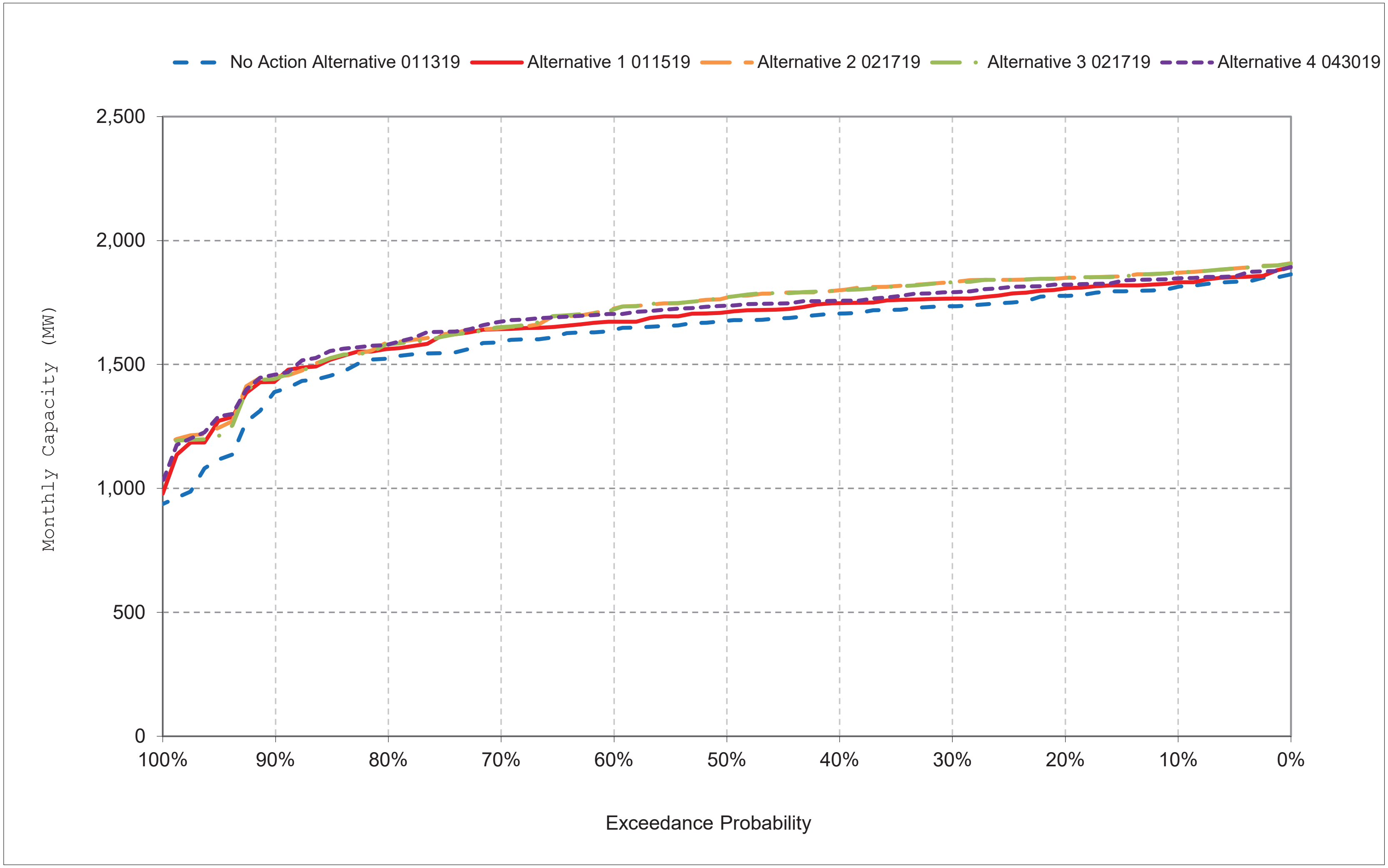
Figure 1-8. CVP Total Capacity, November



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

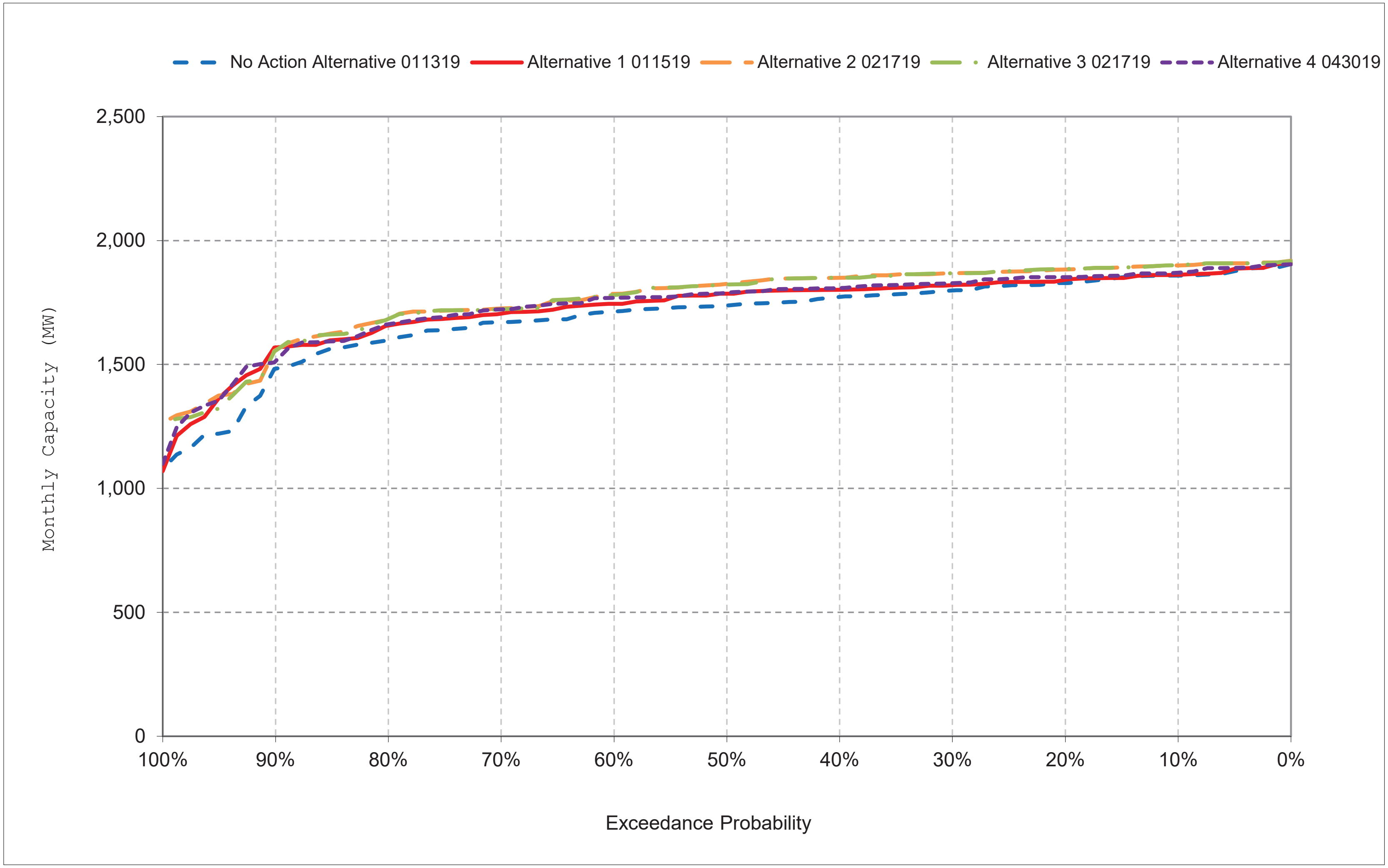
Figure 1-9. CVP Total Capacity, December



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

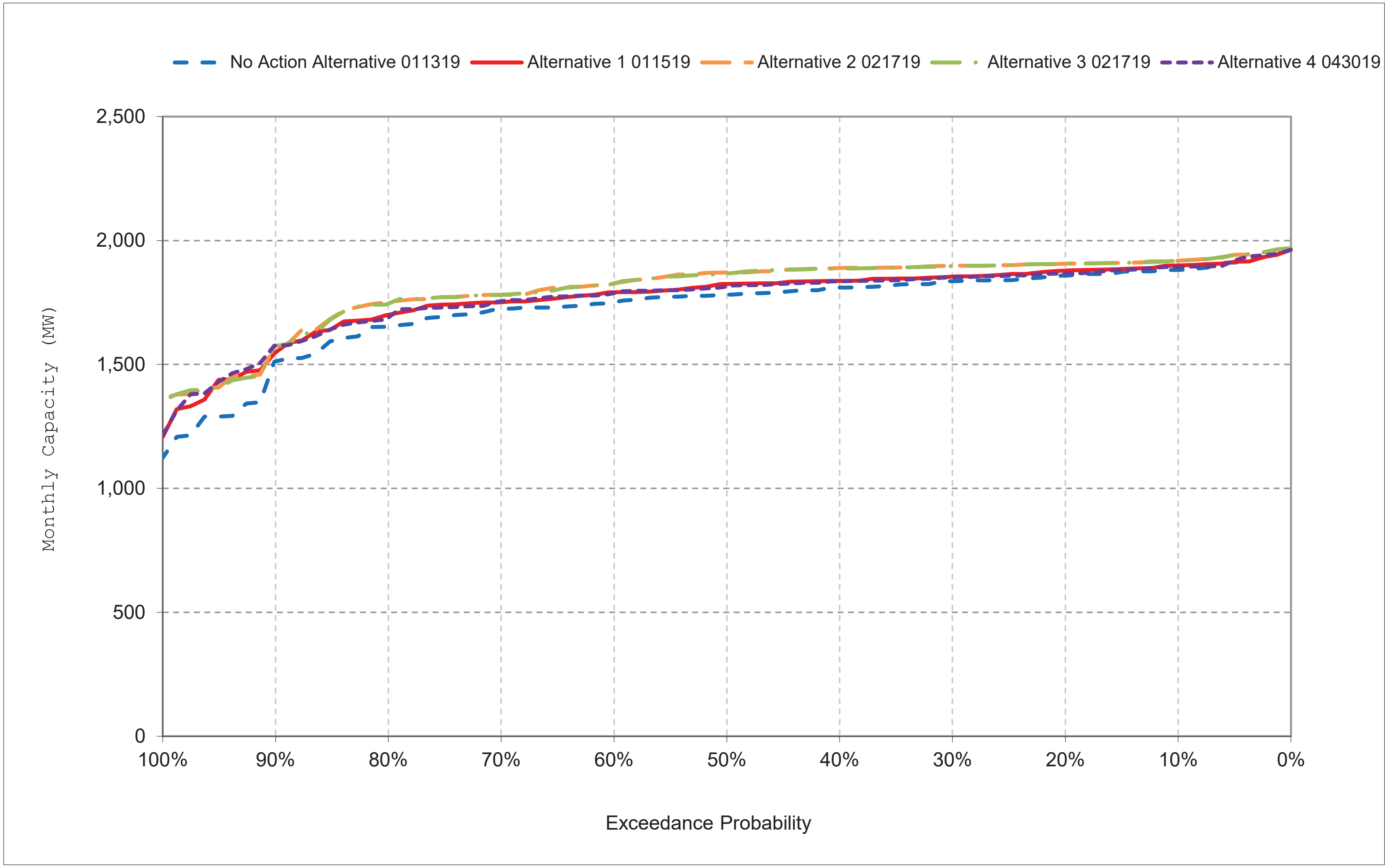
Figure 1-10. CVP Total Capacity, January



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

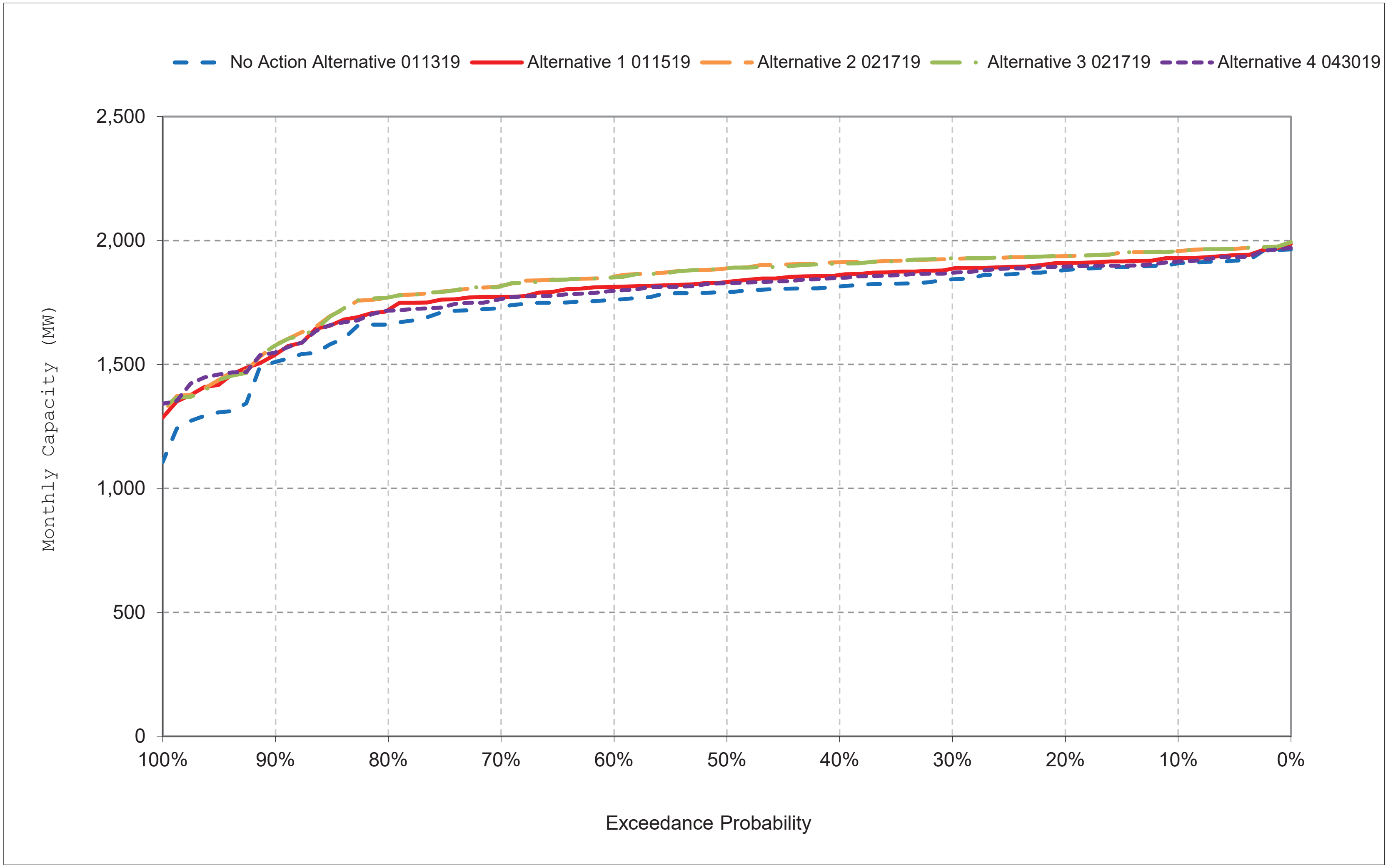
Figure 1-11. CVP Total Capacity, February



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

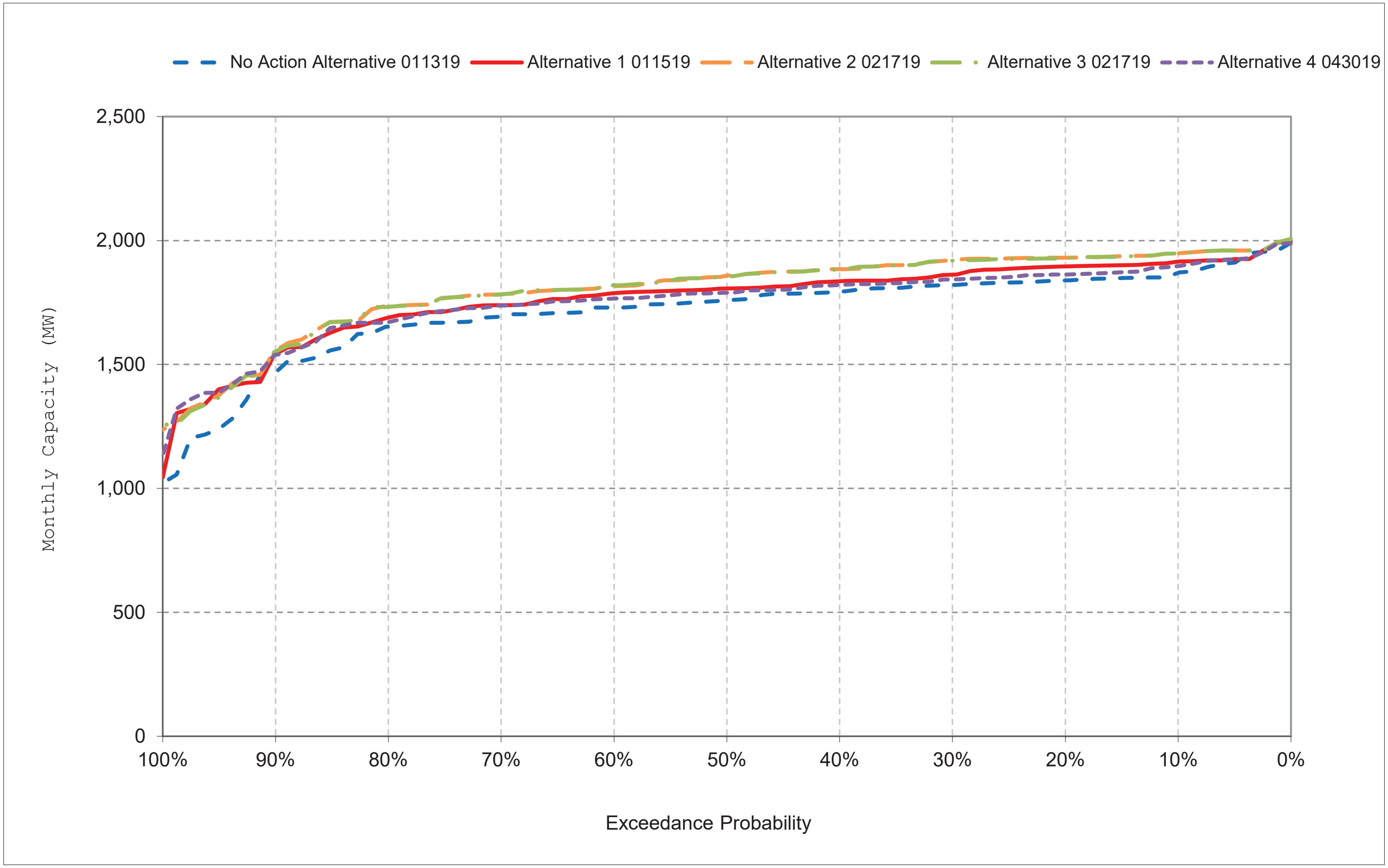
Figure 1-12. CVP Total Capacity, March



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

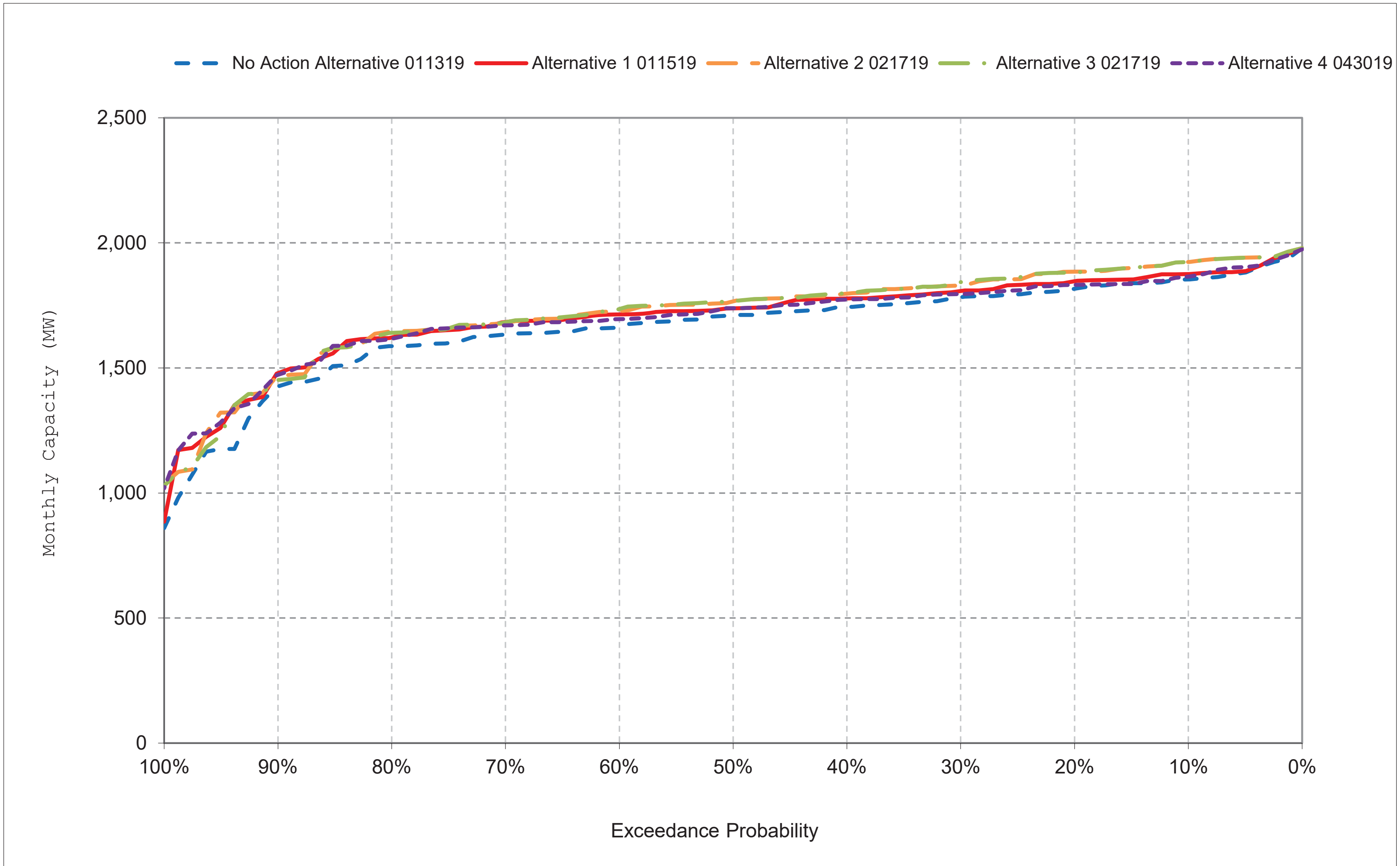
Figure 1-13. CVP Total Capacity, April



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 1-14. CVP Total Capacity, May



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

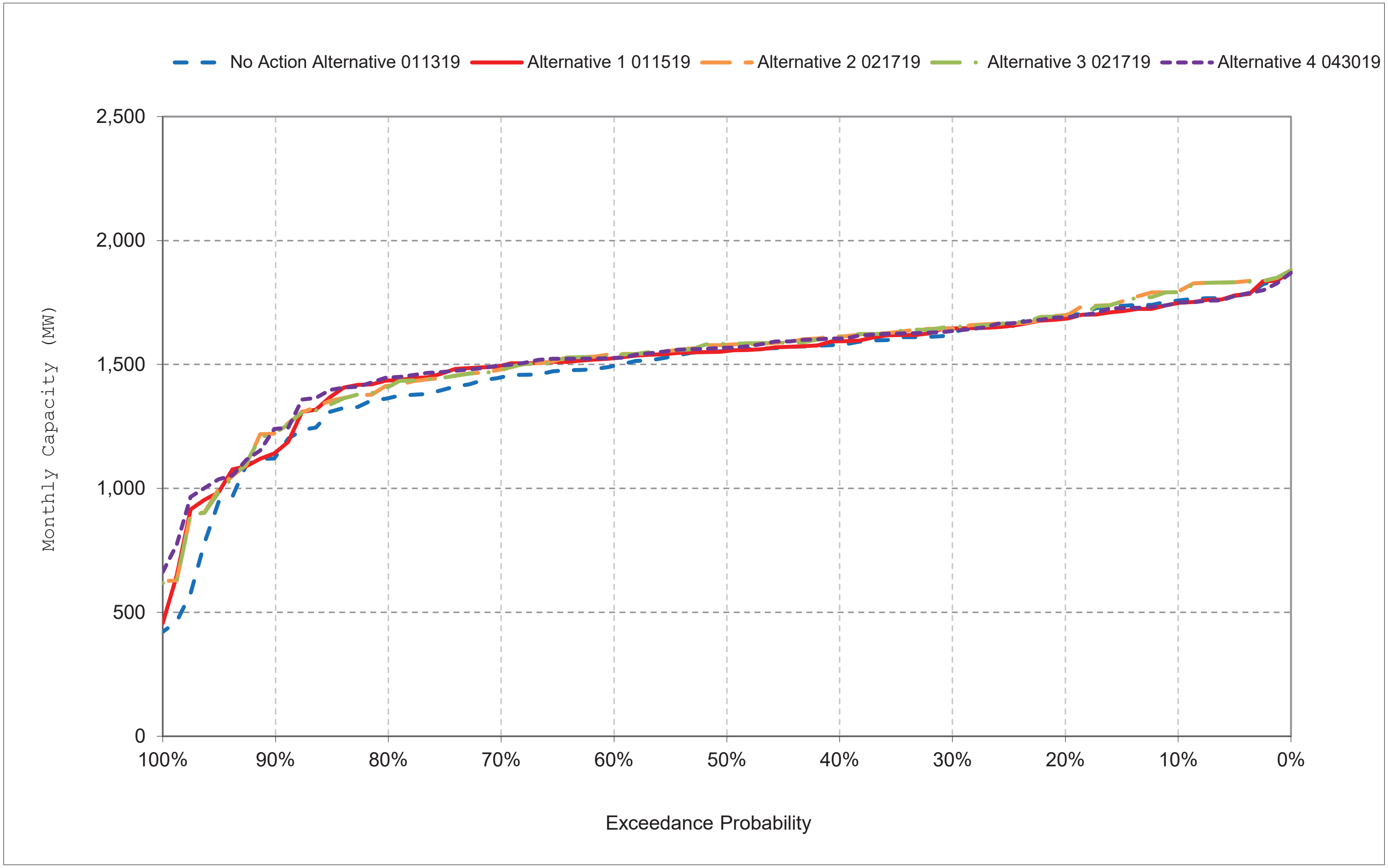
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 1-15. CVP Total Capacity, June

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

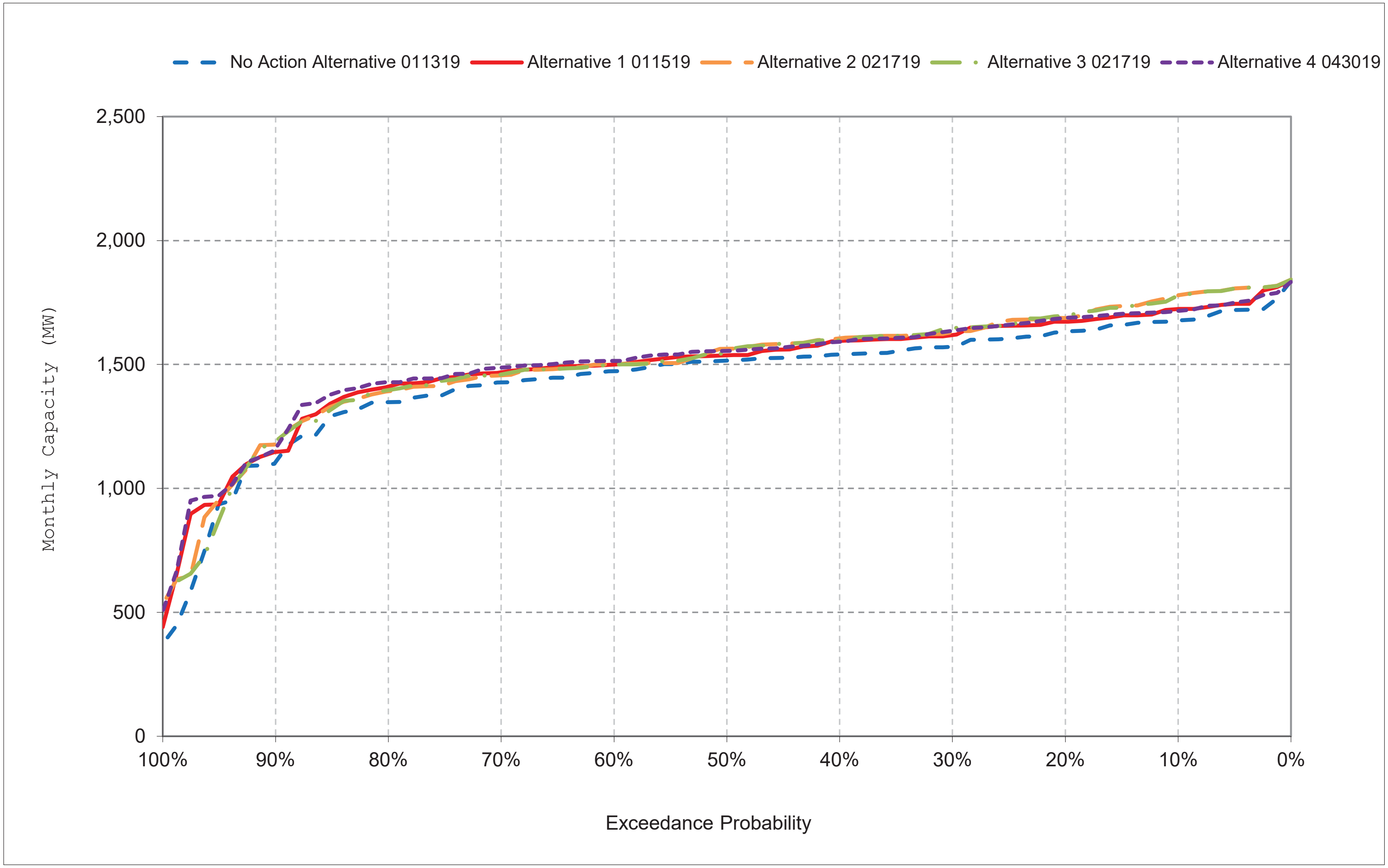
Figure 1-16. CVP Total Capacity, July



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

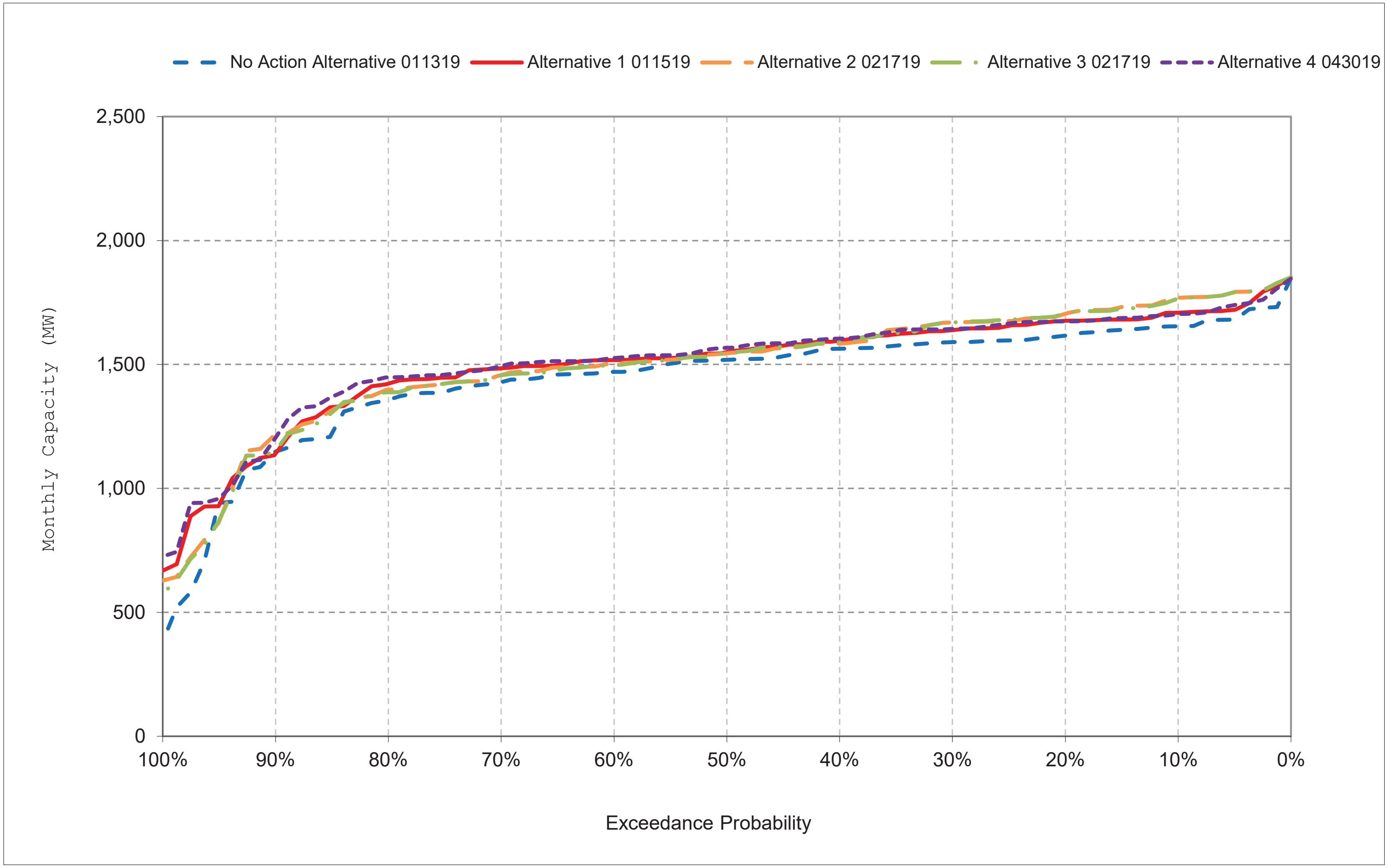
Figure 1-17. CVP Total Capacity, August



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 1-18. CVP Total Capacity, September



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Table 2-1. CVP Total Generation, Monthly Generation

No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	422	445	661	706	677	696	491	643	572	782	597	657
20%	376	381	358	558	623	579	342	582	558	758	555	607
30%	341	337	229	389	475	377	300	524	532	716	525	527
40%	319	287	184	217	238	257	282	488	510	660	501	450
50%	283	252	165	193	186	219	264	472	486	641	483	344
60%	263	193	152	152	153	184	255	454	469	622	463	279
70%	228	154	144	148	135	165	243	421	453	557	443	265
80%	190	129	123	134	125	150	209	347	429	508	392	232
90%	159	118	110	119	112	137	186	289	340	443	332	187
Long Term												
Full Simulation Period[a]	287	266	258	313	316	329	308	474	489	622	476	396
Water Year Types[b,c]												
Wet (32%)	388	390	323	567	502	555	431	595	536	678	547	623
Above Normal (16%)	328	351	255	312	444	385	330	503	518	727	525	457
Below Normal (13%)	255	194	242	168	257	197	261	476	523	673	518	306
Dry (24%)	227	190	283	168	144	186	229	410	488	593	431	251
Critical (15%)	150	96	98	137	113	138	193	285	330	389	304	160

Alternative 1 011519

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	440	298	667	719	706	710	487	614	628	790	588	478
20%	391	271	472	595	653	591	346	572	589	761	565	386
30%	334	249	291	450	494	396	290	537	567	742	545	348
40%	287	215	192	270	289	261	265	488	529	682	508	329
50%	262	204	176	209	203	234	249	471	509	655	501	304
60%	233	174	156	152	164	192	238	444	497	640	488	274
70%	215	156	147	144	147	173	226	412	485	570	470	267
80%	198	139	125	138	128	161	214	380	437	524	402	225
90%	158	125	113	121	121	138	195	303	370	469	345	192
Long Term												
Full Simulation Period[a]	281	218	282	337	333	347	303	474	517	641	490	316
Water Year Types[b,c]												
Wet (32%)	378	282	371	591	520	558	415	576	559	689	560	424
Above Normal (16%)	311	239	292	367	474	419	319	498	550	740	534	326
Below Normal (13%)	255	195	242	216	305	237	263	492	573	694	542	309
Dry (24%)	228	196	291	169	146	198	225	422	505	610	447	255
Critical (15%)	148	113	99	141	116	157	207	301	360	431	315	182

Alternative 1 011519 minus No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	19	-147	6	13	28	14	-5	-29	56	7	-9	-179
20%	14	-110	114	37	29	11	4	-10	32	3	10	-221
30%	-7	-88	61	61	19	19	-9	14	34	25	20	-179
40%	-32	-72	8	53	51	4	-18	0	19	21	7	-121
50%	-21	-48	11	16	16	15	-15	-1	24	14	18	-40
60%	-30	-20	4	0	12	7	-17	-9	28	18	26	-4
70%	-14	3	4	-4	12	8	-17	-9	32	13	27	2
80%	8	9	1	4	3	11	6	33	7	16	10	-8
90%	-2	7	3	2	9	0	9	13	30	27	13	5
Long Term												
Full Simulation Period[a]	-6	-48	24	24	18	18	-6	0	28	18	14	-79
Water Year Types[b,c]												
Wet (32%)	-9	-108	49	24	18	4	-16	-19	23	11	13	-198
Above Normal (16%)	-18	-112	37	55	30	34	-11	-5	32	12	9	-131
Below Normal (13%)	-1	1	0	48	48	41	2	15	50	21	24	3
Dry (24%)	0	6	9	1	2	13	-5	12	17	17	16	4
Critical (15%)	-1	17	1	4	3	19	14	17	31	42	12	22

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 2-2. CVP Total Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	422	445	661	706	677	696	491	643	572	782	597	657
20%	376	381	358	558	623	579	342	582	558	758	555	607
30%	341	337	229	389	475	377	300	524	532	716	525	527
40%	319	287	184	217	238	257	282	488	510	660	501	450
50%	283	252	165	193	186	219	264	472	486	641	483	344
60%	263	193	152	152	153	184	255	454	469	622	463	279
70%	228	154	144	148	135	165	243	421	453	557	443	265
80%	190	129	123	134	125	150	209	347	429	508	392	232
90%	159	118	110	119	112	137	186	289	340	443	332	187
Long Term												
Full Simulation Period[a]	287	266	258	313	316	329	308	474	489	622	476	396
Water Year Types[b,c]												
Wet (32%)	388	390	323	567	502	555	431	595	536	678	547	623
Above Normal (16%)	328	351	255	312	444	385	330	503	518	727	525	457
Below Normal (13%)	255	194	242	168	257	197	261	476	523	673	518	306
Dry (24%)	227	190	283	168	144	186	229	410	488	593	431	251
Critical (15%)	150	96	98	137	113	138	193	285	330	389	304	160

Alternative 2 021719

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	433	294	666	691	742	713	481	631	708	801	645	472
20%	403	259	413	597	654	586	336	581	671	787	598	386
30%	339	235	240	431	459	369	293	546	613	765	578	372
40%	293	214	196	278	298	258	259	517	584	711	553	346
50%	257	197	170	192	200	207	243	490	558	684	529	317
60%	239	173	151	161	163	189	232	456	519	633	497	291
70%	209	149	138	145	136	167	224	436	502	590	459	275
80%	184	135	129	133	121	155	207	391	468	552	423	247
90%	148	125	114	118	110	135	190	308	361	466	361	193
Long Term												
Full Simulation Period[a]	278	212	270	332	338	337	299	485	558	660	512	329
Water Year Types[b,c]												
Wet (32%)	369	280	369	584	540	552	411	578	594	703	588	424
Above Normal (16%)	322	222	256	353	489	401	299	502	636	766	572	336
Below Normal (13%)	265	193	221	217	290	235	257	515	628	727	574	356
Dry (24%)	223	195	278	167	137	179	225	441	533	628	444	272
Critical (15%)	138	100	101	141	113	157	218	310	376	443	342	183

Alternative 2 021719 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	11	-151	5	-15	65	17	-10	-13	136	19	48	-185
20%	27	-121	54	39	31	7	-6	-1	113	30	43	-221
30%	-1	-102	10	41	-16	-8	-7	22	80	48	53	-155
40%	-26	-73	12	60	60	2	-24	29	74	51	52	-104
50%	-26	-55	5	-1	14	-12	-21	17	72	43	46	-27
60%	-25	-20	-1	9	10	4	-23	2	50	12	34	12
70%	-20	-5	-5	-3	1	2	-19	15	49	33	16	10
80%	-6	5	5	-2	-4	5	-1	44	38	44	32	15
90%	-11	7	4	-2	-1	-2	4	19	21	23	30	6
Long Term												
Full Simulation Period[a]	-9	-54	11	19	22	8	-9	11	69	37	37	-67
Water Year Types[b,c]												
Wet (32%)	-19	-111	46	18	38	-2	-20	-17	58	25	41	-199
Above Normal (16%)	-6	-130	1	41	45	16	-31	-1	119	39	46	-122
Below Normal (13%)	9	-1	-21	49	33	38	-4	39	106	54	56	50
Dry (24%)	-4	5	-5	-2	-7	-7	-5	30	44	35	13	21
Critical (15%)	-12	3	4	5	0	19	25	26	46	54	39	23

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 2-3. CVP Total Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	422	445	661	706	677	696	491	643	572	782	597	657
20%	376	381	358	558	623	579	342	582	558	758	555	607
30%	341	337	229	389	475	377	300	524	532	716	525	527
40%	319	287	184	217	238	257	282	488	510	660	501	450
50%	283	252	165	193	186	219	264	472	486	641	483	344
60%	263	193	152	152	153	184	255	454	469	622	463	279
70%	228	154	144	148	135	165	243	421	453	557	443	265
80%	190	129	123	134	125	150	209	347	429	508	392	232
90%	159	118	110	119	112	137	186	289	340	443	332	187
Long Term												
Full Simulation Period[a]	287	266	258	313	316	329	308	474	489	622	476	396
Water Year Types[b,c]												
Wet (32%)	388	390	323	567	502	555	431	595	536	678	547	623
Above Normal (16%)	328	351	255	312	444	385	330	503	518	727	525	457
Below Normal (13%)	255	194	242	168	257	197	261	476	523	673	518	306
Dry (24%)	227	190	283	168	144	186	229	410	488	593	431	251
Critical (15%)	150	96	98	137	113	138	193	285	330	389	304	160

Alternative 3 021719

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	439	298	666	691	742	714	481	631	714	807	638	469
20%	409	272	417	583	653	586	341	588	666	791	608	399
30%	346	236	253	431	459	369	286	539	612	764	578	363
40%	307	212	193	278	298	257	268	507	566	713	553	337
50%	274	196	171	195	190	215	254	489	554	679	527	327
60%	245	168	153	159	165	187	233	455	515	637	498	293
70%	218	149	138	146	136	167	223	433	500	586	458	278
80%	196	133	129	136	120	148	207	389	468	551	424	243
90%	146	124	115	118	111	136	194	308	358	459	344	194
Long Term												
Full Simulation Period[a]	287	213	275	330	336	335	299	483	554	659	511	327
Water Year Types[b,c]												
Wet (32%)	376	281	376	581	539	551	410	570	591	704	592	417
Above Normal (16%)	308	235	270	349	487	400	298	503	627	769	568	338
Below Normal (13%)	292	195	225	216	289	235	260	516	623	726	569	356
Dry (24%)	244	188	279	164	137	176	225	441	532	627	442	275
Critical (15%)	141	98	100	151	108	156	220	311	369	433	338	182

Alternative 3 021719 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	17	-147	5	-15	65	18	-10	-13	142	24	41	-188
20%	33	-109	59	25	30	7	-1	6	108	33	53	-208
30%	6	-101	23	41	-16	-8	-13	15	80	48	52	-163
40%	-12	-75	9	60	60	1	-14	19	56	53	52	-112
50%	-9	-56	6	1	4	-4	-10	17	69	38	43	-17
60%	-18	-25	1	7	13	3	-22	1	46	15	35	14
70%	-11	-5	-5	-2	1	2	-20	12	47	29	14	13
80%	6	3	6	1	-5	-2	-1	42	38	43	32	10
90%	-13	6	5	-1	-1	-2	8	18	18	16	12	6
Long Term												
Full Simulation Period[a]	1	-53	16	18	21	7	-9	9	65	37	36	-68
Water Year Types[b,c]												
Wet (32%)	-12	-109	53	14	37	-4	-21	-25	55	26	45	-206
Above Normal (16%)	-21	-117	15	37	44	15	-31	0	109	42	43	-119
Below Normal (13%)	36	0	-17	48	32	38	-1	40	100	53	50	51
Dry (24%)	16	-3	-4	-5	-6	-10	-4	31	44	34	12	24
Critical (15%)	-8	2	2	14	-5	18	27	26	39	44	35	22

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 2-4. CVP Total Generation, Monthly Generation

No Action Alternative 011319

Statistic	Monthly Generation (GWh) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	422	445	661	706	677	696	491	643	572	782	597	657
20%	376	381	358	558	623	579	342	582	558	758	555	607
30%	341	337	229	389	475	377	300	524	532	716	525	527
40%	319	287	184	217	238	257	282	488	510	660	501	450
50%	283	252	165	193	186	219	264	472	486	641	483	344
60%	263	193	152	152	153	184	255	454	469	622	463	279
70%	228	154	144	148	135	165	243	421	453	557	443	265
80%	190	129	123	134	125	150	209	347	429	508	392	232
90%	159	118	110	119	112	137	186	289	340	443	332	187
Long Term												
Full Simulation Period[a]	287	266	258	313	316	329	308	474	489	622	476	396
Water Year Types[b,c]												
Wet (32%)	388	390	323	567	502	555	431	595	536	678	547	623
Above Normal (16%)	328	351	255	312	444	385	330	503	518	727	525	457
Below Normal (13%)	255	194	242	168	257	197	261	476	523	673	518	306
Dry (24%)	227	190	283	168	144	186	229	410	488	593	431	251
Critical (15%)	150	96	98	137	113	138	193	285	330	389	304	160

Alternative 4 043019

Statistic	Monthly Generation (GWh) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	439	292	644	673	682	706	487	608	580	776	578	463
20%	352	254	466	580	630	595	373	575	564	762	553	376
30%	320	224	288	426	440	414	335	532	536	726	533	351
40%	284	206	197	276	268	295	313	491	515	667	506	321
50%	260	194	169	194	215	248	285	467	500	638	496	286
60%	241	175	153	155	160	219	261	455	483	614	476	277
70%	219	153	147	143	147	187	250	438	470	573	452	255
80%	193	140	137	138	130	168	224	392	411	521	393	223
90%	171	122	113	122	121	145	191	323	366	438	334	181
Long Term												
Full Simulation Period[a]	280	212	280	327	327	353	323	474	494	629	479	310
Water Year Types[b,c]												
Wet (32%)	371	269	363	577	511	559	441	583	547	686	553	413
Above Normal (16%)	313	242	288	348	454	435	359	507	515	749	532	336
Below Normal (13%)	241	196	247	221	294	258	277	470	523	688	507	284
Dry (24%)	230	191	292	159	148	208	242	418	486	586	437	255
Critical (15%)	167	108	101	143	118	147	204	301	344	393	308	173

Alternative 4 043019 minus No Action Alternative 011319

Statistic	Monthly Generation (GWh) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	18	**-153**	**-17**	**-33**	5	10	**-4**	**-35**	8	**-7**	**-19**	**-194**
20%	**-24**	**-126**	107	22	7	15	31	**-7**	6	5	**-3**	**-231**
30%	**-20**	**-113**	58	37	**-35**	37	35	9	4	9	8	**-176**
40%	**-34**	**-81**	13	58	31	39	31	2	5	7	5	**-129**
50%	**-22**	**-58**	3	1	29	29	21	**-6**	15	**-3**	13	**-58**
60%	**-23**	**-19**	1	3	7	35	6	2	14	**-8**	13	**-2**
70%	**-10**	**0**	4	**-5**	12	22	7	17	17	16	9	**-11**
80%	2	10	13	4	5	18	15	46	**-19**	13	1	**-10**
90%	12	4	3	3	10	7	5	34	26	**-4**	3	**-6**
Long Term												
Full Simulation Period[a]	**-6**	**-54**	21	14	11	24	14	0	5	7	4	**-85**
Water Year Types[b,c]												
Wet (32%)	**-17**	**-121**	40	10	9	4	10	**-12**	11	7	6	**-210**
Above Normal (16%)	**-15**	**-110**	33	35	11	50	29	4	**-2**	21	7	**-121**
Below Normal (13%)	**-15**	1	5	53	37	61	16	**-6**	0	15	**-11**	**-21**
Dry (24%)	2	1	10	**-10**	4	23	12	8	**-2**	**-7**	6	5
Critical (15%)	18	12	3	6	5	9	11	16	15	4	4	14

a Based on the 82-year simulation period.

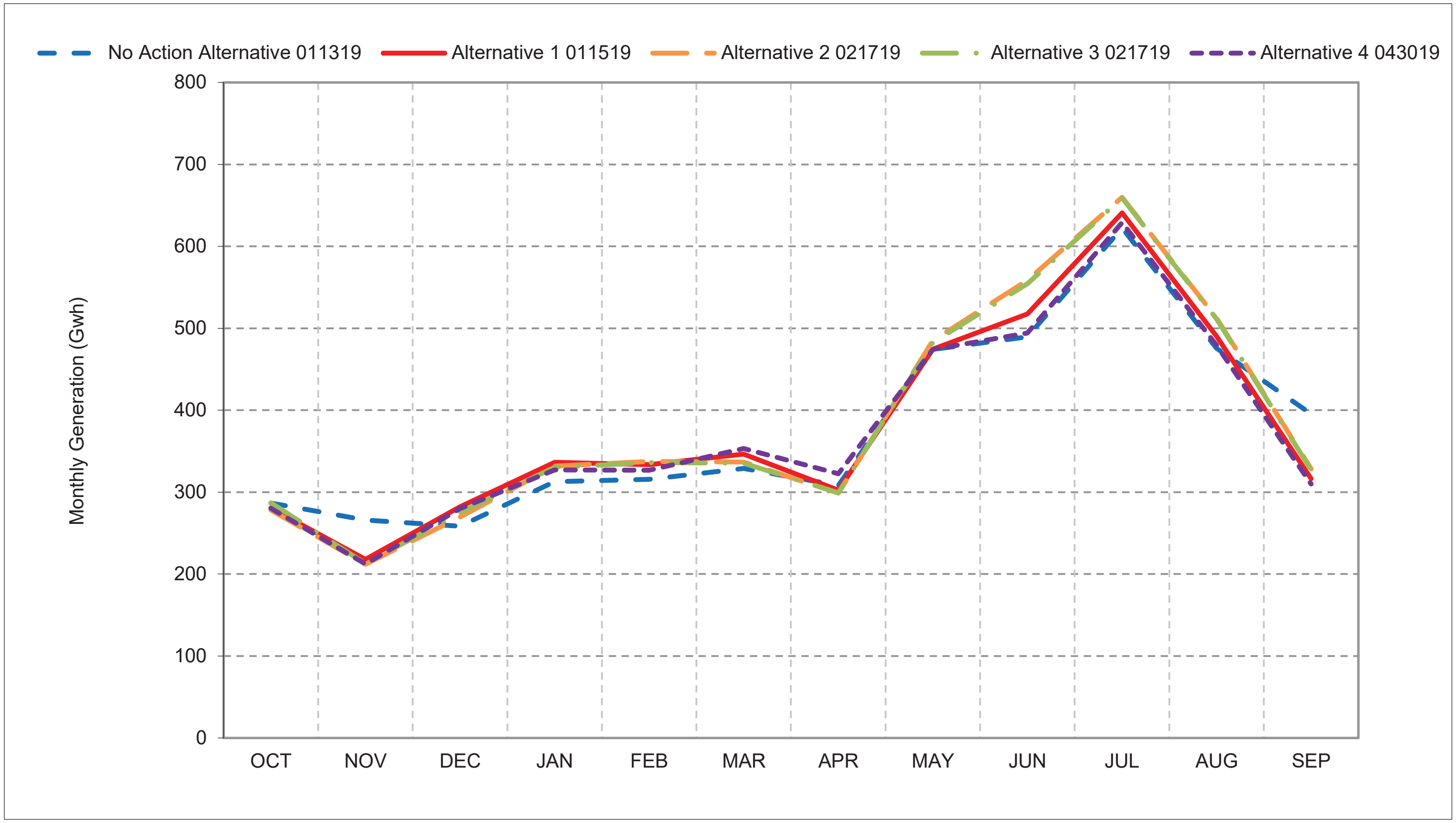
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

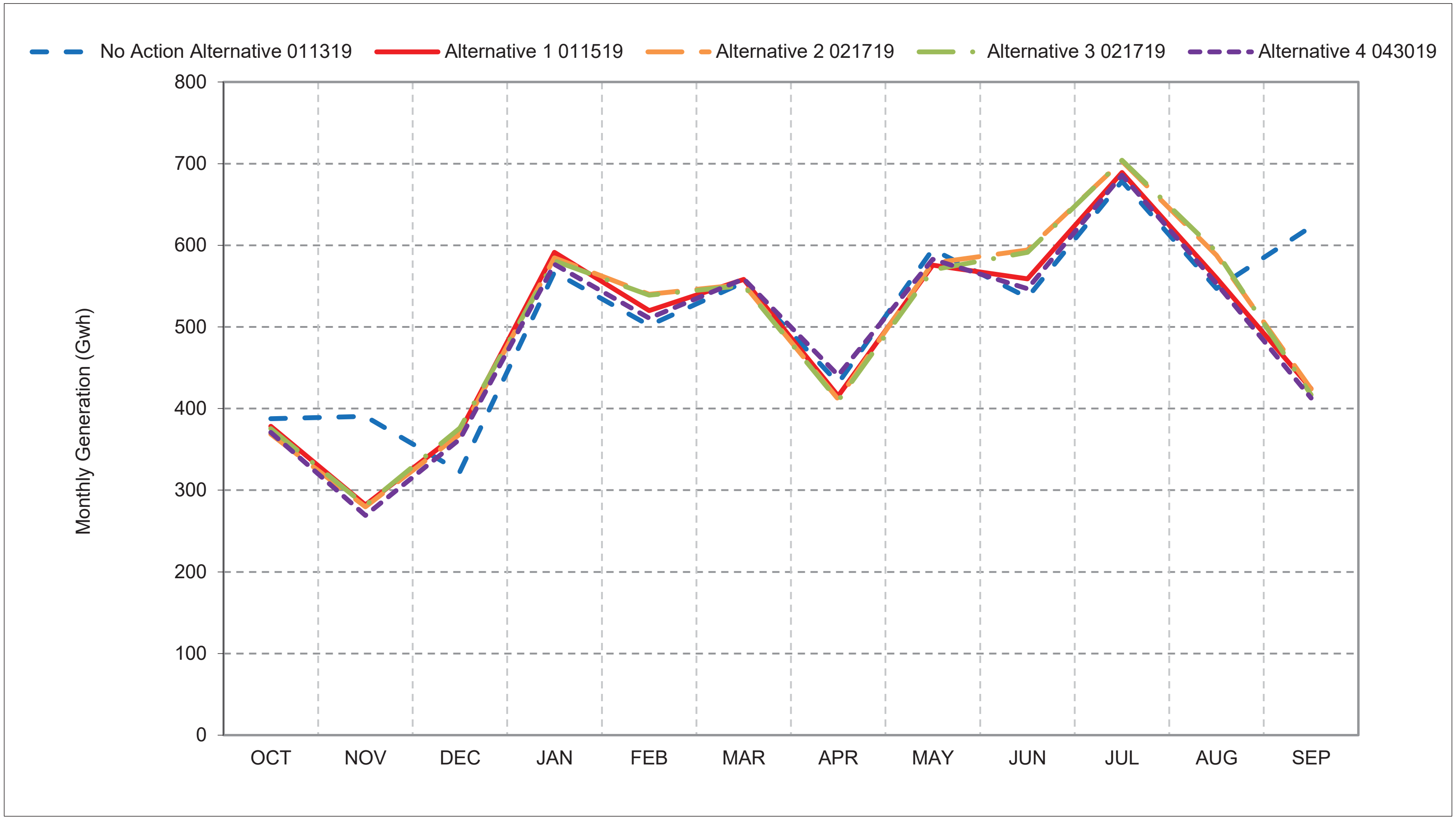
e These are draft results meant for qualitative analysis and are subject to revision.

Figure 2-1. CVP Total Generation, Long-Term Average Generation



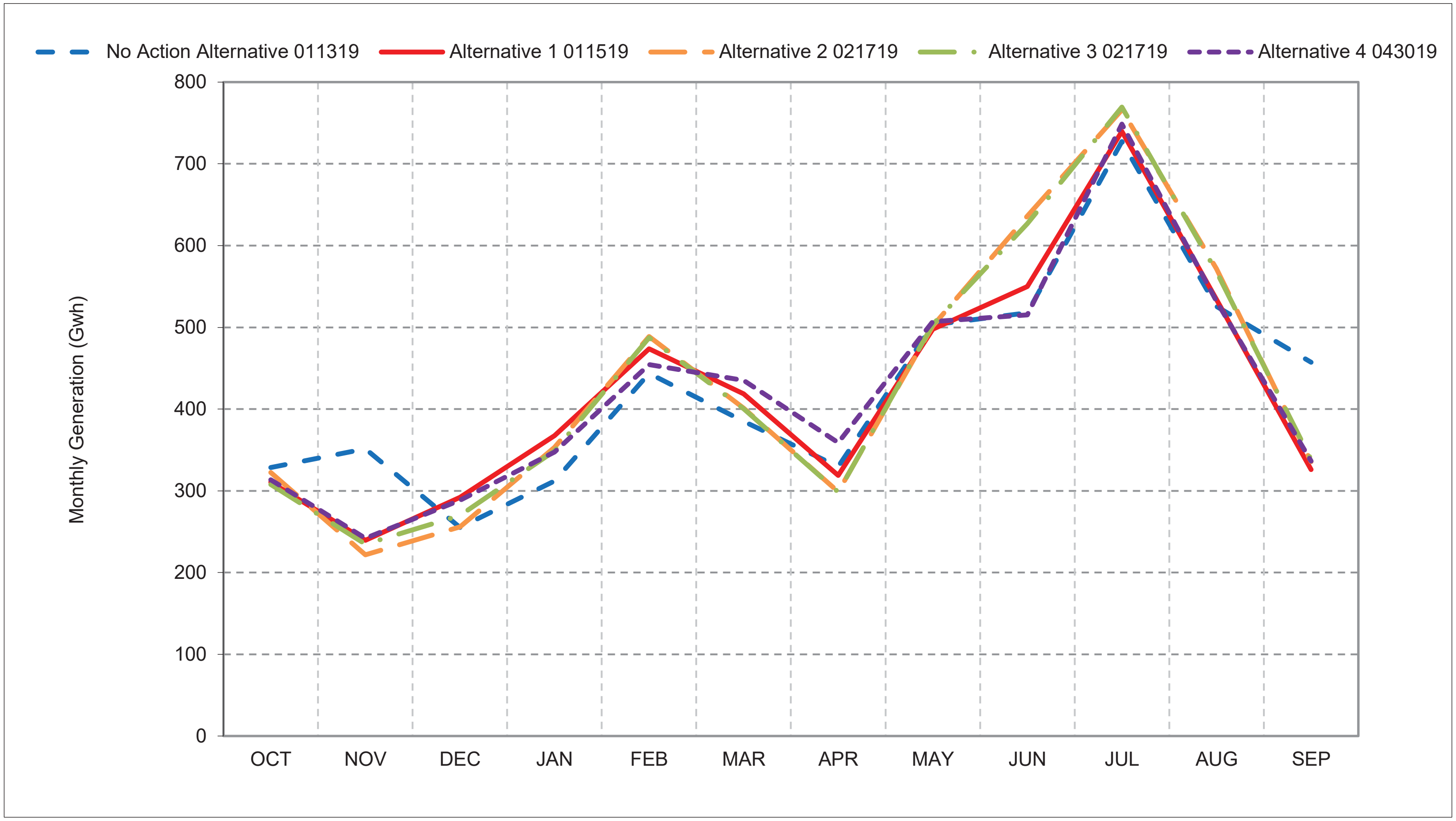
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 2-2. CVP Total Generation, Wet Year Average Generation



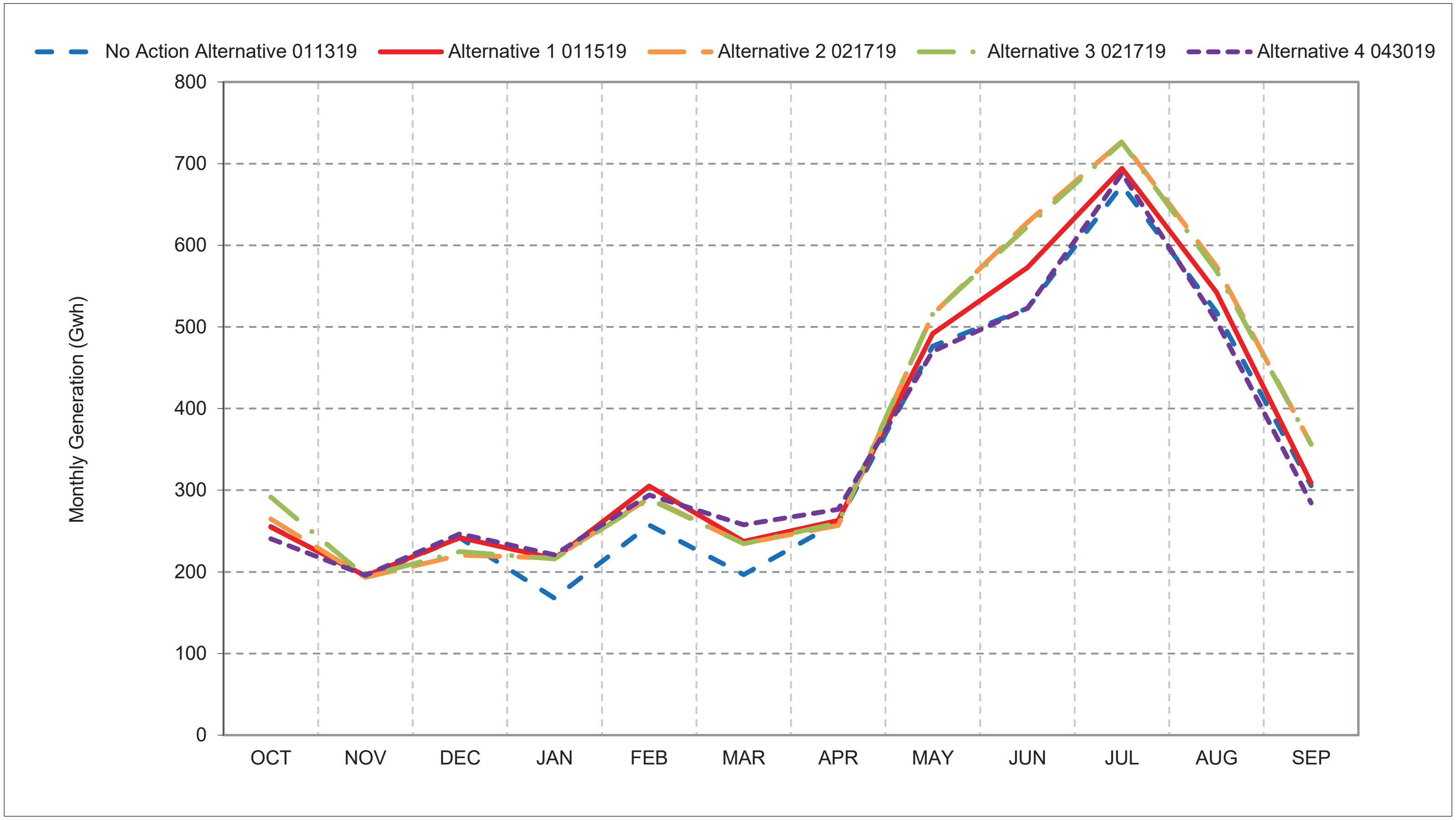
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 2-3. CVP Total Generation, Above Normal Year Average Generation



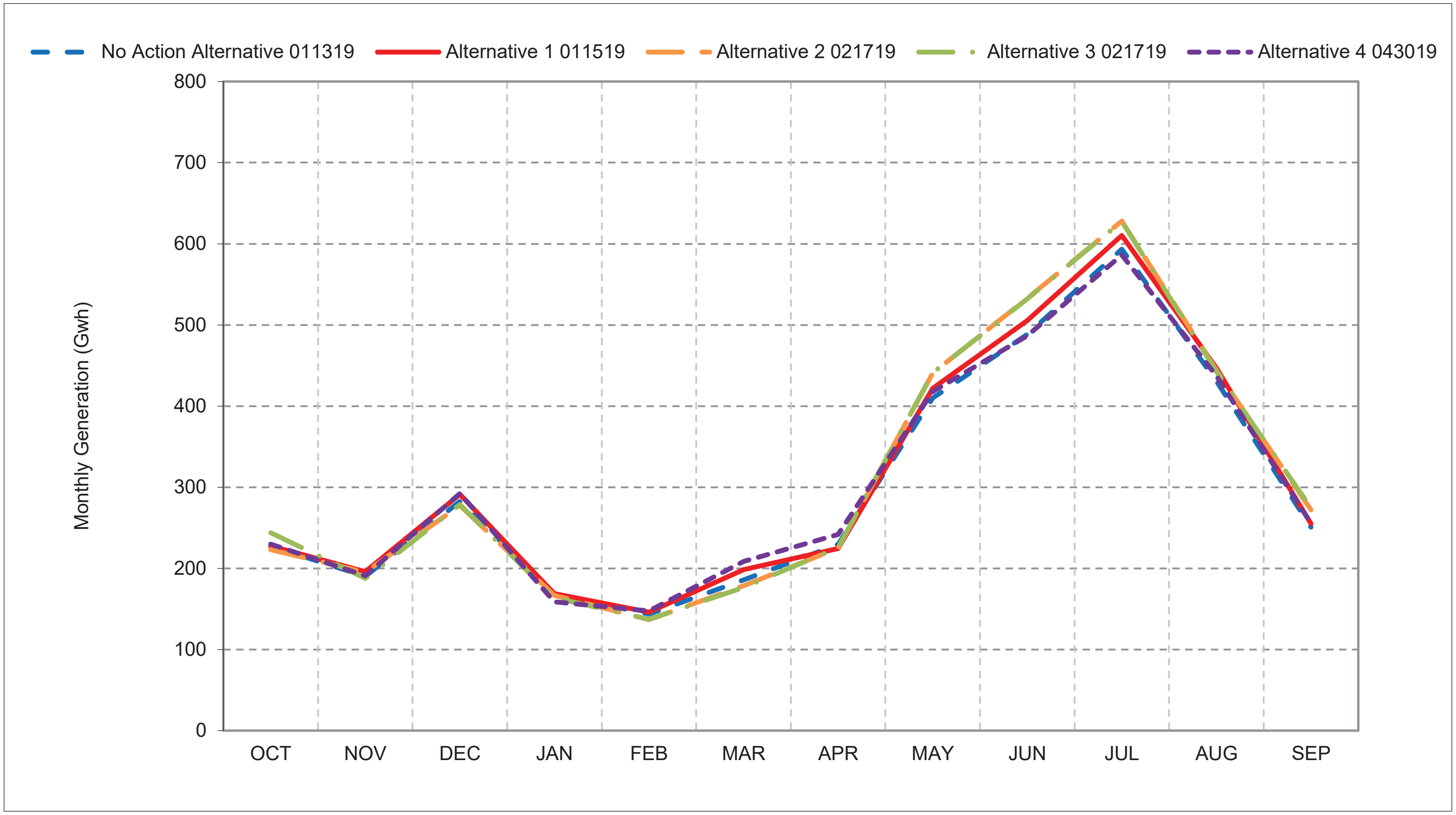
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 2-4. CVP Total Generation, Below Normal Year Average Generation



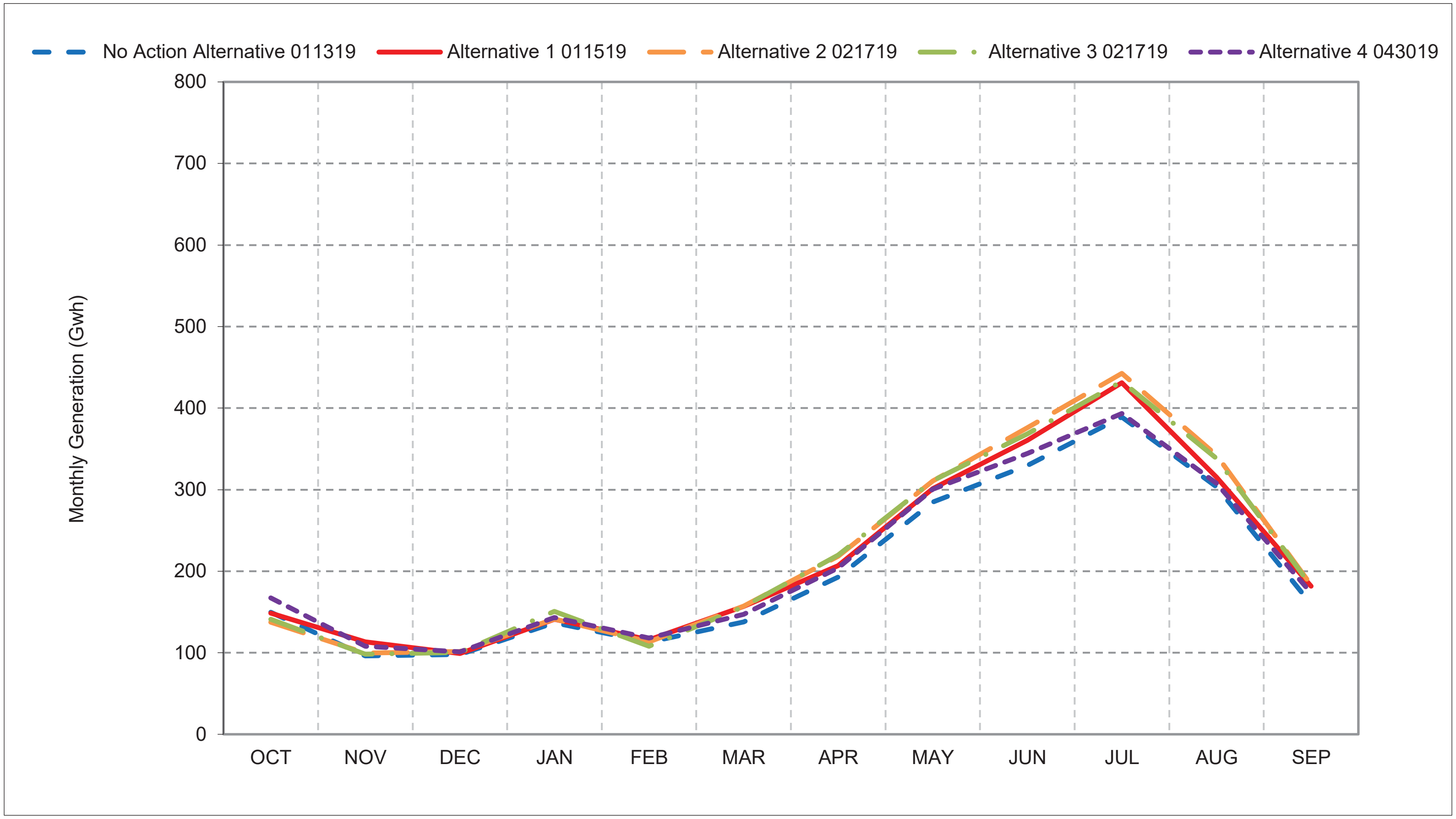
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 2-5. CVP Total Generation, Dry Year Average Generation



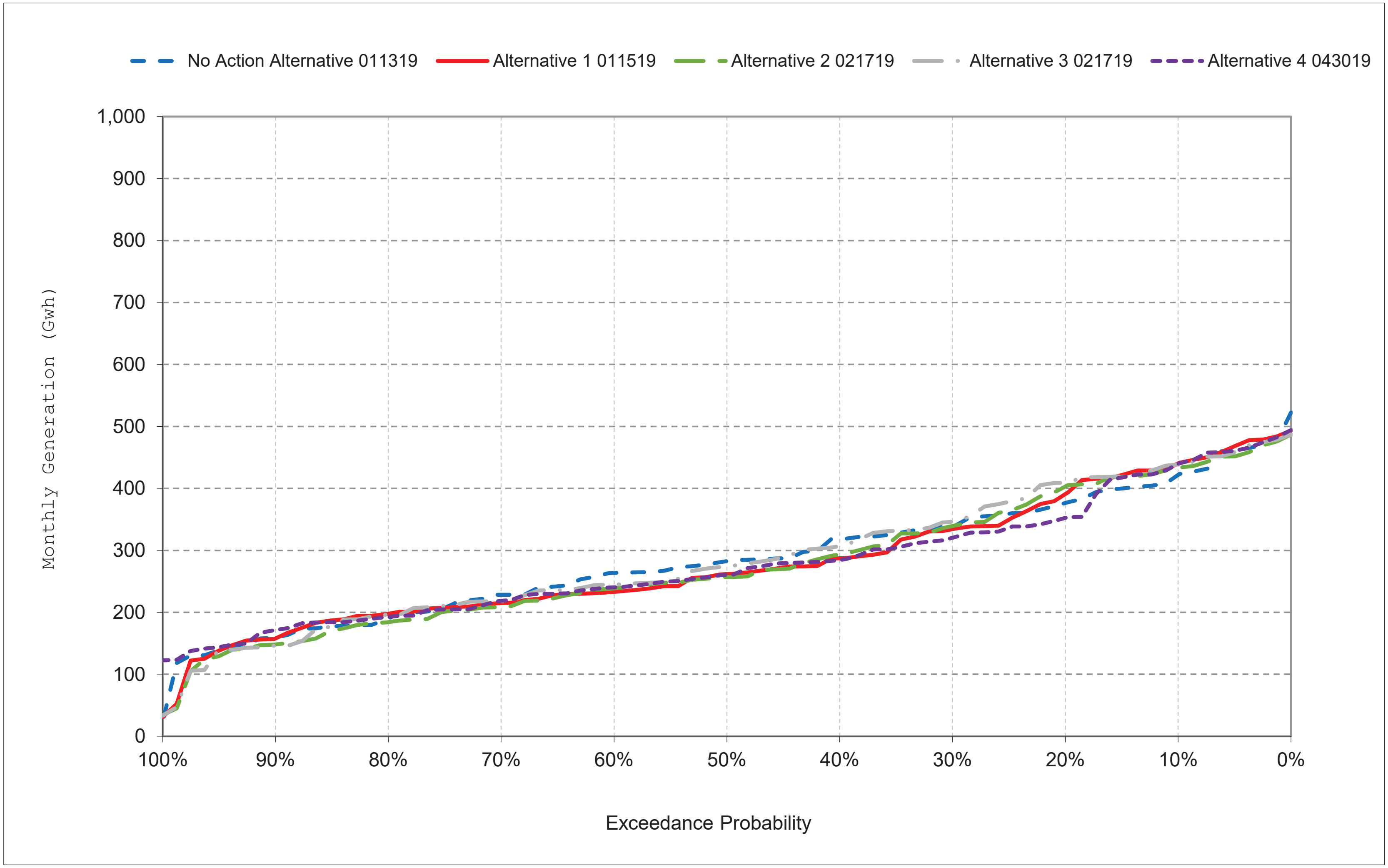
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 2-6. CVP Total Generation, Critical Year Average Generation



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

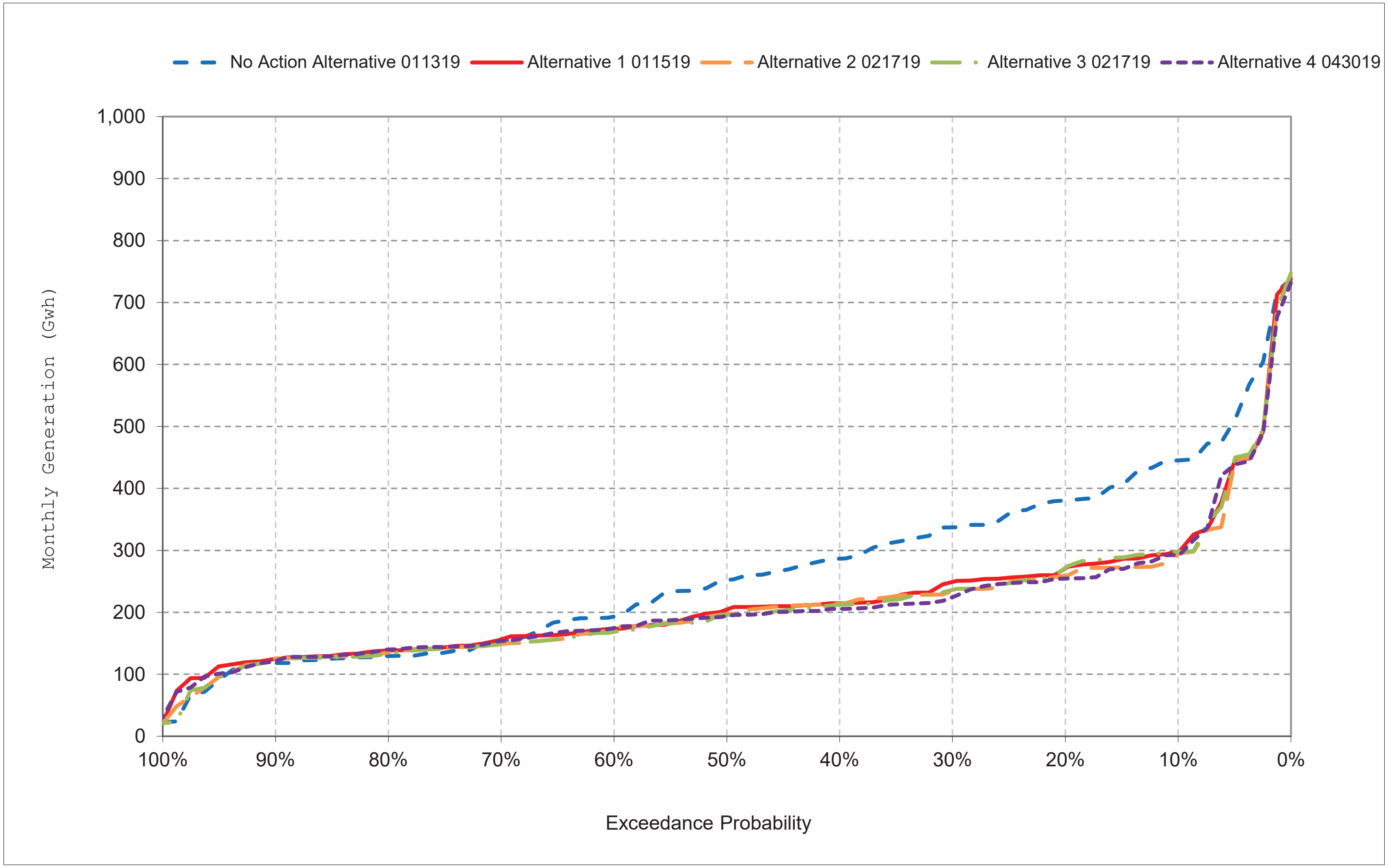
Figure 2-7. CVP Total Generation, October



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

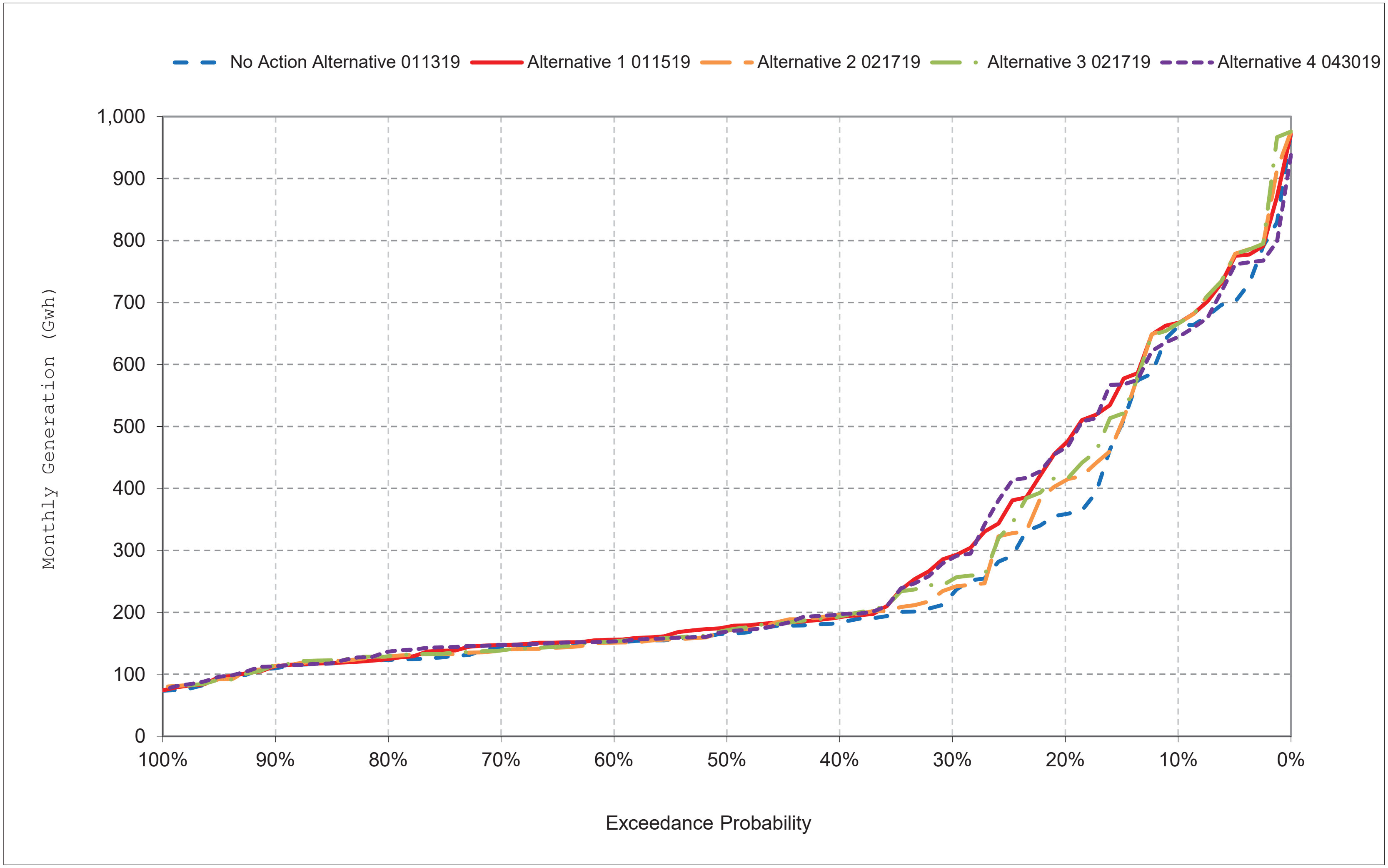
Figure 2-8. CVP Total Generation, November



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

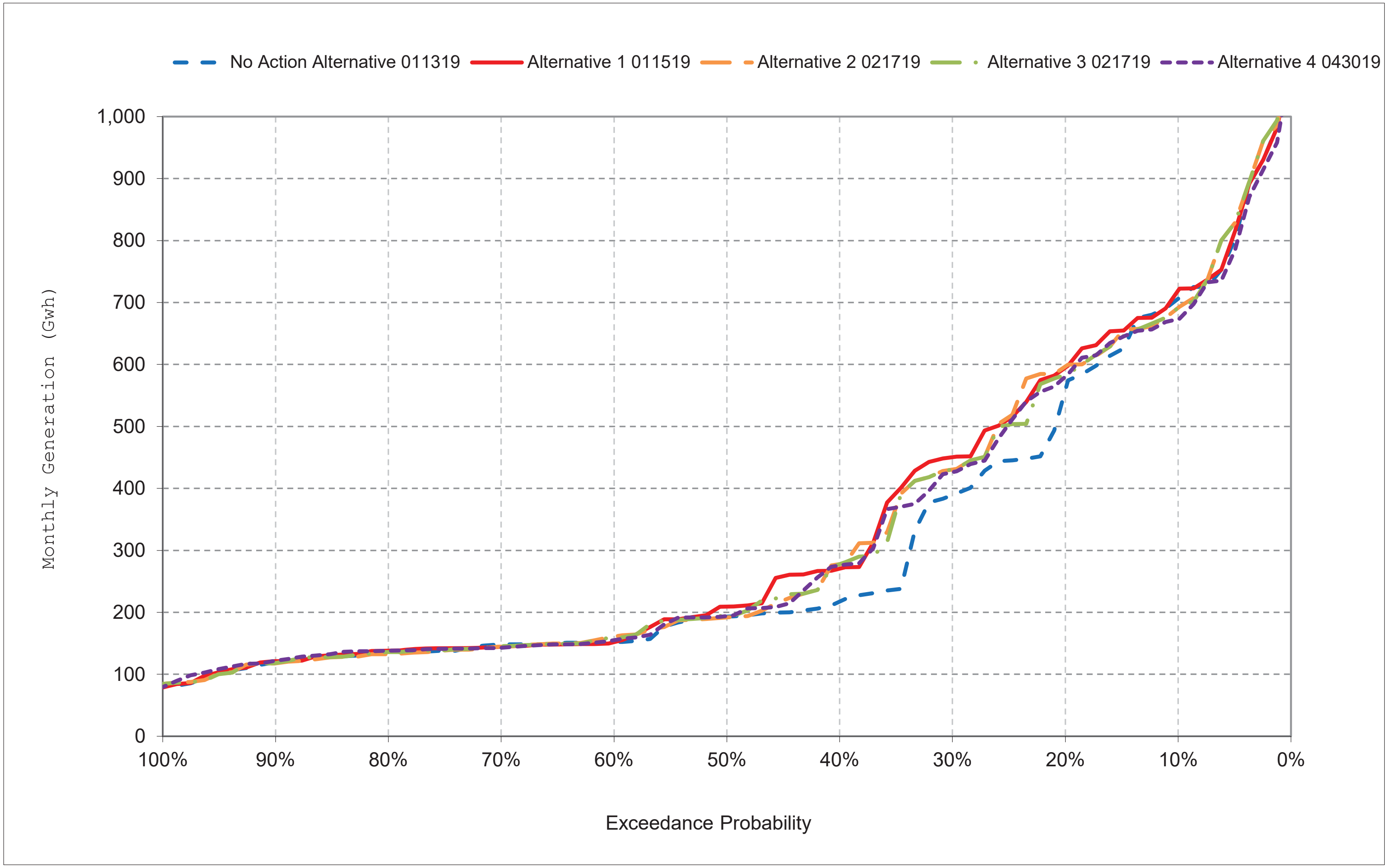
Figure 2-9. CVP Total Generation, December



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

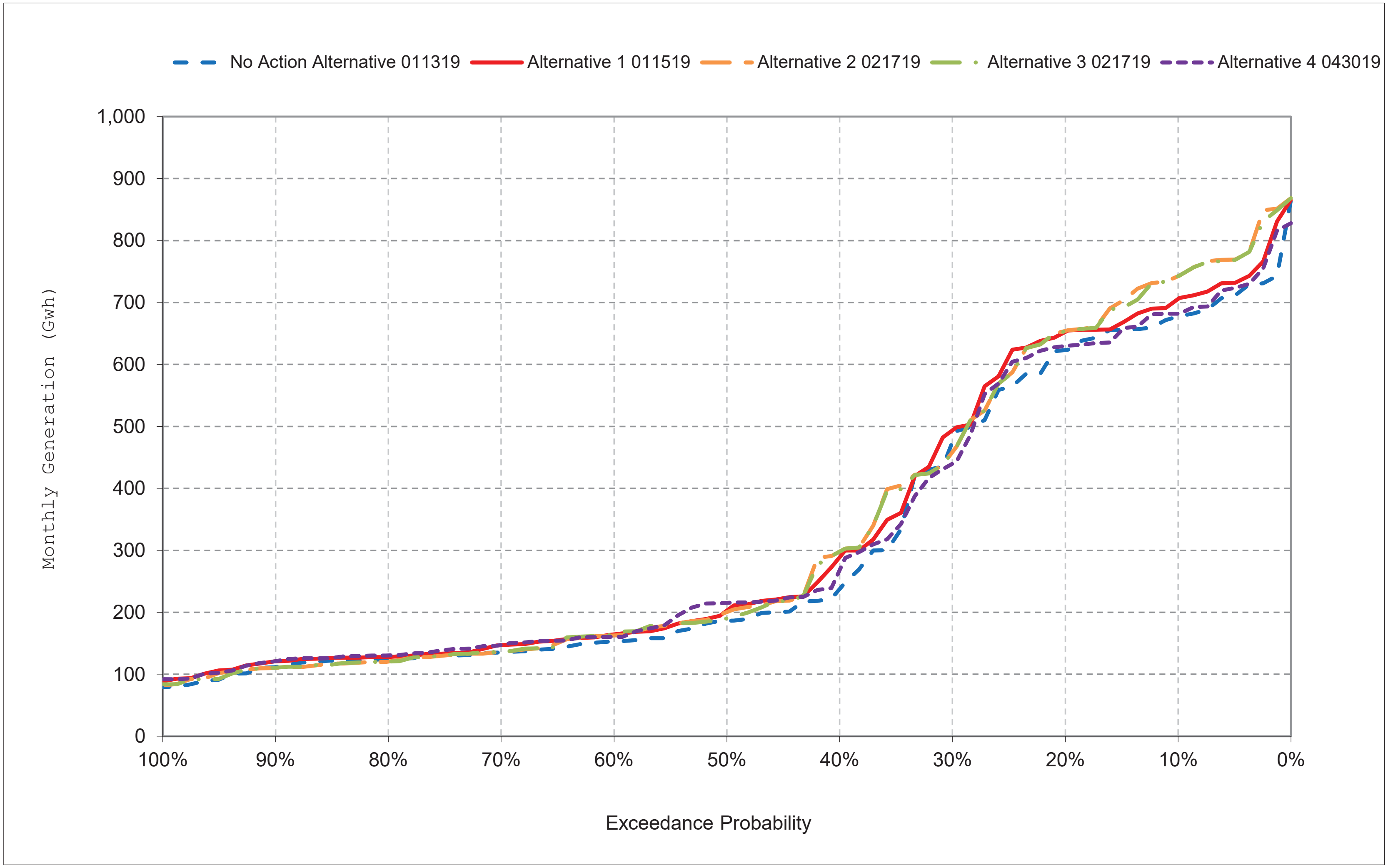
Figure 2-10. CVP Total Generation, January



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

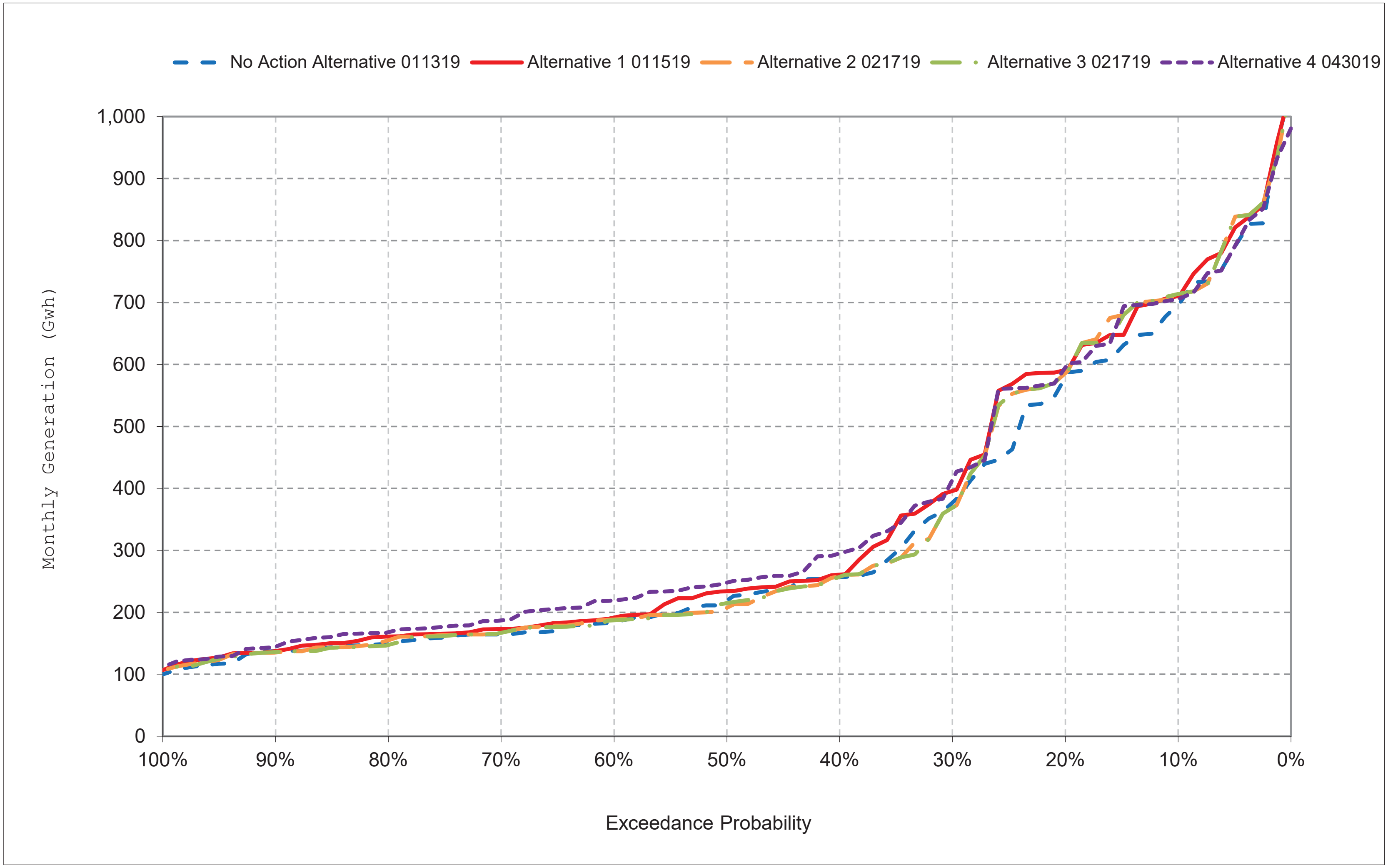
Figure 2-11. CVP Total Generation, February



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

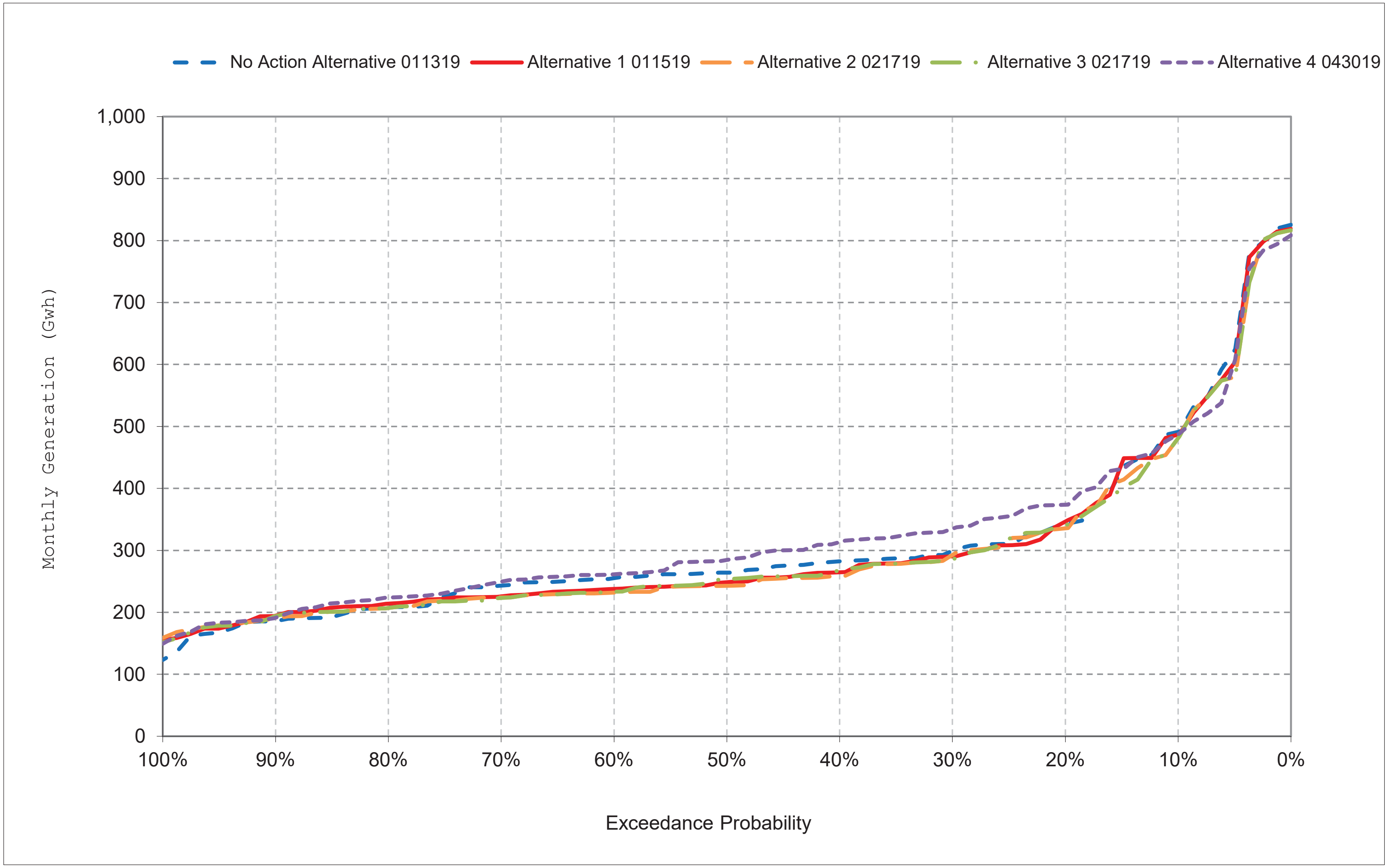
Figure 2-12. CVP Total Generation, March



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

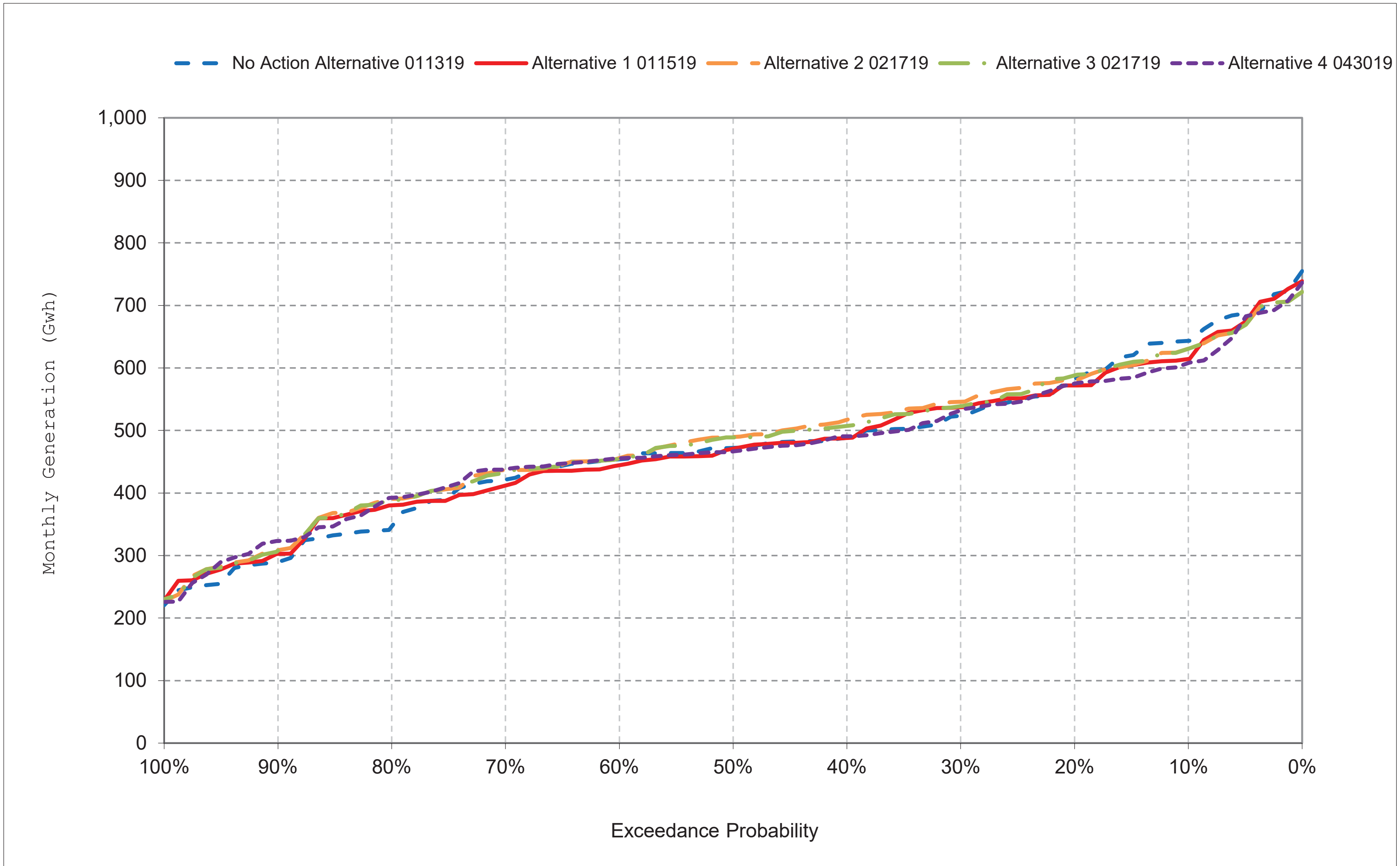
Figure 2-13. CVP Total Generation, April



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

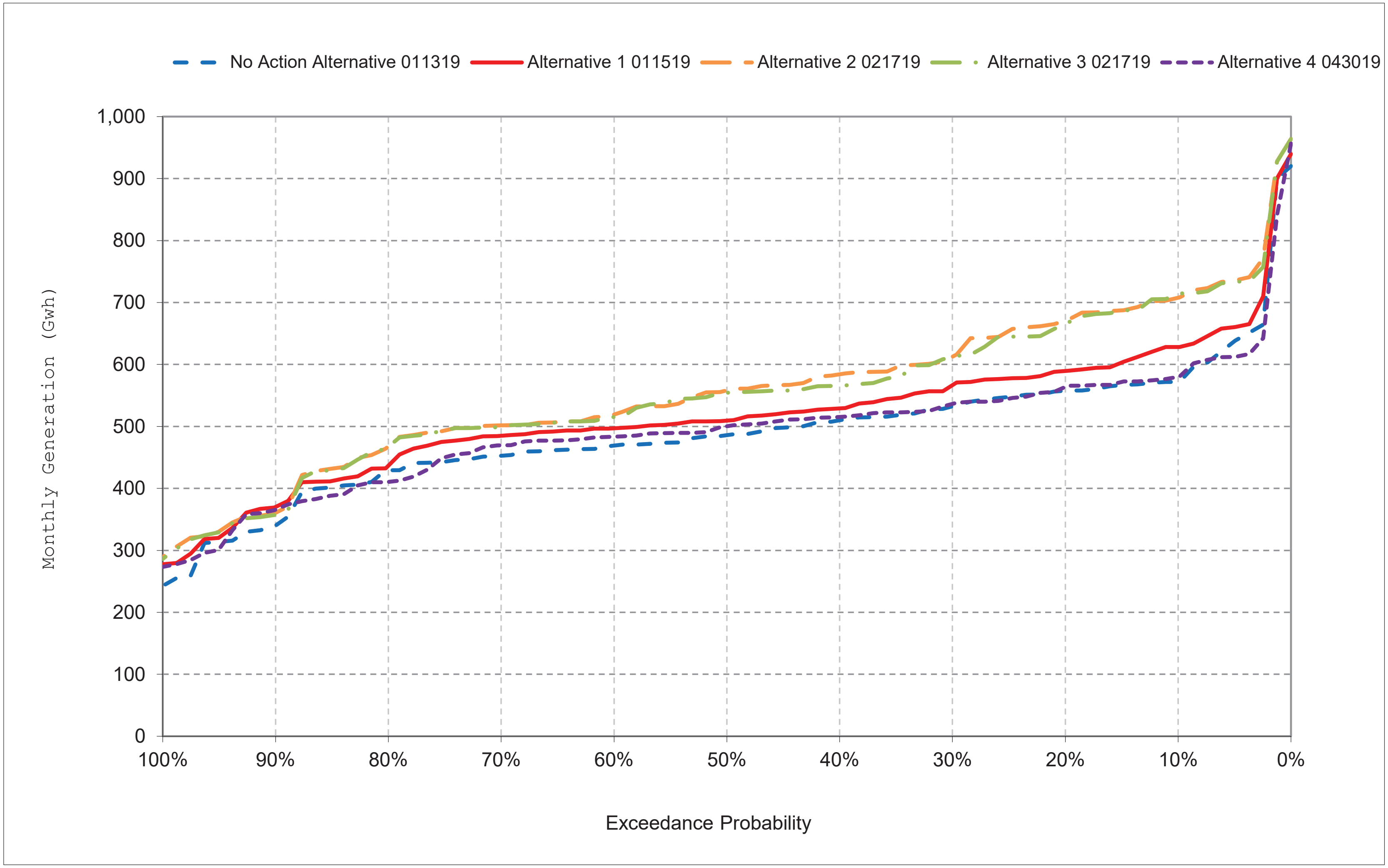
Figure 2-14. CVP Total Generation, May



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

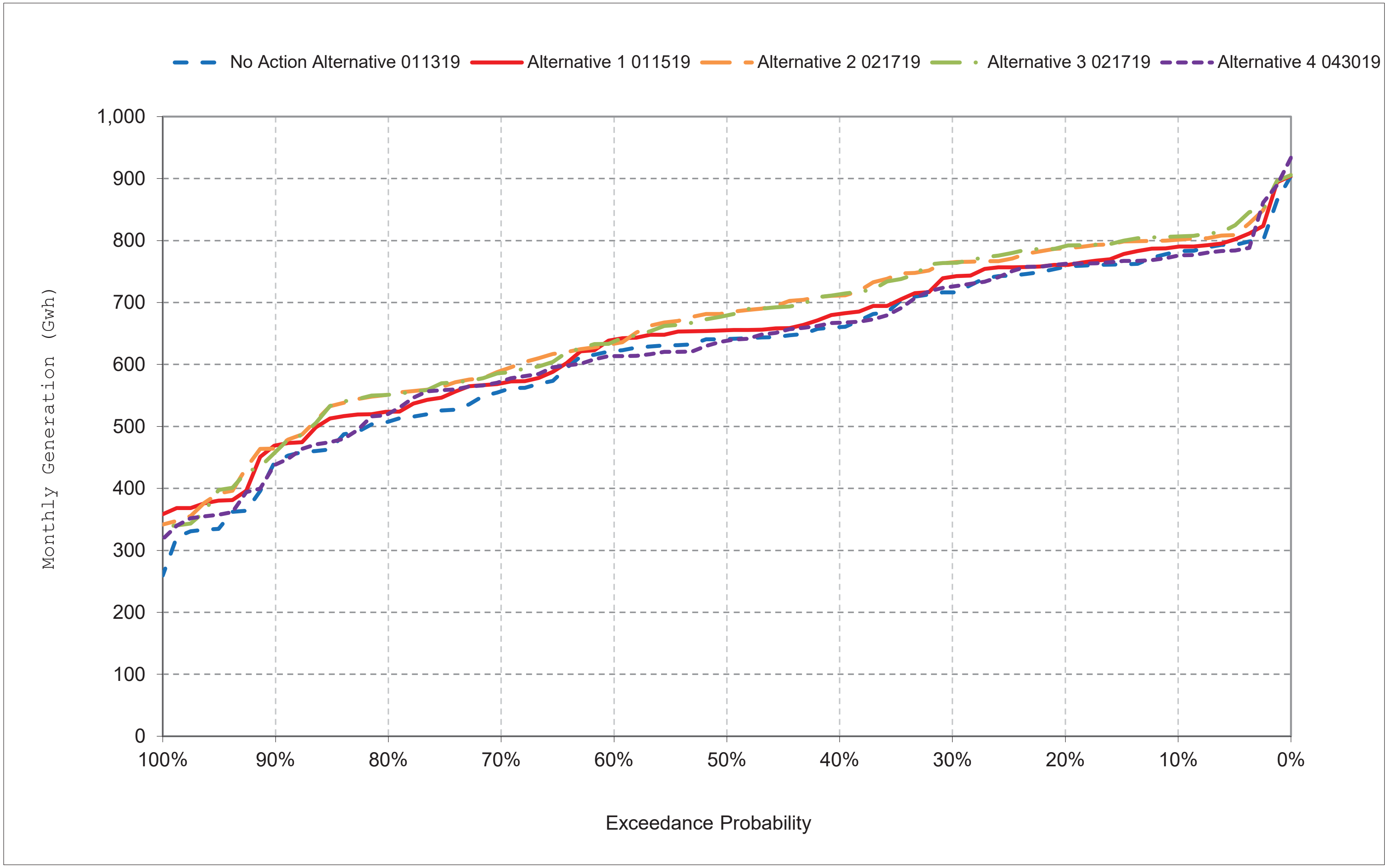
Figure 2-15. CVP Total Generation, June



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

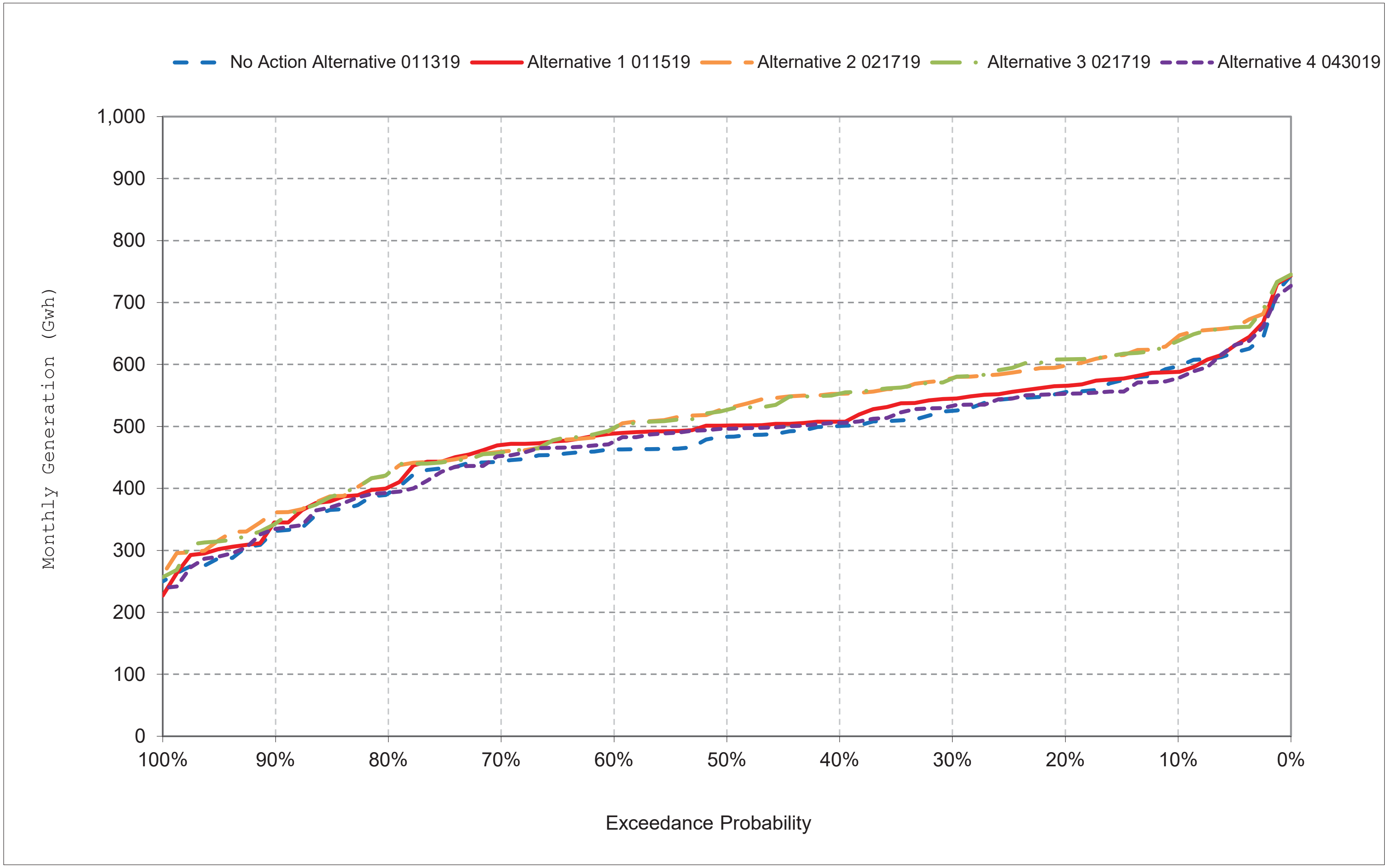
Figure 2-16. CVP Total Generation, July



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

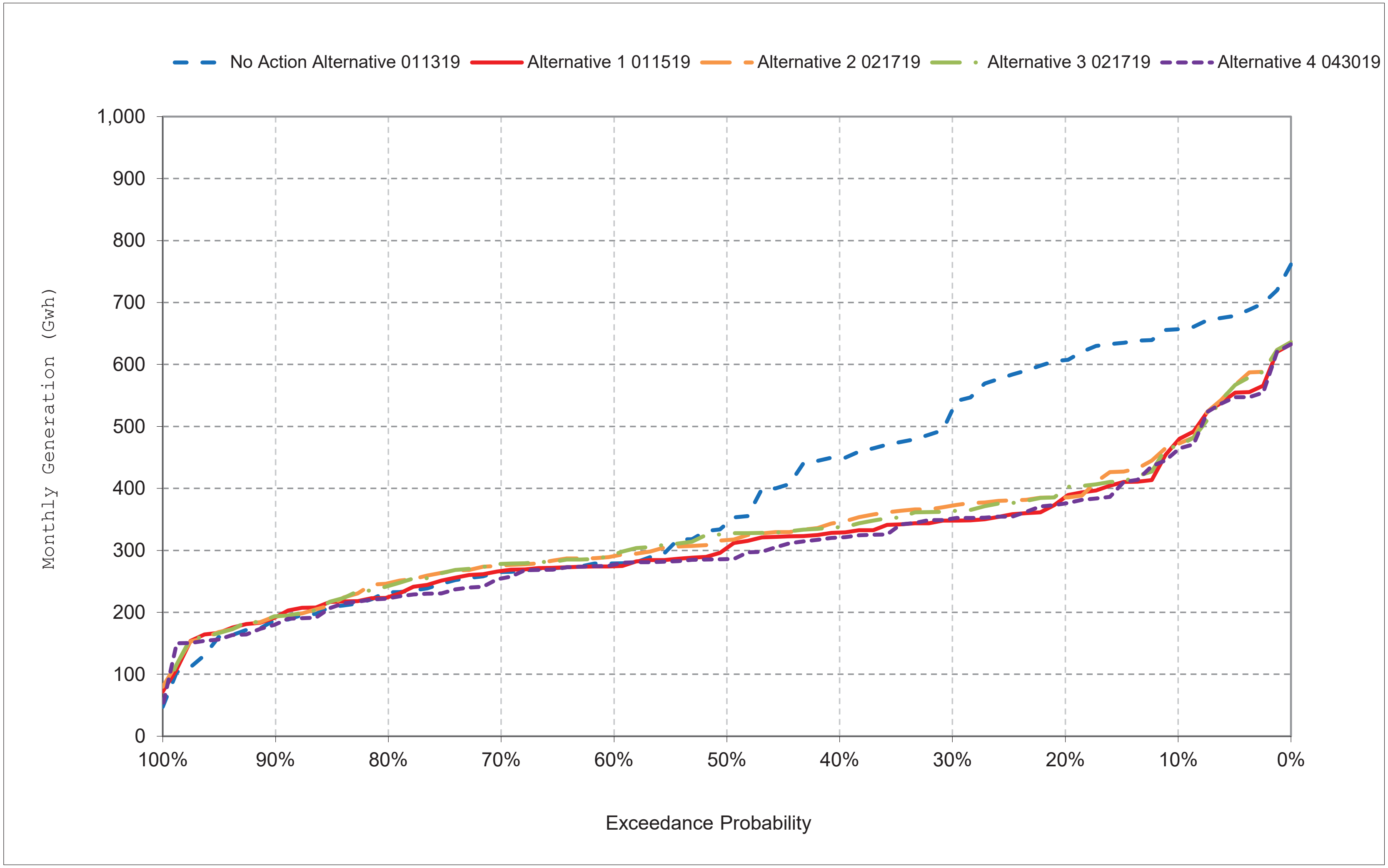
Figure 2-17. CVP Total Generation, August



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 2-18. CVP Total Generation, September



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Table 3-1. CVP Total Energy Use, Monthly Energy Use

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Energy Use (GWh)											
Probability of Exceedance												
10%	117	176	159	165	155	153	71	77	151	172	158	112
20%	106	152	157	160	150	143	50	56	129	161	151	111
30%	87	142	152	145	143	134	44	52	116	153	145	111
40%	83	131	148	140	135	130	42	49	97	139	139	110
50%	80	113	143	137	122	118	41	47	92	130	126	108
60%	75	98	135	133	112	98	39	44	79	117	119	101
70%	68	83	123	123	92	88	36	42	70	109	102	87
80%	62	68	97	109	75	71	33	38	54	87	92	76
90%	55	48	68	91	56	46	27	32	43	66	74	68
Long Term												
Full Simulation Period[a]	82	112	127	132	115	109	44	52	93	125	121	96
Water Year Types[b,c]												
Wet (32%)	94	146	145	145	139	127	57	72	134	155	147	108
Above Normal (16%)	82	141	150	129	129	128	43	50	109	118	135	109
Below Normal (13%)	88	94	117	129	111	113	38	42	79	125	128	104
Dry (24%)	71	89	119	131	99	105	41	44	67	122	104	87
Critical (15%)	67	65	86	113	76	51	26	34	40	70	72	66

Alternative 1 011519

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Energy Use (GWh)											
Probability of Exceedance												
10%	158	151	163	164	152	149	131	122	151	173	159	127
20%	127	142	150	158	147	144	107	119	125	168	158	114
30%	120	134	143	151	138	136	91	101	117	158	155	112
40%	110	126	140	146	132	132	84	94	112	150	149	111
50%	87	115	131	138	127	125	79	84	106	134	136	111
60%	78	88	114	134	122	118	64	74	94	119	128	109
70%	74	73	101	130	116	96	50	64	86	104	107	100
80%	65	61	83	118	109	79	40	55	75	86	96	80
90%	53	43	61	95	82	67	31	47	53	73	77	69
Long Term												
Full Simulation Period[a]	96	103	119	135	125	116	77	85	102	128	130	105
Water Year Types[b,c]												
Wet (32%)	113	139	143	145	130	123	106	115	135	159	157	122
Above Normal (16%)	127	109	117	138	130	124	101	96	111	128	139	111
Below Normal (13%)	90	84	109	140	127	116	67	77	106	134	146	122
Dry (24%)	78	84	118	131	126	122	56	67	83	119	113	90
Critical (15%)	65	65	80	113	108	82	32	43	53	71	73	68

Alternative 1 011519 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Energy Use (GWh)											
Probability of Exceedance												
10%	41	-25	4	-1	-4	-4	60	45	0	1	1	14
20%	21	-10	-7	-1	-3	1	57	63	-4	7	7	3
30%	33	-8	-9	6	-5	2	47	49	1	5	9	1
40%	27	-5	-9	5	-3	2	42	45	15	11	9	1
50%	8	2	-12	1	5	6	38	37	14	4	9	2
60%	3	-11	-21	1	10	19	25	30	15	2	9	8
70%	6	-10	-22	7	23	8	14	22	16	-4	6	13
80%	4	-8	-13	10	34	9	8	17	21	-1	4	4
90%	-2	-5	-7	4	26	22	4	15	10	7	4	1
Long Term												
Full Simulation Period[a]	15	-10	-8	3	11	7	33	33	10	3	9	8
Water Year Types[b,c]												
Wet (32%)	18	-7	-2	0	-9	-4	49	44	1	4	10	14
Above Normal (16%)	45	-32	-33	9	2	-4	58	46	2	10	3	3
Below Normal (13%)	2	-10	-7	11	16	3	29	35	26	9	18	18
Dry (24%)	7	-5	0	0	27	17	16	23	15	-3	9	4
Critical (15%)	-2	1	-6	0	32	31	6	10	13	1	2	2

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 3-2. CVP Total Energy Use, Monthly Energy Use

No Action Alternative 011319

	Monthly Energy Use (GWh)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	117	176	159	165	155	153	71	77	151	172	158	112
20%	106	152	157	160	150	143	50	56	129	161	151	111
30%	87	142	152	145	143	134	44	52	116	153	145	111
40%	83	131	148	140	135	130	42	49	97	139	139	110
50%	80	113	143	137	122	118	41	47	92	130	126	108
60%	75	98	135	133	112	98	39	44	79	117	119	101
70%	68	83	123	123	92	88	36	42	70	109	102	87
80%	62	68	97	109	75	71	33	38	54	87	92	76
90%	55	48	68	91	56	46	27	32	43	66	74	68
Long Term												
Full Simulation Period[a]	82	112	127	132	115	109	44	52	93	125	121	96
Water Year Types[b,c]												
Wet (32%)	94	146	145	145	139	127	57	72	134	155	147	108
Above Normal (16%)	82	141	150	129	129	128	43	50	109	118	135	109
Below Normal (13%)	88	94	117	129	111	113	38	42	79	125	128	104
Dry (24%)	71	89	119	131	99	105	41	44	67	122	104	87
Critical (15%)	67	65	86	113	76	51	26	34	40	70	72	66

Alternative 2 021719

	Monthly Energy Use (GWh)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	162	158	167	171	169	172	102	122	153	212	192	142
20%	142	142	164	168	155	152	97	116	147	172	164	123
30%	125	139	159	164	148	149	91	106	146	170	159	114
40%	108	130	156	162	145	141	85	99	141	165	157	112
50%	84	113	151	161	142	123	81	93	131	156	156	112
60%	76	99	141	159	140	106	69	85	110	138	144	111
70%	71	83	124	143	135	88	53	76	90	120	109	100
80%	57	73	109	114	85	72	39	66	73	99	90	89
90%	50	63	80	77	75	67	29	54	54	78	76	77
Long Term												
Full Simulation Period[a]	98	111	137	146	137	119	73	90	114	146	139	109
Water Year Types[b,c]												
Wet (32%)	126	148	155	160	143	122	94	112	146	164	170	118
Above Normal (16%)	149	105	148	157	164	133	91	104	142	158	158	118
Below Normal (13%)	84	102	125	150	123	117	73	91	120	175	165	133
Dry (24%)	62	101	130	141	135	130	56	70	83	130	104	99
Critical (15%)	55	65	109	110	111	82	39	56	59	92	81	75

Alternative 2 021719 minus No Action Alternative 011319

	Monthly Energy Use (GWh)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	45	**-18**	8	6	14	20	31	45	2	41	34	30
20%	36	**-10**	6	8	5	10	47	60	18	10	14	11
30%	38	**-3**	7	19	5	15	46	55	30	17	14	3
40%	25	**-1**	7	22	10	11	43	50	44	26	18	2
50%	4	0	7	24	20	4	41	46	40	26	29	3
60%	1	1	6	26	28	8	30	41	31	21	25	10
70%	3	1	1	20	43	**-1**	17	34	20	11	7	14
80%	**-5**	5	13	5	10	1	7	28	19	12	**-2**	13
90%	**-6**	14	12	**-13**	19	21	2	21	11	13	3	9
Long Term												
Full Simulation Period[a]	16	**-1**	10	14	23	11	30	38	21	21	18	13
Water Year Types[b,c]												
Wet (32%)	32	3	10	15	4	**-5**	37	40	12	9	24	10
Above Normal (16%)	68	**-36**	**-2**	29	35	5	48	54	33	40	23	10
Below Normal (13%)	**-3**	8	8	22	12	5	35	49	41	51	37	29
Dry (24%)	**-9**	12	11	10	36	26	16	26	16	7	0	13
Critical (15%)	**-13**	0	23	**-2**	36	31	12	22	19	22	10	9

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 3-3. CVP Total Energy Use, Monthly Energy Use

No Action Alternative 011319

Statistic	Monthly Energy Use (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	117	176	159	165	155	153	71	77	151	172	158	112
20%	106	152	157	160	150	143	50	56	129	161	151	111
30%	87	142	152	145	143	134	44	52	116	153	145	111
40%	83	131	148	140	135	130	42	49	97	139	139	110
50%	80	113	143	137	122	118	41	47	92	130	126	108
60%	75	98	135	133	112	98	39	44	79	117	119	101
70%	68	83	123	123	92	88	36	42	70	109	102	87
80%	62	68	97	109	75	71	33	38	54	87	92	76
90%	55	48	68	91	56	46	27	32	43	66	74	68
Long Term												
Full Simulation Period[a]	82	112	127	132	115	109	44	52	93	125	121	96
Water Year Types[b,c]												
Wet (32%)	94	146	145	145	139	127	57	72	134	155	147	108
Above Normal (16%)	82	141	150	129	129	128	43	50	109	118	135	109
Below Normal (13%)	88	94	117	129	111	113	38	42	79	125	128	104
Dry (24%)	71	89	119	131	99	105	41	44	67	122	104	87
Critical (15%)	67	65	86	113	76	51	26	34	40	70	72	66

Alternative 3 021719

Statistic	Monthly Energy Use (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	149	158	169	173	197	171	102	121	153	180	194	149
20%	128	144	163	168	156	152	93	116	147	172	171	121
30%	123	141	160	164	150	148	91	107	146	169	159	113
40%	114	132	156	163	145	138	85	97	140	165	157	112
50%	91	120	150	161	142	119	80	93	129	157	155	112
60%	78	97	141	158	139	94	68	81	105	148	143	111
70%	66	82	133	146	132	86	53	76	88	119	108	102
80%	58	72	114	118	86	72	41	63	73	100	91	87
90%	47	59	86	79	74	67	29	53	54	79	73	76
Long Term												
Full Simulation Period[a]	97	112	139	146	139	117	72	89	113	144	139	109
Water Year Types[b,c]												
Wet (32%)	126	147	157	154	145	127	89	110	144	168	174	115
Above Normal (16%)	136	118	147	161	180	121	93	104	142	151	160	121
Below Normal (13%)	88	101	128	155	115	119	74	91	119	168	161	136
Dry (24%)	65	99	134	142	134	123	55	70	84	129	103	101
Critical (15%)	52	61	109	112	111	83	38	54	58	86	80	74

Alternative 3 021719 minus No Action Alternative 011319

Statistic	Monthly Energy Use (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	32	-18	10	7	42	18	31	44	2	8	36	37
20%	22	-8	5	8	6	9	43	60	18	11	20	10
30%	36	-1	8	19	7	14	46	56	30	17	14	2
40%	31	1	8	23	10	8	43	48	43	25	18	2
50%	11	7	7	24	20	1	40	46	37	28	29	3
60%	3	-2	6	25	27	-5	29	36	27	31	24	10
70%	-2	-1	10	23	39	-3	17	34	18	10	7	16
80%	-4	3	18	9	11	2	8	25	19	13	-1	11
90%	-9	11	19	-12	18	21	1	21	11	14	-1	8
Long Term												
Full Simulation Period[a]	15	0	12	14	24	8	28	37	20	19	18	13
Water Year Types[b,c]												
Wet (32%)	32	1	12	9	6	-1	32	38	10	12	27	7
Above Normal (16%)	54	-23	-3	32	52	-7	50	55	33	33	24	13
Below Normal (13%)	0	7	11	27	4	6	36	48	39	43	33	32
Dry (24%)	-7	10	15	11	35	18	15	26	16	7	0	14
Critical (15%)	-15	-4	23	0	36	32	12	21	18	16	9	7

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 3-4. CVP Total Energy Use, Monthly Energy Use

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Energy Use (GWh)											
Probability of Exceedance												
10%	117	176	159	165	155	153	71	77	151	172	158	112
20%	106	152	157	160	150	143	50	56	129	161	151	111
30%	87	142	152	145	143	134	44	52	116	153	145	111
40%	83	131	148	140	135	130	42	49	97	139	139	110
50%	80	113	143	137	122	118	41	47	92	130	126	108
60%	75	98	135	133	112	98	39	44	79	117	119	101
70%	68	83	123	123	92	88	36	42	70	109	102	87
80%	62	68	97	109	75	71	33	38	54	87	92	76
90%	55	48	68	91	56	46	27	32	43	66	74	68
Long Term												
Full Simulation Period[a]	82	112	127	132	115	109	44	52	93	125	121	96
Water Year Types[b,c]												
Wet (32%)	94	146	145	145	139	127	57	72	134	155	147	108
Above Normal (16%)	82	141	150	129	129	128	43	50	109	118	135	109
Below Normal (13%)	88	94	117	129	111	113	38	42	79	125	128	104
Dry (24%)	71	89	119	131	99	105	41	44	67	122	104	87
Critical (15%)	67	65	86	113	76	51	26	34	40	70	72	66

Alternative 4 043019

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Energy Use (GWh)											
Probability of Exceedance												
10%	150	145	159	164	152	92	80	115	146	168	156	111
20%	135	137	154	160	146	67	73	69	121	155	152	109
30%	120	129	145	149	133	55	58	55	110	139	132	107
40%	92	122	139	144	128	40	49	49	101	123	121	105
50%	83	102	131	139	122	33	41	42	90	111	115	104
60%	72	87	114	133	113	30	32	36	83	103	102	96
70%	68	72	101	126	107	28	26	31	76	93	89	78
80%	60	62	84	118	78	26	23	27	67	81	82	72
90%	51	43	51	91	33	23	16	20	30	38	51	65
Long Term												
Full Simulation Period[a]	94	98	119	134	115	49	46	51	91	111	111	96
Water Year Types[b,c]												
Wet (32%)	121	129	140	145	131	78	73	82	129	151	146	118
Above Normal (16%)	126	104	121	147	107	51	53	53	103	112	123	106
Below Normal (13%)	72	85	116	141	124	35	37	38	84	109	114	96
Dry (24%)	68	84	119	121	112	35	30	35	76	106	94	82
Critical (15%)	66	62	73	112	86	23	18	20	30	37	50	59

Alternative 4 043019 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Energy Use (GWh)											
Probability of Exceedance												
10%	33	-32	0	-1	-3	-61	9	38	-5	-4	-2	-1
20%	29	-16	-3	0	-4	-76	22	13	-9	-6	2	-3
30%	33	-13	-6	5	-10	-79	13	4	-6	-14	-13	-4
40%	9	-10	-9	4	-8	-90	7	0	4	-17	-18	-5
50%	3	-11	-12	2	0	-86	1	-5	-1	-19	-11	-4
60%	-3	-11	-21	0	1	-68	-6	-9	4	-14	-17	-5
70%	1	-11	-22	2	14	-60	-10	-11	6	-16	-13	-9
80%	-1	-6	-13	9	3	-45	-10	-11	13	-7	-10	-4
90%	-4	-5	-16	1	-23	-23	-11	-12	-13	-28	-23	-3
Long Term												
Full Simulation Period[a]	12	-14	-8	2	0	-60	2	-1	-1	-13	-10	-1
Water Year Types[b,c]												
Wet (32%)	27	-17	-5	0	-8	-50	16	10	-5	-4	-1	10
Above Normal (16%)	44	-37	-29	19	-21	-77	10	3	-7	-6	-13	-3
Below Normal (13%)	-16	-9	0	12	13	-77	-1	-4	5	-16	-15	-8
Dry (24%)	-3	-4	1	-10	13	-70	-11	-9	9	-17	-10	-5
Critical (15%)	-1	-3	-13	0	10	-28	-9	-13	-10	-33	-21	-7

a Based on the 82-year simulation period.

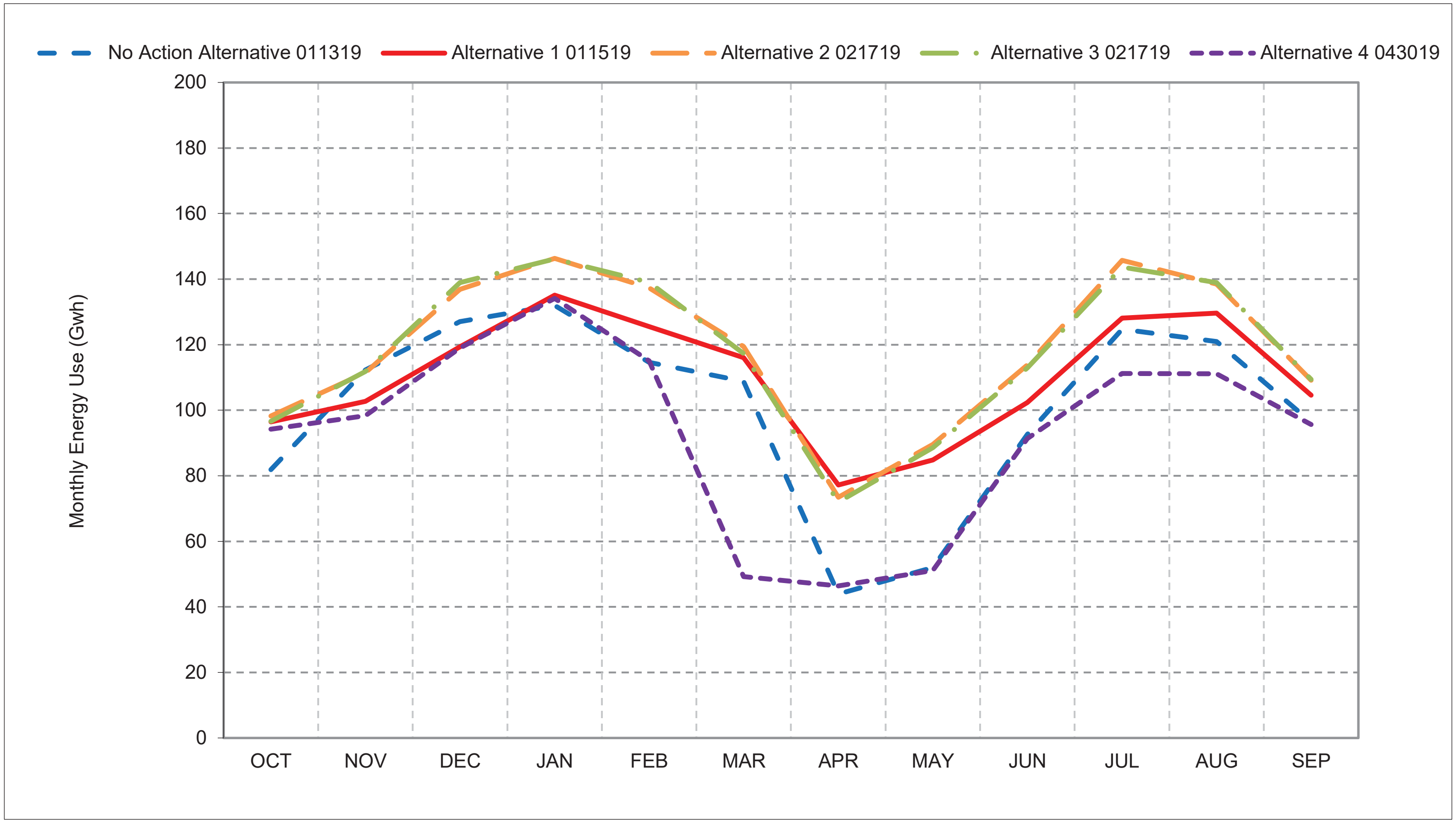
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

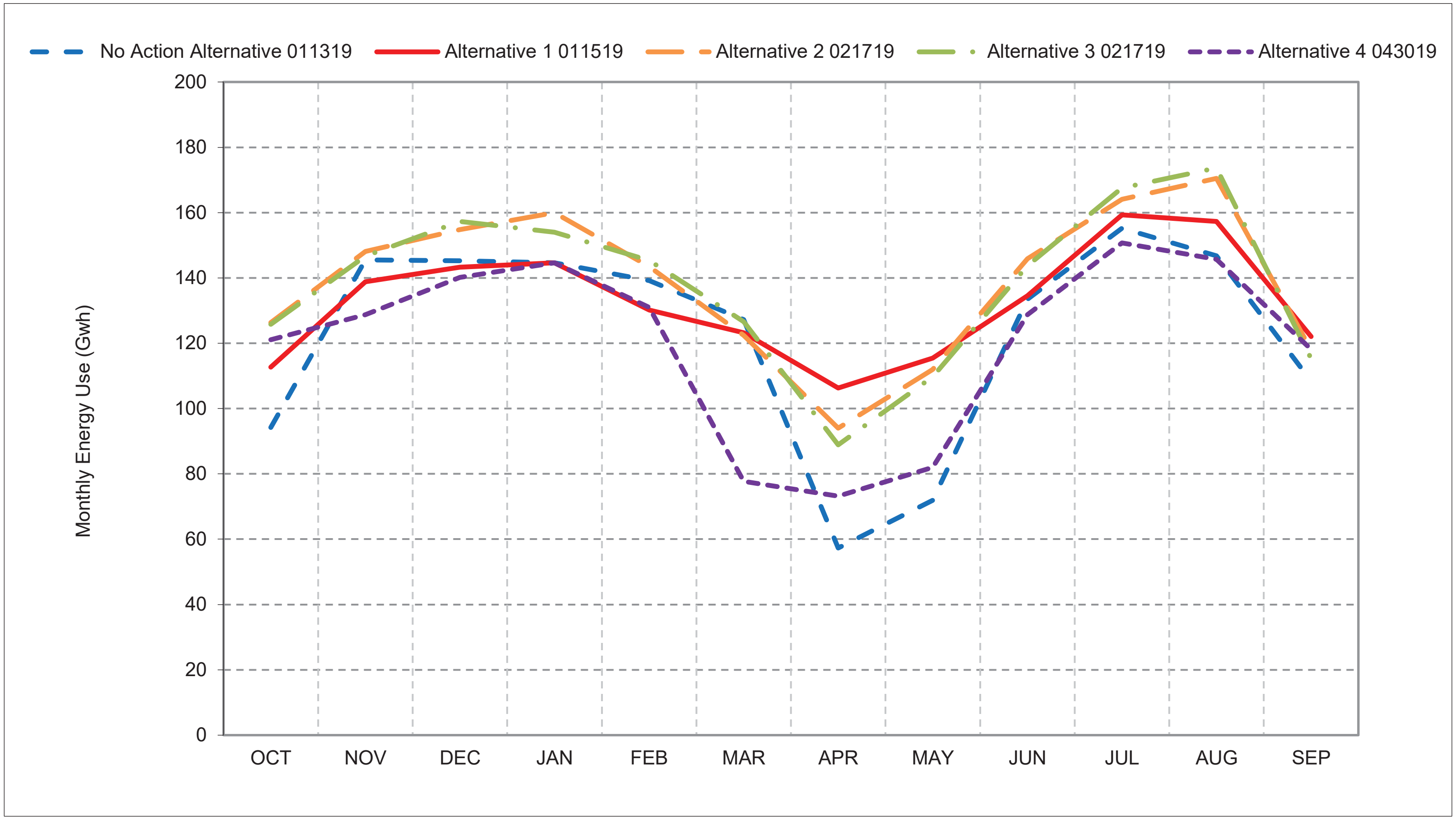
e These are draft results meant for qualitative analysis and are subject to revision.

Figure 3-1. CVP Total Energy Use, Long-Term Average Energy Use



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 3-2. CVP Total Energy Use, Wet Year Average Energy Use



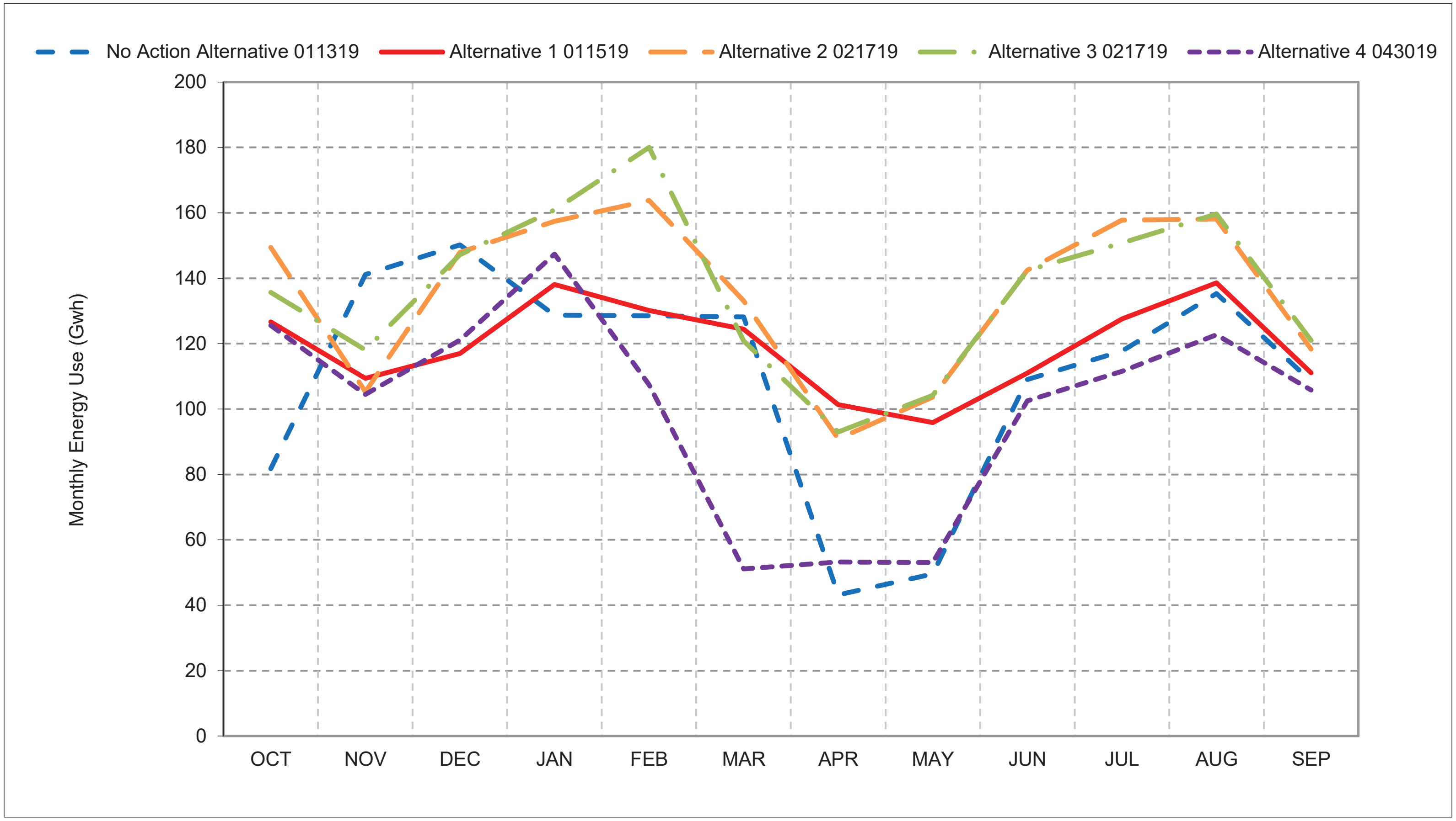
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

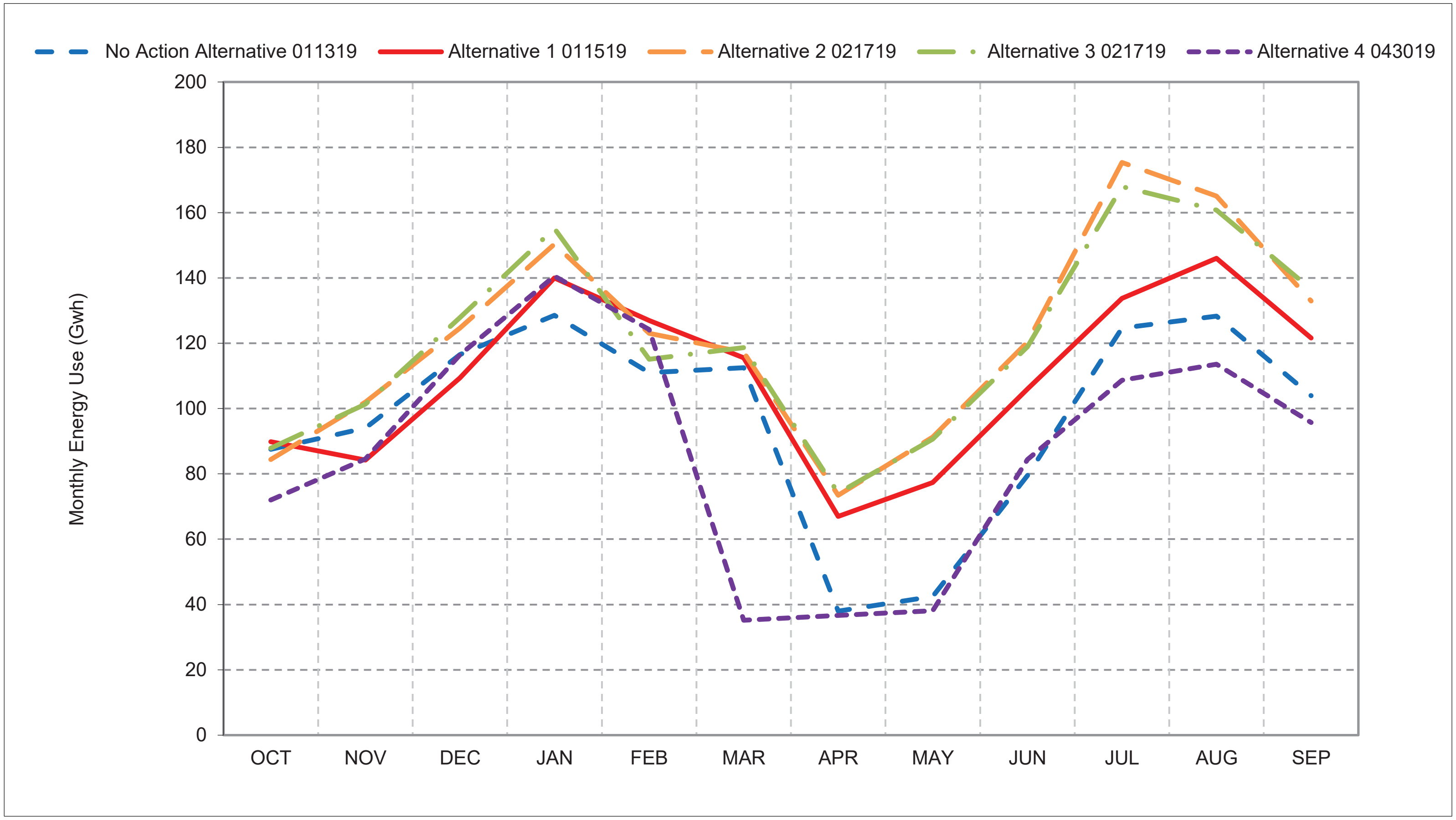
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 3-3. CVP Total Energy Use, Above Normal Year Average Energy Use



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 3-4. CVP Total Energy Use, Below Normal Year Average Energy Use



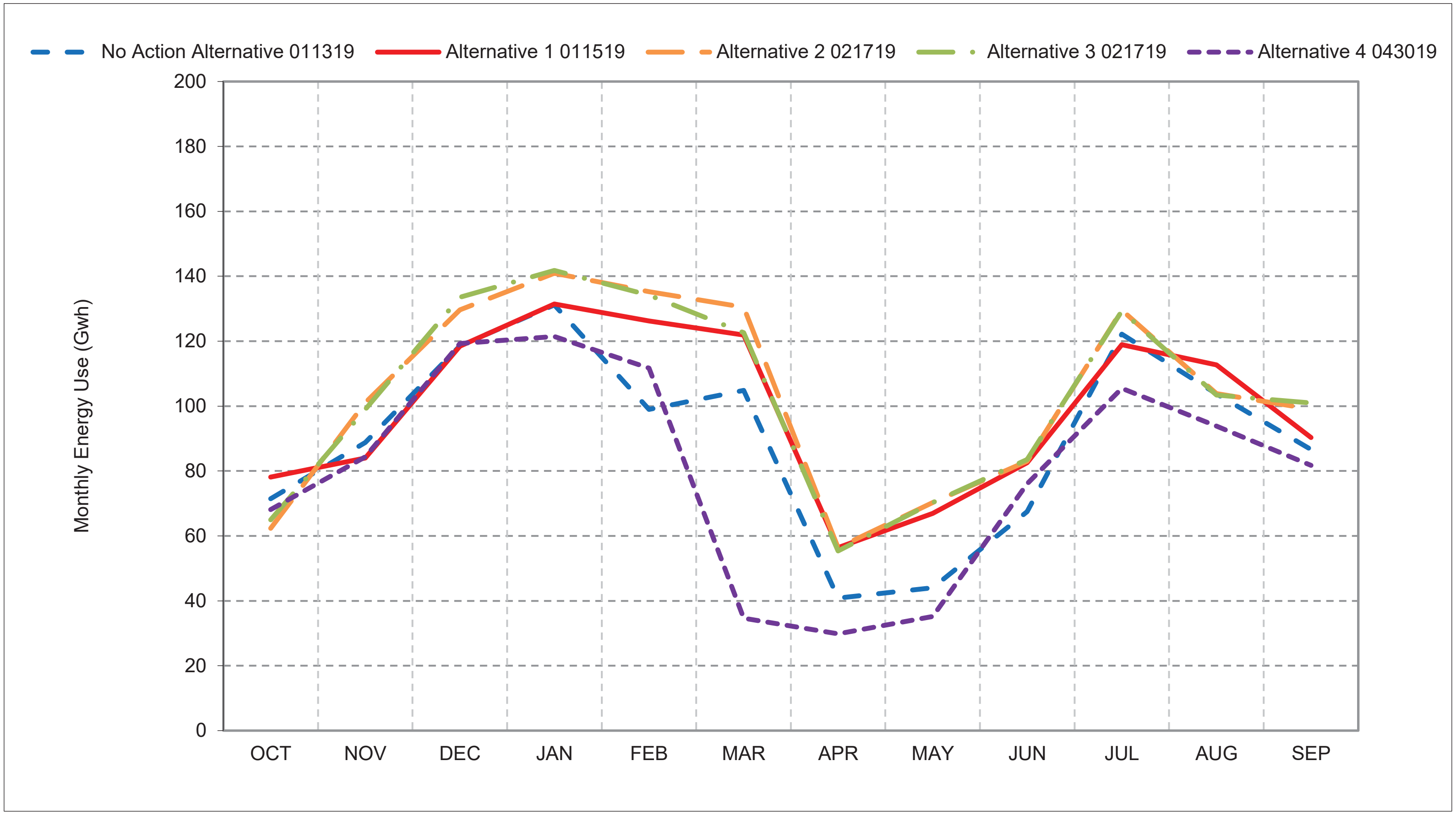
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 3-5. CVP Total Energy Use, Dry Year Average Energy Use



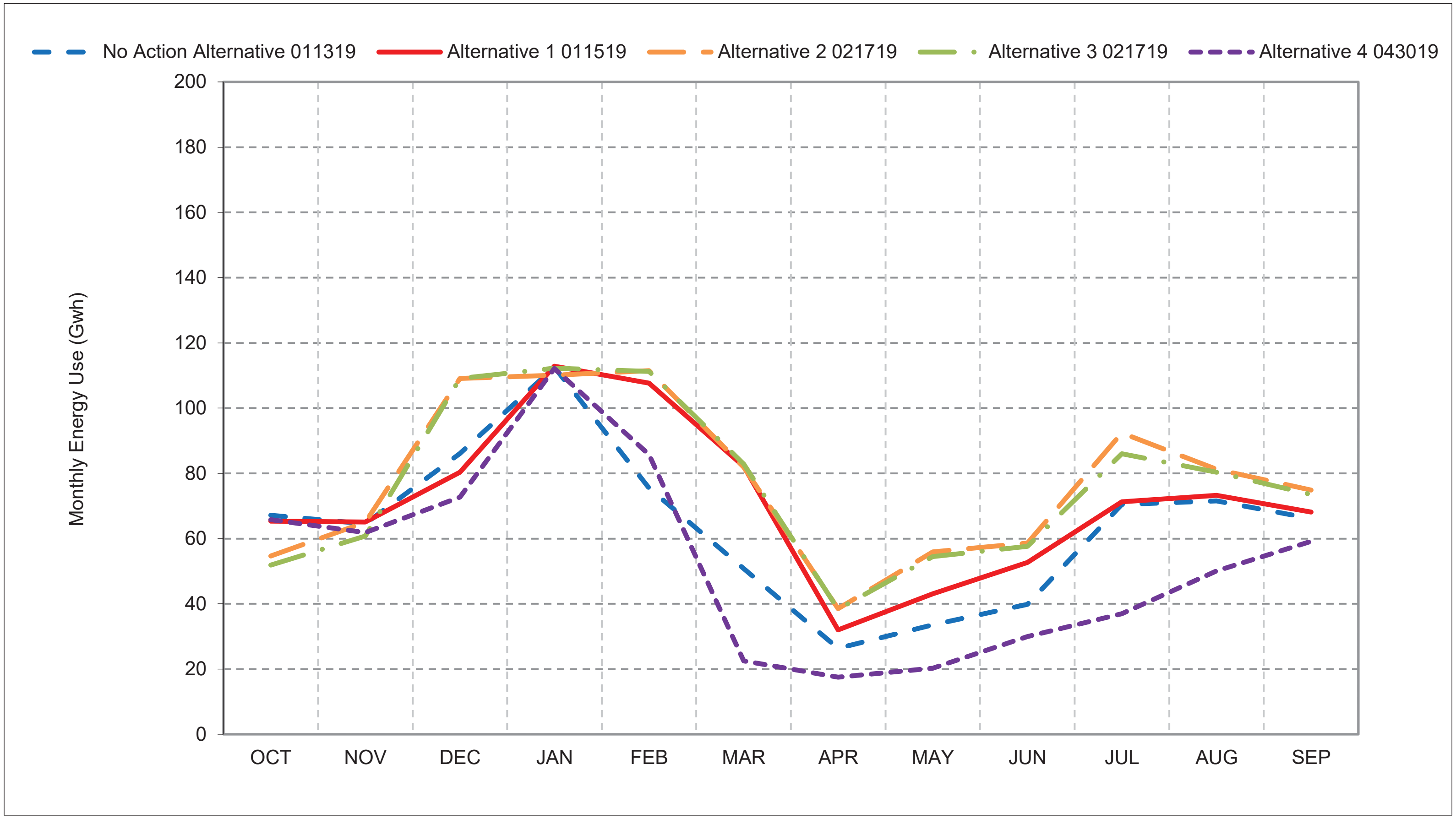
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

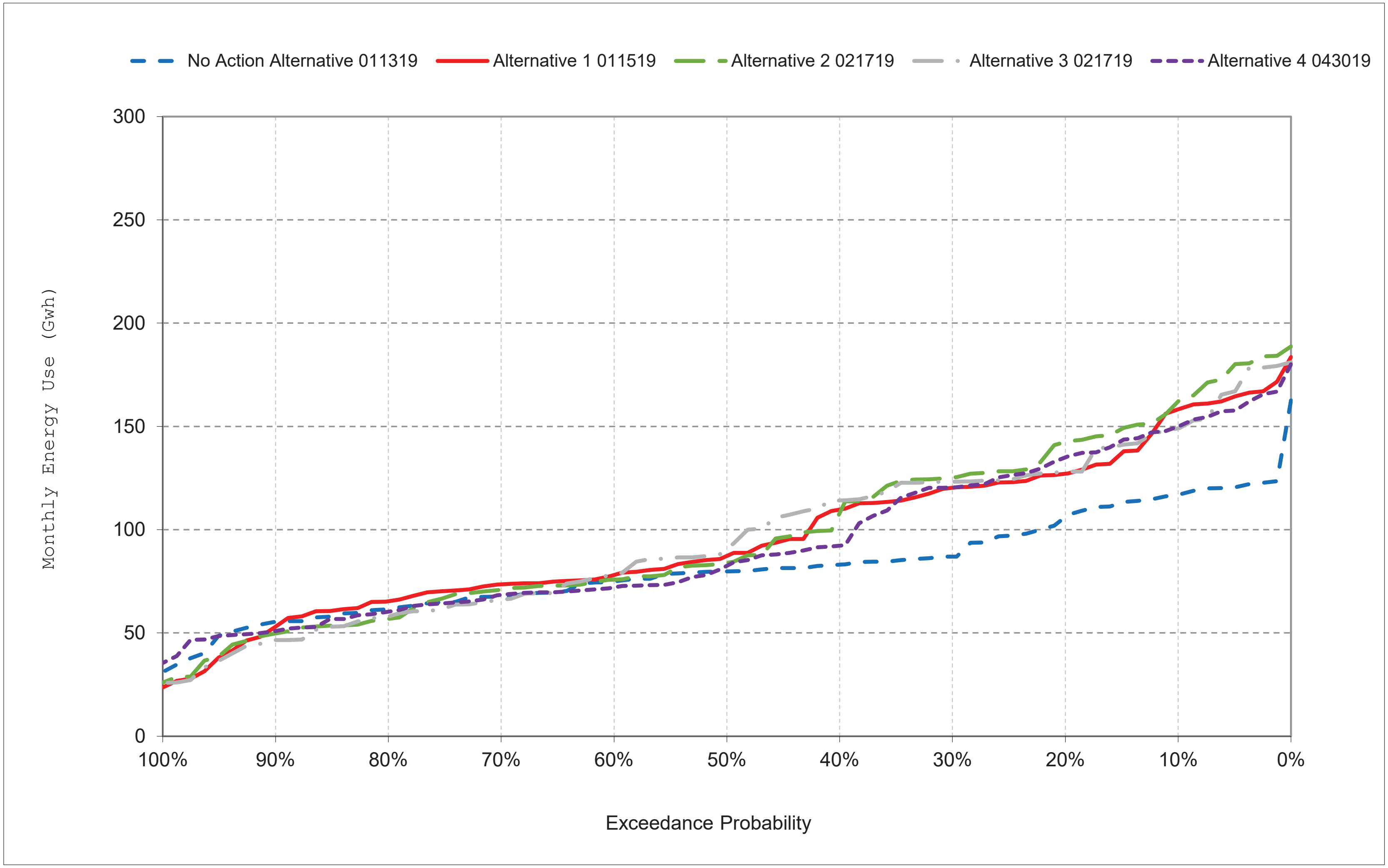
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 3-6. CVP Total Energy Use, Critical Year Average Energy Use



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

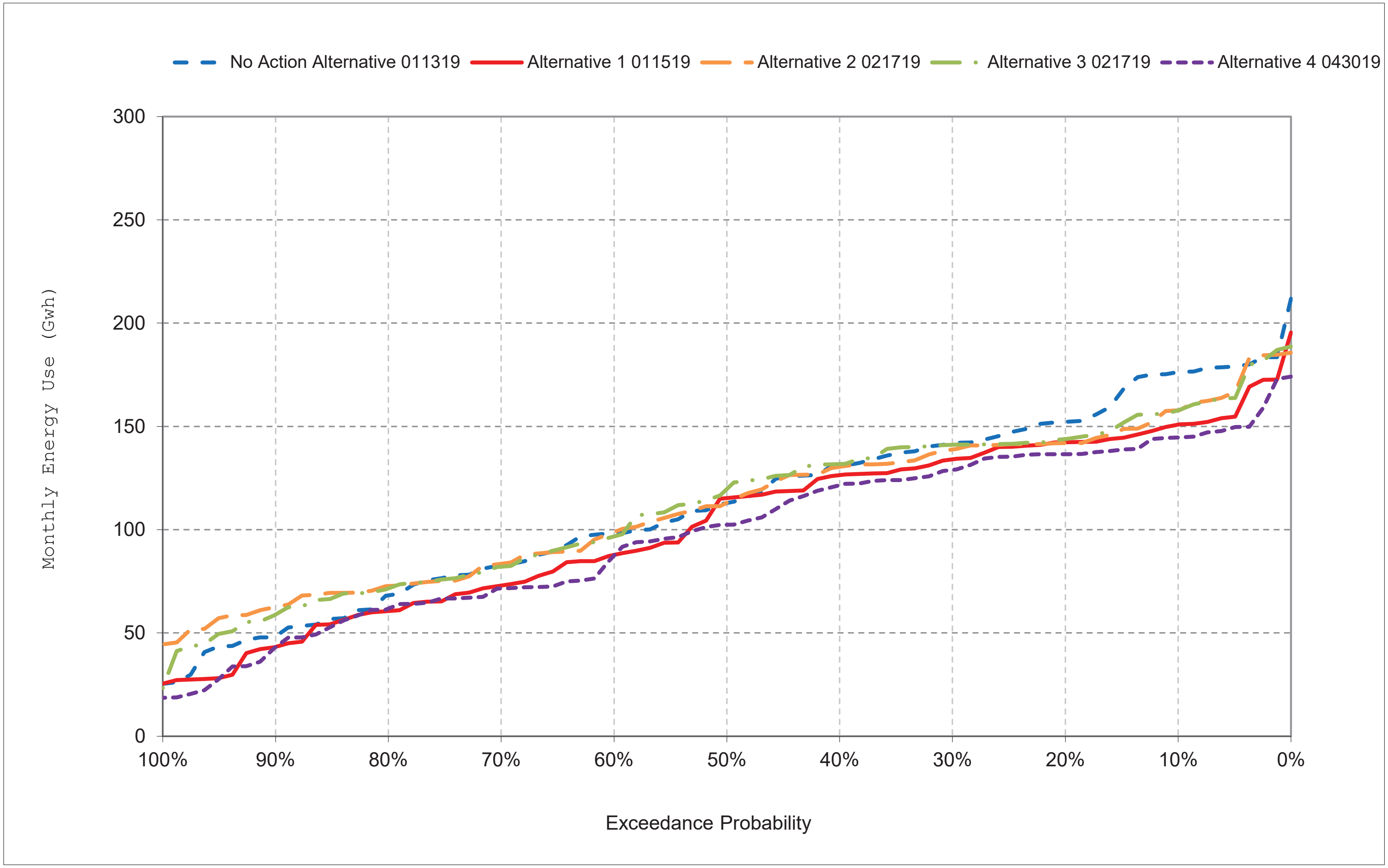
Figure 3-7. CVP Total Energy Use, October



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

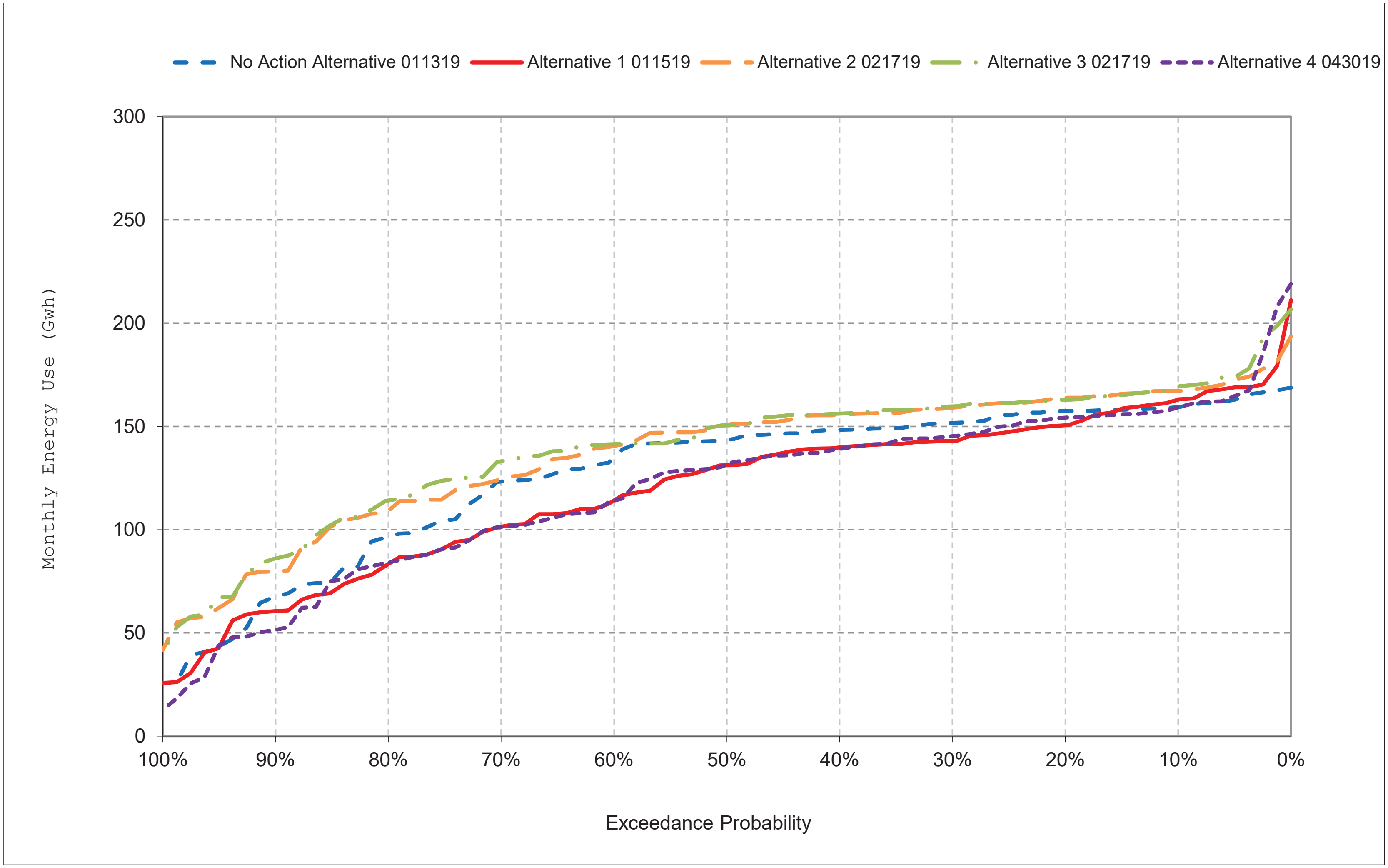
Figure 3-8. CVP Total Energy Use, November



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

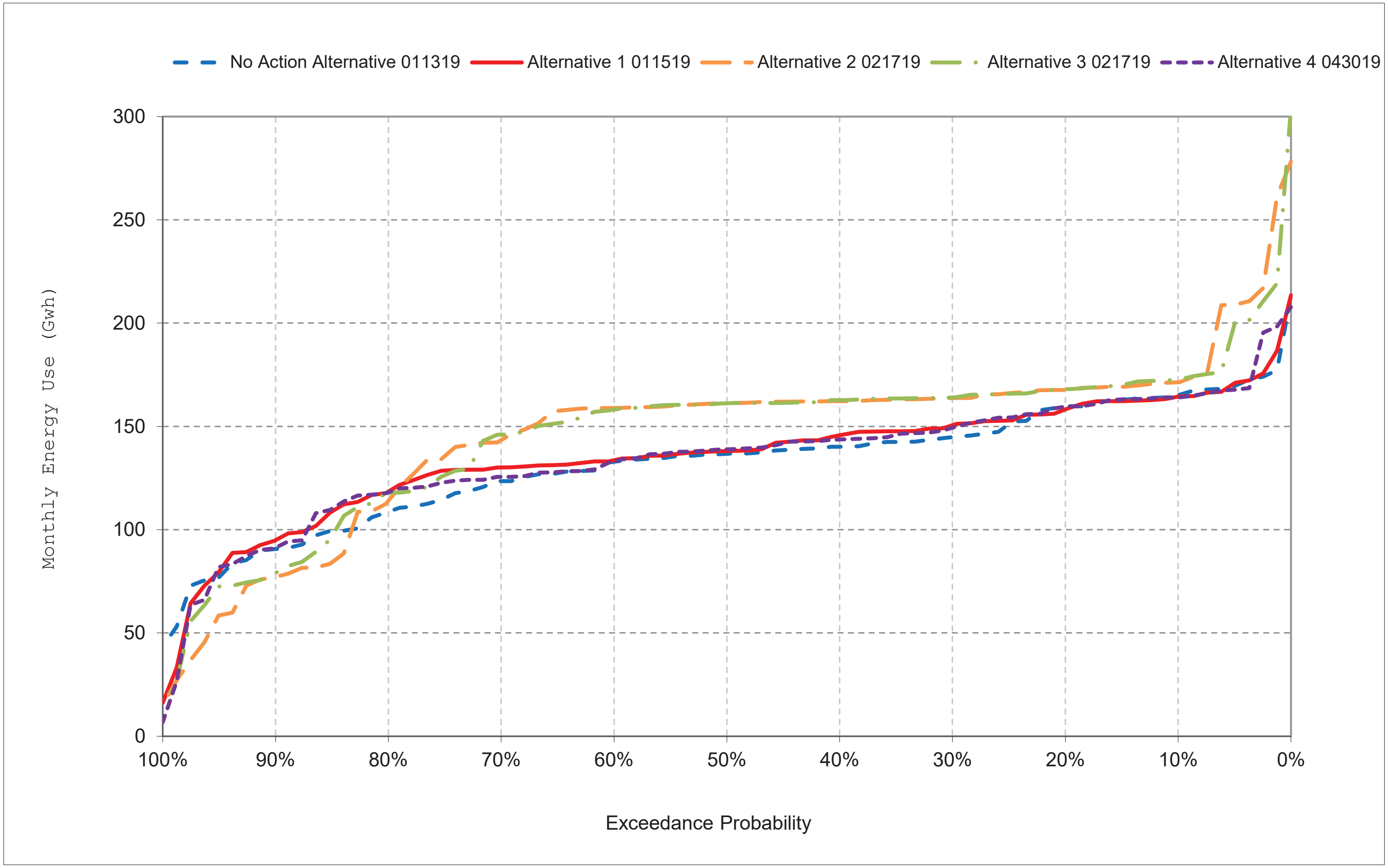
Figure 3-9. CVP Total Energy Use, December



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

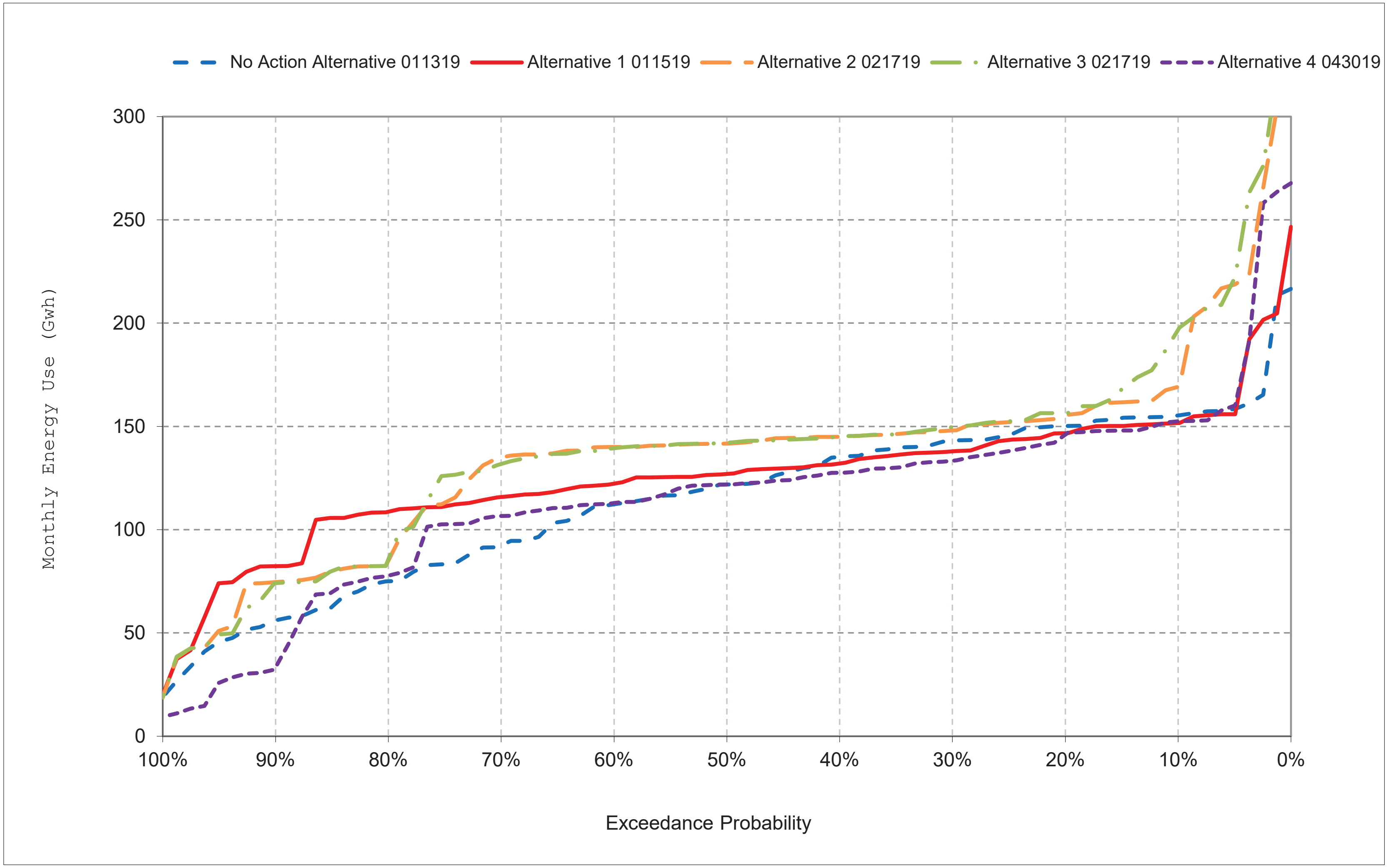
Figure 3-10. CVP Total Energy Use, January



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

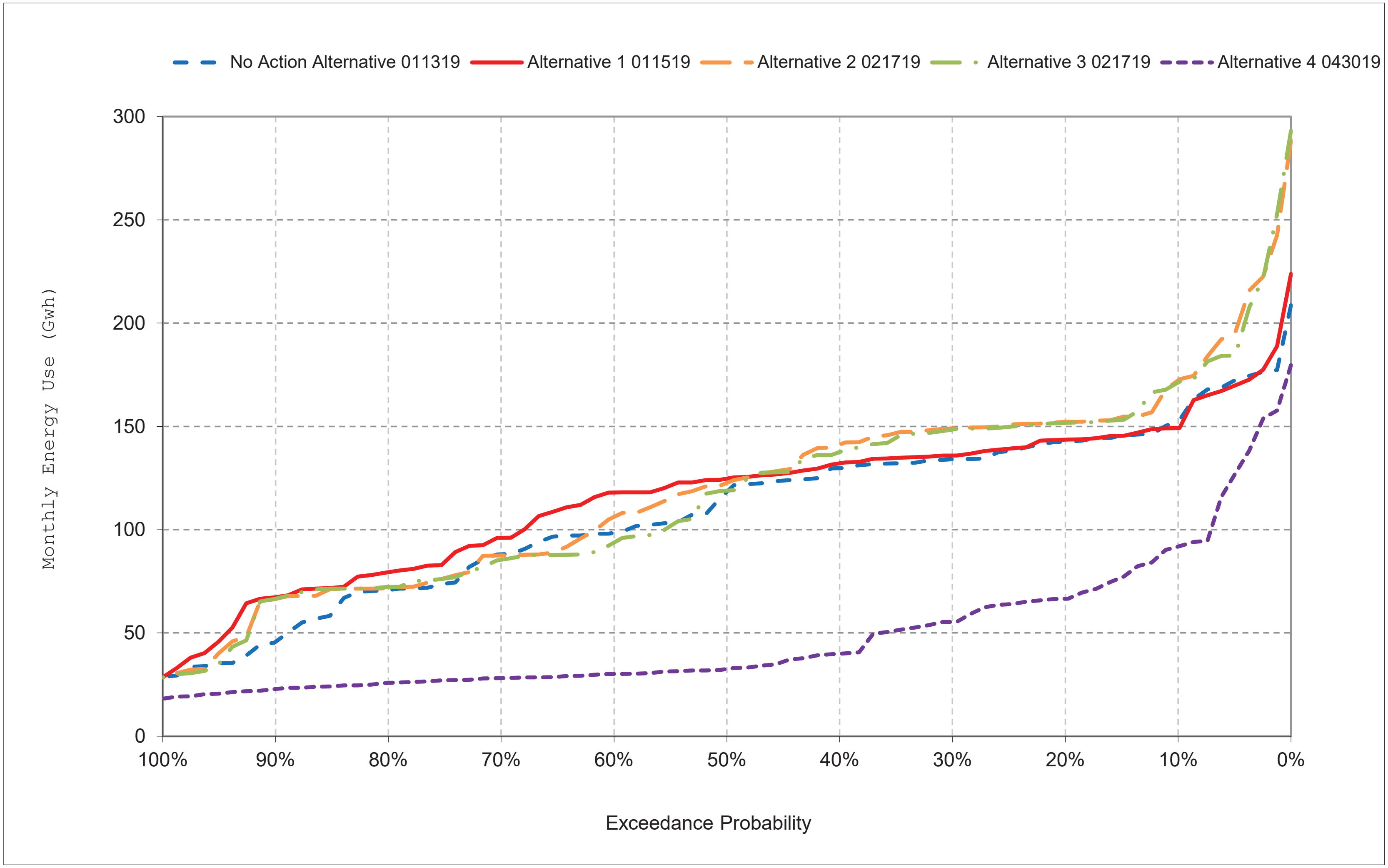
Figure 3-11. CVP Total Energy Use, February



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

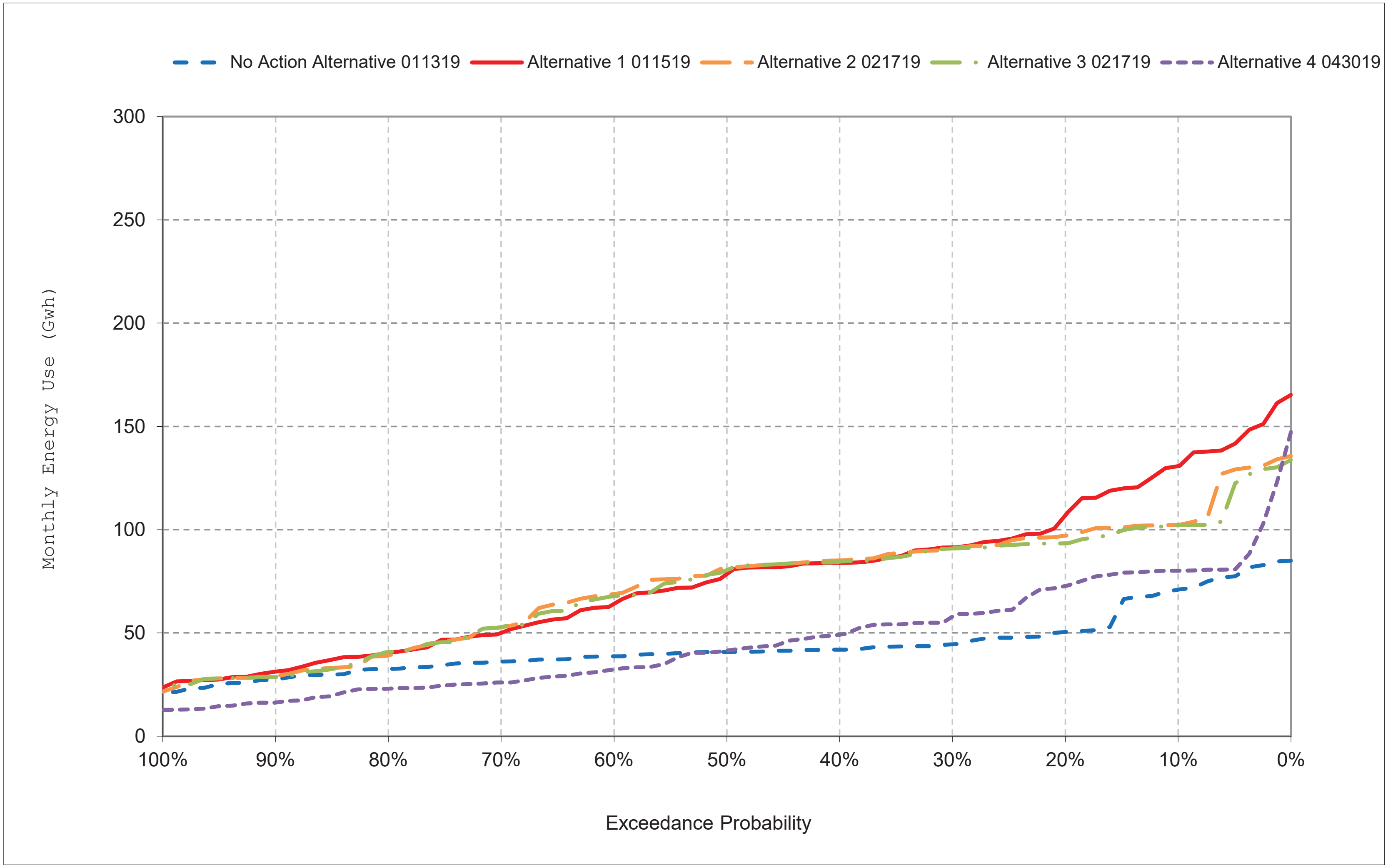
Figure 3-12. CVP Total Energy Use, March



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

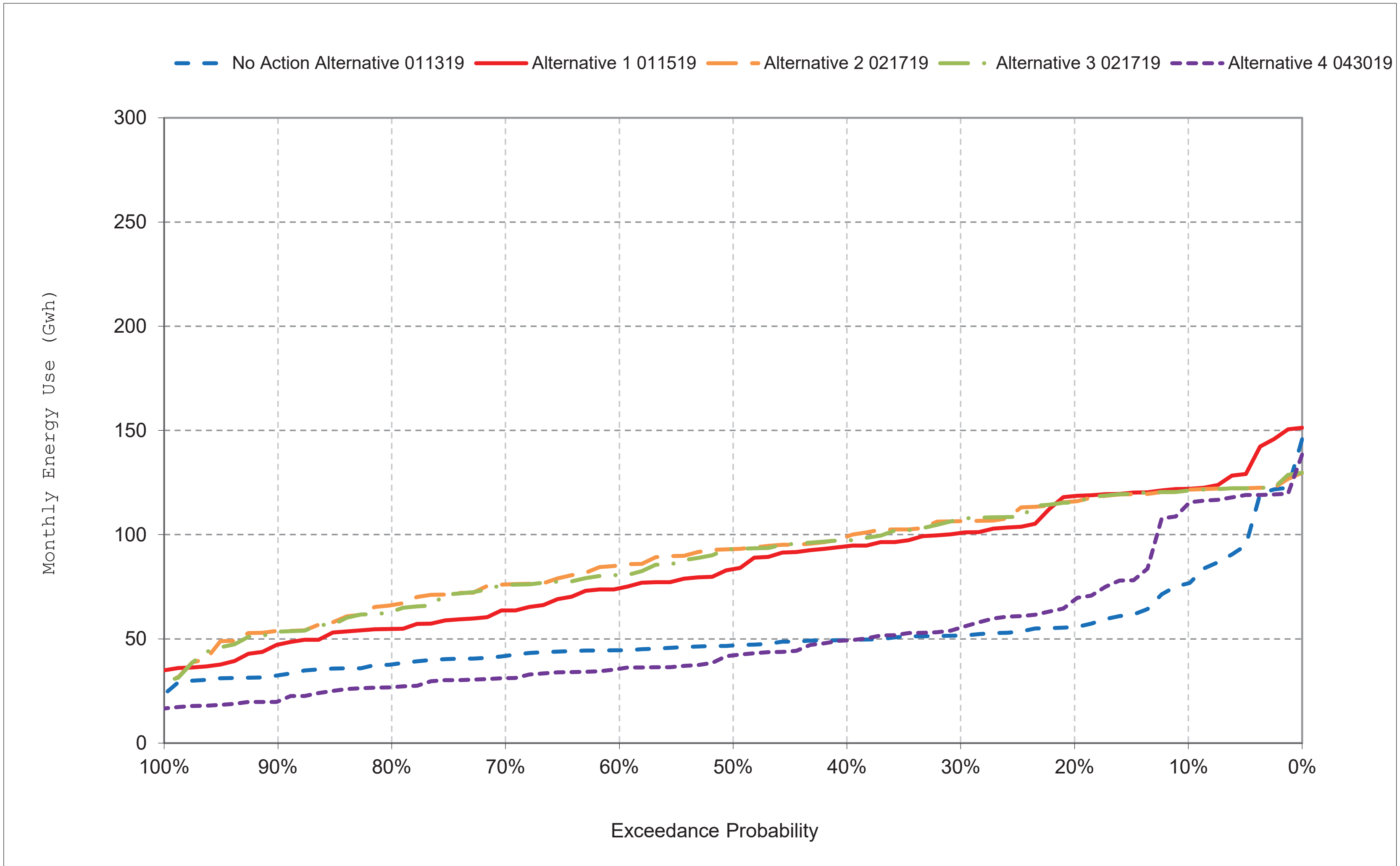
Figure 3-13. CVP Total Energy Use, April



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

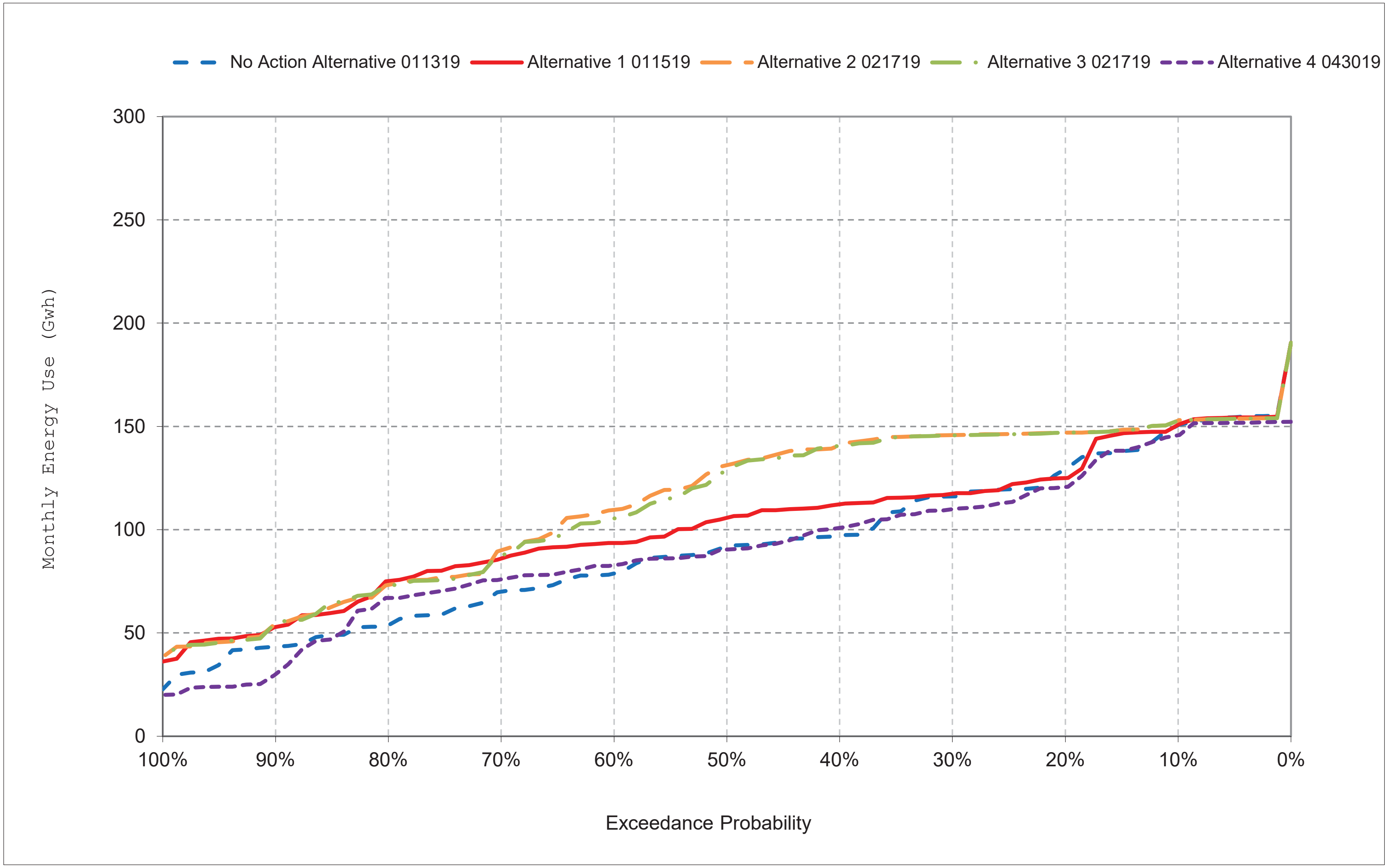
Figure 3-14. CVP Total Energy Use, May



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

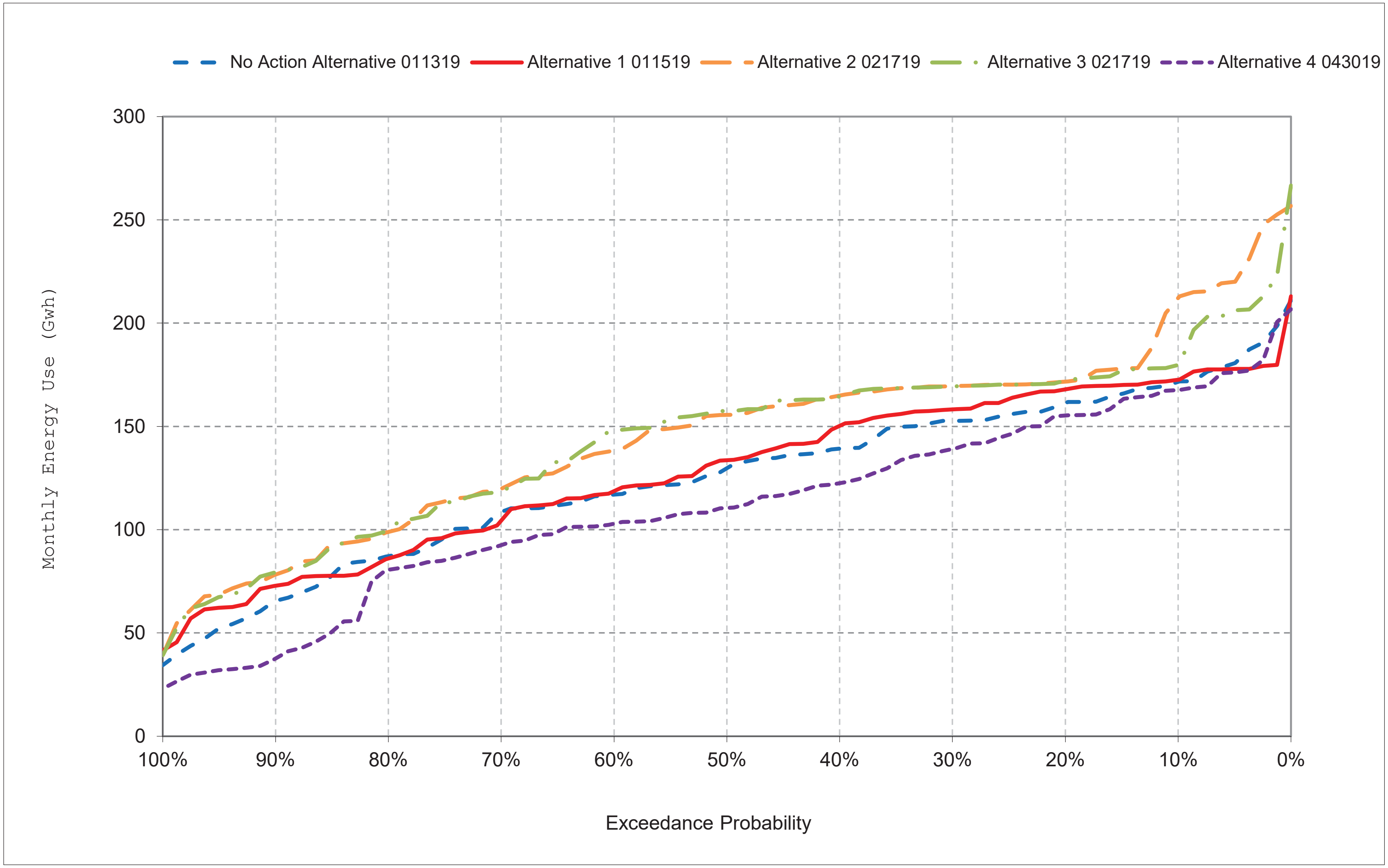
Figure 3-15. CVP Total Energy Use, June



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

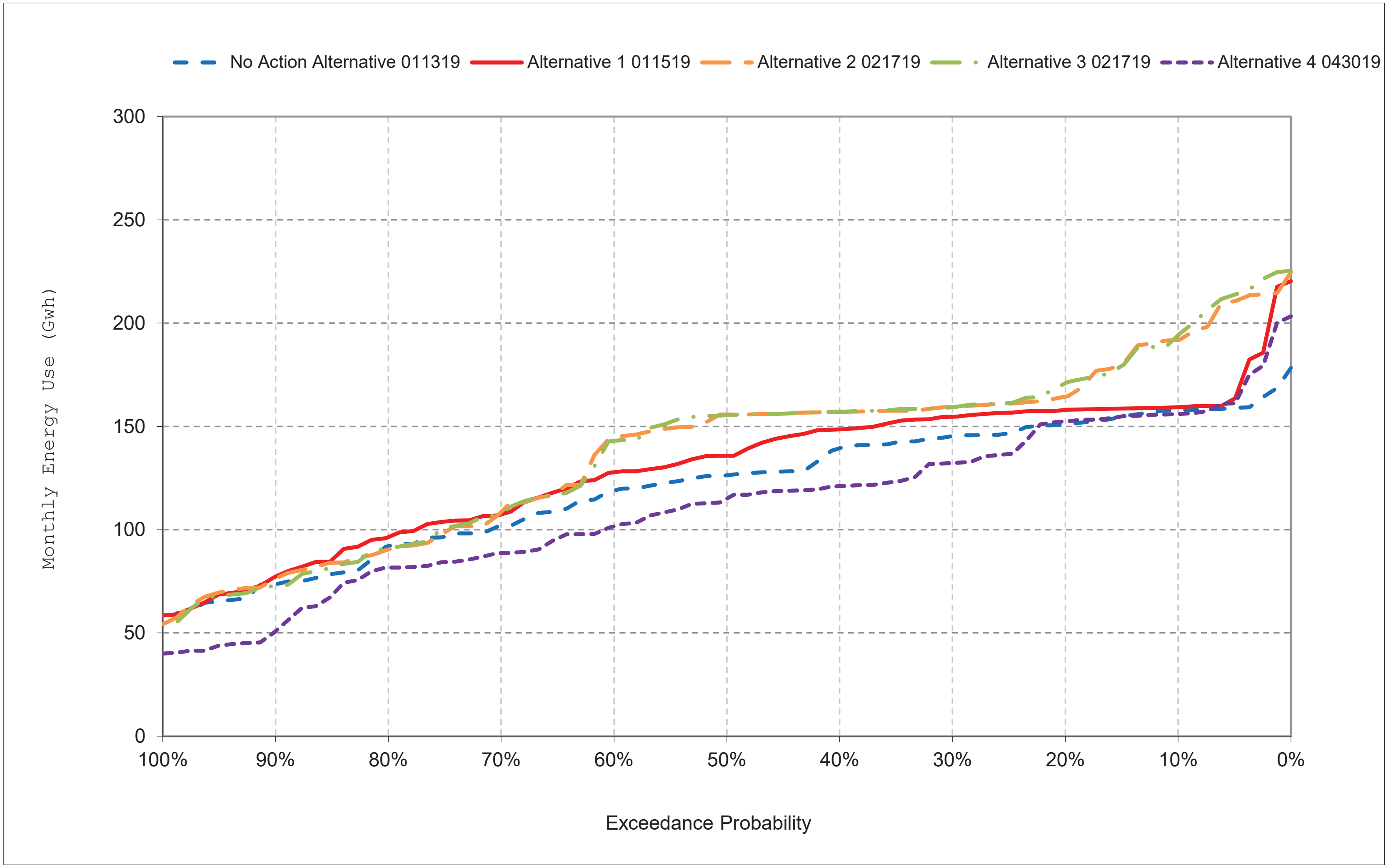
Figure 3-16. CVP Total Energy Use, July



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

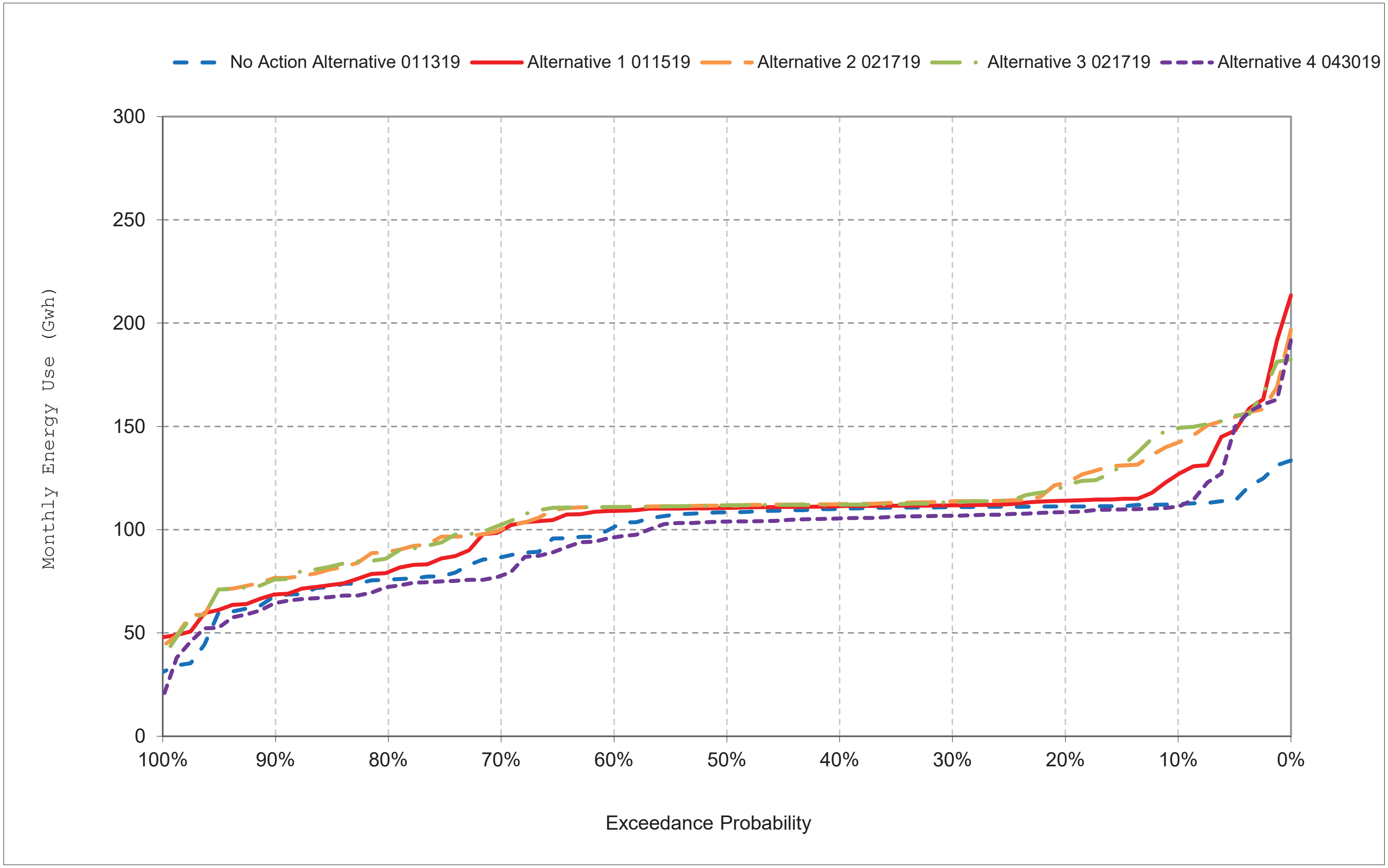
Figure 3-17. CVP Total Energy Use, August



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 3-18. CVP Total Energy Use, September



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Table 4-1. CVP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	324	294	501	553	535	552	442	584	504	654	449	545
20%	289	227	210	424	474	416	287	511	453	617	416	498
30%	248	192	94	221	348	301	257	482	420	584	394	416
40%	225	163	66	100	153	151	239	440	408	541	372	350
50%	207	140	55	61	73	116	229	421	391	500	354	249
60%	178	105	34	48	57	88	215	407	367	472	338	184
70%	144	79	17	18	43	70	201	380	350	420	323	170
80%	113	59	1	6	27	52	175	311	335	391	305	148
90%	92	36	-6	-15	7	34	155	256	295	331	245	97
Long Term												
Full Simulation Period[a]	205	154	131	181	201	220	264	422	397	498	355	299
Water Year Types[b,c]												
Wet (32%)	293	245	178	422	363	427	374	523	403	523	400	514
Above Normal (16%)	247	210	105	183	315	257	287	453	409	610	390	349
Below Normal (13%)	168	100	125	39	146	84	223	434	443	549	390	202
Dry (24%)	156	102	164	37	45	81	189	366	421	471	327	164
Critical (15%)	82	32	12	24	37	87	166	251	290	319	232	94

Alternative 1 011519

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	312	209	510	551	568	582	399	524	509	656	447	362
20%	293	137	326	466	498	495	257	481	478	627	420	247
30%	207	122	130	329	356	271	225	440	448	603	395	232
40%	177	104	87	137	150	153	191	418	427	550	376	214
50%	160	94	70	84	74	125	178	385	405	504	362	197
60%	140	82	58	45	49	104	167	358	386	483	349	184
70%	127	64	45	9	25	70	153	331	366	456	334	170
80%	109	61	27	1	8	48	146	300	352	404	304	143
90%	92	36	12	-8	-6	27	138	256	316	349	254	108
Long Term												
Full Simulation Period[a]	184	115	163	201	208	231	225	390	415	513	361	212
Water Year Types[b,c]												
Wet (32%)	266	143	228	447	390	435	309	460	424	530	403	302
Above Normal (16%)	184	130	175	229	343	294	217	402	439	612	396	215
Below Normal (13%)	165	111	132	76	178	122	196	414	467	560	396	187
Dry (24%)	150	112	173	37	20	77	168	355	423	491	334	165
Critical (15%)	83	48	19	28	8	75	175	258	308	360	242	113

Alternative 1 011519 minus No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-12	-84	9	-2	34	30	-43	-61	6	2	-2	-183
20%	4	-90	116	43	24	79	-31	-30	25	10	3	-251
30%	-41	-70	37	108	8	-30	-32	-41	28	19	0	-184
40%	-48	-59	21	37	-3	3	-48	-22	20	10	3	-136
50%	-46	-47	15	23	1	9	-50	-36	15	4	8	-52
60%	-38	-23	23	-3	-8	16	-49	-49	19	11	11	0
70%	-17	-15	27	-9	-19	0	-49	-49	16	36	11	-1
80%	-5	2	26	-5	-18	-4	-29	-10	17	13	-1	-5
90%	0	0	18	7	-13	-7	-16	0	20	18	10	10
Long Term												
Full Simulation Period[a]	-21	-38	31	21	7	11	-39	-32	18	15	6	-87
Water Year Types[b,c]												
Wet (32%)	-28	-102	51	24	27	8	-65	-63	22	7	3	-212
Above Normal (16%)	-63	-80	70	46	28	37	-69	-52	30	3	6	-134
Below Normal (13%)	-3	11	7	37	32	38	-27	-19	24	12	7	-14
Dry (24%)	-6	11	9	0	-25	-4	-20	-11	2	20	7	1
Critical (15%)	1	17	7	4	-29	-12	8	7	18	41	10	20

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 4-2. CVP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	324	294	501	553	535	552	442	584	504	654	449	545
20%	289	227	210	424	474	416	287	511	453	617	416	498
30%	248	192	94	221	348	301	257	482	420	584	394	416
40%	225	163	66	100	153	151	239	440	408	541	372	350
50%	207	140	55	61	73	116	229	421	391	500	354	249
60%	178	105	34	48	57	88	215	407	367	472	338	184
70%	144	79	17	18	43	70	201	380	350	420	323	170
80%	113	59	1	6	27	52	175	311	335	391	305	148
90%	92	36	-6	-15	7	34	155	256	295	331	245	97
Long Term												
Full Simulation Period[a]	205	154	131	181	201	220	264	422	397	498	355	299
Water Year Types[b,c]												
Wet (32%)	293	245	178	422	363	427	374	523	403	523	400	514
Above Normal (16%)	247	210	105	183	315	257	287	453	409	610	390	349
Below Normal (13%)	168	100	125	39	146	84	223	434	443	549	390	202
Dry (24%)	156	102	164	37	45	81	189	366	421	471	327	164
Critical (15%)	82	32	12	24	37	87	166	251	290	319	232	94

Alternative 2 021719

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	300	156	500	530	615	563	394	528	582	635	466	338
20%	276	125	246	416	488	439	273	489	540	616	440	273
30%	207	101	88	326	299	271	242	449	500	583	418	251
40%	173	92	69	146	139	157	199	427	457	562	385	218
50%	165	84	45	61	74	120	190	398	433	529	367	201
60%	154	72	28	30	41	91	167	370	416	493	352	189
70%	130	65	11	5	16	52	151	334	371	462	338	174
80%	119	47	-1	-13	-9	32	133	310	353	418	318	147
90%	95	25	-16	-27	-25	13	109	259	312	366	277	101
Long Term												
Full Simulation Period[a]	180	100	133	185	200	217	226	395	445	514	374	219
Water Year Types[b,c]												
Wet (32%)	242	132	214	424	396	430	317	466	448	539	417	306
Above Normal (16%)	173	116	108	196	325	268	208	398	494	608	414	217
Below Normal (13%)	180	91	96	67	167	117	184	424	508	552	409	223
Dry (24%)	161	94	148	26	2	48	168	370	450	498	340	173
Critical (15%)	83	35	-8	31	2	75	180	255	317	350	261	108

Alternative 2 021719 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	-24	-137	-1	-22	81	11	-48	-56	78	-19	17	-208
20%	-12	-102	36	-7	14	23	-15	-22	87	-1	23	-225
30%	-40	-91	-5	105	-48	-30	-15	-32	79	-1	24	-165
40%	-52	-71	2	46	-14	7	-40	-13	50	21	13	-132
50%	-42	-56	-10	1	1	3	-39	-23	43	29	13	-48
60%	-23	-33	-7	-18	-16	3	-48	-37	49	21	13	5
70%	-14	-14	-6	-13	-27	-18	-50	-46	21	43	14	4
80%	5	-12	-2	-19	-35	-20	-42	-1	19	27	13	-2
90%	3	-12	-11	-12	-32	-21	-46	3	17	35	32	3
Long Term												
Full Simulation Period[a]	-25	-53	1	5	-1	-3	-39	-27	48	16	19	-80
Water Year Types[b,c]												
Wet (32%)	-51	-113	36	2	34	2	-57	-57	46	16	17	-208
Above Normal (16%)	-74	-94	3	12	10	11	-79	-56	85	-1	23	-132
Below Normal (13%)	12	-9	-29	27	21	33	-39	-10	65	3	19	21
Dry (24%)	5	-7	-16	-11	-43	-33	-20	4	29	27	13	9
Critical (15%)	1	3	-19	7	-36	-12	13	3	28	32	29	14

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision.

Table 4-3. CVP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	324	294	501	553	535	552	442	584	504	654	449	545
20%	289	227	210	424	474	416	287	511	453	617	416	498
30%	248	192	94	221	348	301	257	482	420	584	394	416
40%	225	163	66	100	153	151	239	440	408	541	372	350
50%	207	140	55	61	73	116	229	421	391	500	354	249
60%	178	105	34	48	57	88	215	407	367	472	338	184
70%	144	79	17	18	43	70	201	380	350	420	323	170
80%	113	59	1	6	27	52	175	311	335	391	305	148
90%	92	36	-6	-15	7	34	155	256	295	331	245	97
Long Term												
Full Simulation Period[a]	205	154	131	181	201	220	264	422	397	498	355	299
Water Year Types[b,c]												
Wet (32%)	293	245	178	422	363	427	374	523	403	523	400	514
Above Normal (16%)	247	210	105	183	315	257	287	453	409	610	390	349
Below Normal (13%)	168	100	125	39	146	84	223	434	443	549	390	202
Dry (24%)	156	102	164	37	45	81	189	366	421	471	327	164
Critical (15%)	82	32	12	24	37	87	166	251	290	319	232	94

Alternative 3 021719

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	315	159	500	526	593	562	395	526	583	652	466	328
20%	282	127	256	410	473	437	282	485	540	622	441	268
30%	228	96	101	296	297	272	235	442	488	593	411	251
40%	201	94	69	144	144	147	202	419	445	565	387	218
50%	173	83	45	53	78	119	193	395	426	529	366	206
60%	156	71	32	26	46	93	171	369	415	488	351	191
70%	146	59	10	4	17	61	153	332	369	460	337	174
80%	123	45	-4	-13	-8	29	131	306	351	416	314	145
90%	95	23	-19	-26	-25	15	109	260	311	358	271	106
Long Term												
Full Simulation Period[a]	191	101	136	184	197	218	227	394	441	515	373	218
Water Year Types[b,c]												
Wet (32%)	250	135	219	427	394	424	321	460	448	537	418	302
Above Normal (16%)	172	117	122	188	307	280	205	399	484	619	408	217
Below Normal (13%)	204	93	97	61	174	116	186	425	504	558	408	220
Dry (24%)	179	89	145	22	3	54	170	371	448	498	339	174
Critical (15%)	89	38	-9	39	-3	73	181	256	311	347	258	108

Alternative 3 021719 minus No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	**-9**	**-135**	**-1**	**-27**	58	10	**-47**	**-58**	79	**-2**	17	**-218**
20%	**-7**	**-100**	46	**-14**	**-1**	21	**-6**	**-26**	87	5	25	**-230**
30%	**-20**	**-95**	8	75	**-51**	**-30**	**-22**	**-40**	68	9	16	**-164**
40%	**-24**	**-70**	2	44	**-9**	**-3**	**-37**	**-21**	38	24	15	**-132**
50%	**-33**	**-57**	**-10**	**-8**	4	2	**-36**	**-26**	35	29	12	**-43**
60%	**-22**	**-34**	**-3**	**-22**	**-11**	5	**-44**	**-38**	48	16	13	6
70%	2	**-20**	**-7**	**-14**	**-26**	**-9**	**-48**	**-48**	19	41	13	4
80%	10	**-14**	**-6**	**-19**	**-35**	**-24**	**-44**	**-5**	17	25	9	**-3**
90%	3	**-13**	**-13**	**-10**	**-32**	**-20**	**-46**	4	16	27	27	8
Long Term												
Full Simulation Period[a]	**-14**	**-53**	4	3	**-4**	**-2**	**-37**	**-28**	44	18	18	**-81**
Water Year Types[b,c]												
Wet (32%)	**-44**	**-110**	41	5	31	**-3**	**-53**	**-63**	45	13	18	**-213**
Above Normal (16%)	**-75**	**-94**	17	5	**-8**	23	**-81**	**-54**	76	9	18	**-132**
Below Normal (13%)	36	**-7**	**-28**	21	28	32	**-37**	**-9**	61	9	18	18
Dry (24%)	23	**-13**	**-19**	**-15**	**-42**	**-27**	**-18**	5	28	27	12	9
Critical (15%)	7	6	**-21**	14	**-41**	**-14**	15	5	21	28	26	15

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 4-4. CVP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	324	294	501	553	535	552	442	584	504	654	449	545
20%	289	227	210	424	474	416	287	511	453	617	416	498
30%	248	192	94	221	348	301	257	482	420	584	394	416
40%	225	163	66	100	153	151	239	440	408	541	372	350
50%	207	140	55	61	73	116	229	421	391	500	354	249
60%	178	105	34	48	57	88	215	407	367	472	338	184
70%	144	79	17	18	43	70	201	380	350	420	323	170
80%	113	59	1	6	27	52	175	311	335	391	305	148
90%	92	36	-6	-15	7	34	155	256	295	331	245	97
Long Term												
Full Simulation Period[a]	205	154	131	181	201	220	264	422	397	498	355	299
Water Year Types[b,c]												
Wet (32%)	293	245	178	422	363	427	374	523	403	523	400	514
Above Normal (16%)	247	210	105	183	315	257	287	453	409	610	390	349
Below Normal (13%)	168	100	125	39	146	84	223	434	443	549	390	202
Dry (24%)	156	102	164	37	45	81	189	366	421	471	327	164
Critical (15%)	82	32	12	24	37	87	166	251	290	319	232	94

Alternative 4 043019

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	305	202	490	527	591	665	412	532	483	677	450	327
20%	236	142	319	456	482	518	317	490	452	635	423	258
30%	211	119	125	291	290	342	284	466	432	609	404	242
40%	176	103	94	137	144	242	262	443	420	541	385	211
50%	169	98	76	67	85	211	244	428	402	499	369	199
60%	156	84	59	39	67	179	222	411	376	476	359	188
70%	142	69	37	11	34	152	205	390	362	455	345	175
80%	125	61	21	3	19	141	197	354	344	410	311	156
90%	97	39	7	0	8	116	173	294	309	365	276	95
Long Term												
Full Simulation Period[a]	186	114	161	193	212	304	276	423	403	518	368	214
Water Year Types[b,c]												
Wet (32%)	250	140	223	432	380	481	368	501	418	535	407	295
Above Normal (16%)	188	137	167	200	347	384	306	454	413	637	409	231
Below Normal (13%)	169	111	130	80	170	222	240	432	439	579	393	189
Dry (24%)	162	107	173	37	36	174	212	383	410	481	343	174
Critical (15%)	102	46	28	31	32	125	186	280	314	356	258	114

Alternative 4 043019 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	-19	-91	-11	-26	57	113	-30	-52	-21	23	1	-219
20%	-52	-85	109	33	9	103	30	-21	0	18	7	-240
30%	-37	-72	31	70	-57	41	27	-16	12	25	10	-174
40%	-49	-60	28	37	-9	92	23	3	12	0	13	-139
50%	-38	-43	22	7	12	95	15	7	11	-1	14	-50
60%	-22	-21	24	-9	10	91	7	4	9	4	20	3
70%	-2	-10	20	-6	-9	82	3	10	12	35	22	5
80%	11	2	20	-3	-8	88	22	43	10	20	6	7
90%	5	3	12	15	1	82	18	38	14	35	31	-2
Long Term												
Full Simulation Period[a]	-19	-40	29	12	11	84	12	1	6	20	14	-85
Water Year Types[b,c]												
Wet (32%)	-44	-104	45	10	17	54	-6	-22	15	12	7	-219
Above Normal (16%)	-59	-73	62	17	32	127	19	0	4	27	19	-118
Below Normal (13%)	1	11	5	41	24	138	17	-2	-5	31	4	-13
Dry (24%)	6	5	9	0	-9	93	23	16	-11	10	16	9
Critical (15%)	19	15	17	7	-5	38	20	29	25	38	26	21

a Based on the 82-year simulation period.

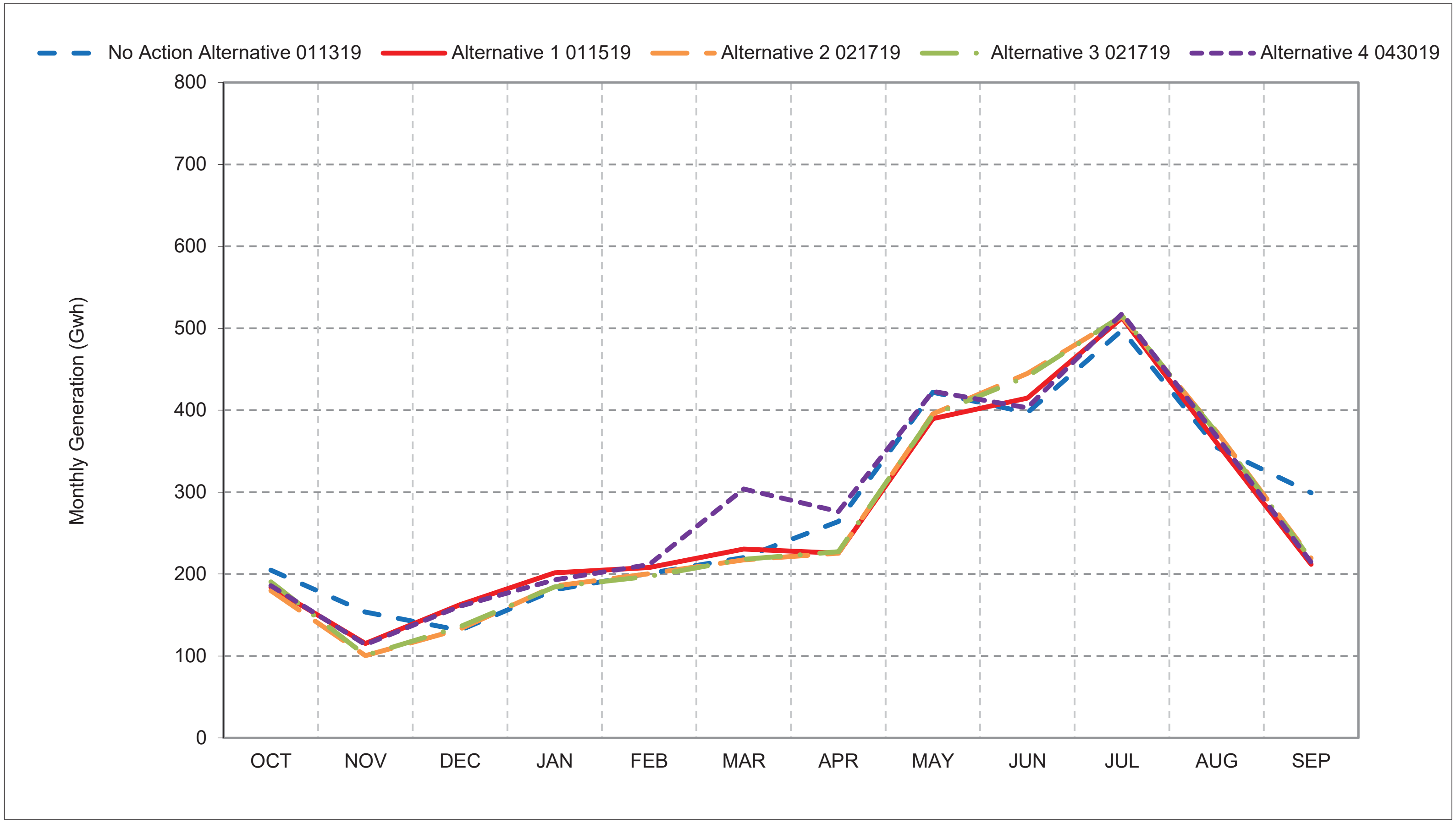
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

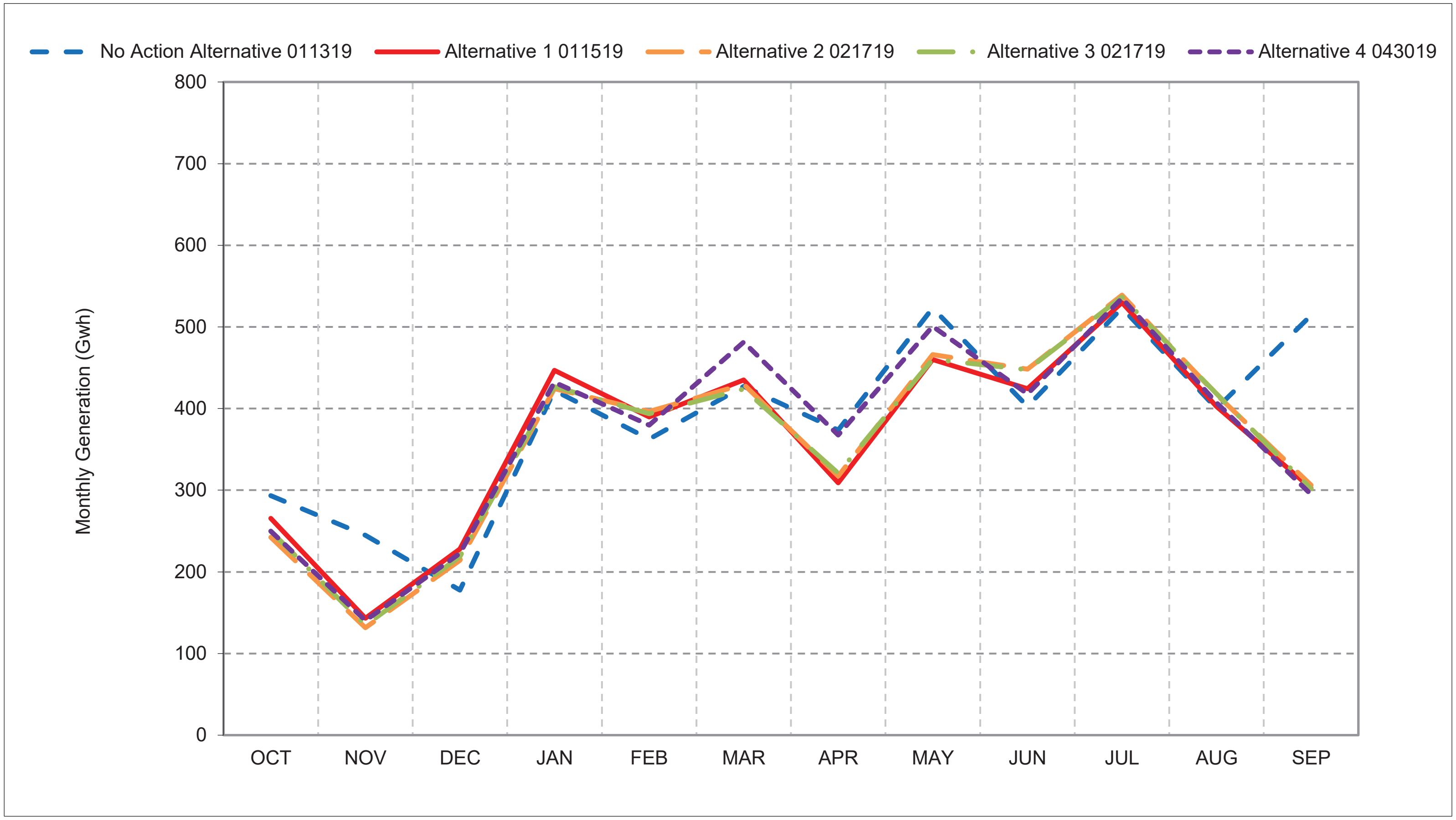
e These are draft results meant for qualitative analysis and are subject to revision.

Figure 4-1. CVP Net Generation, Long-Term Average Generation



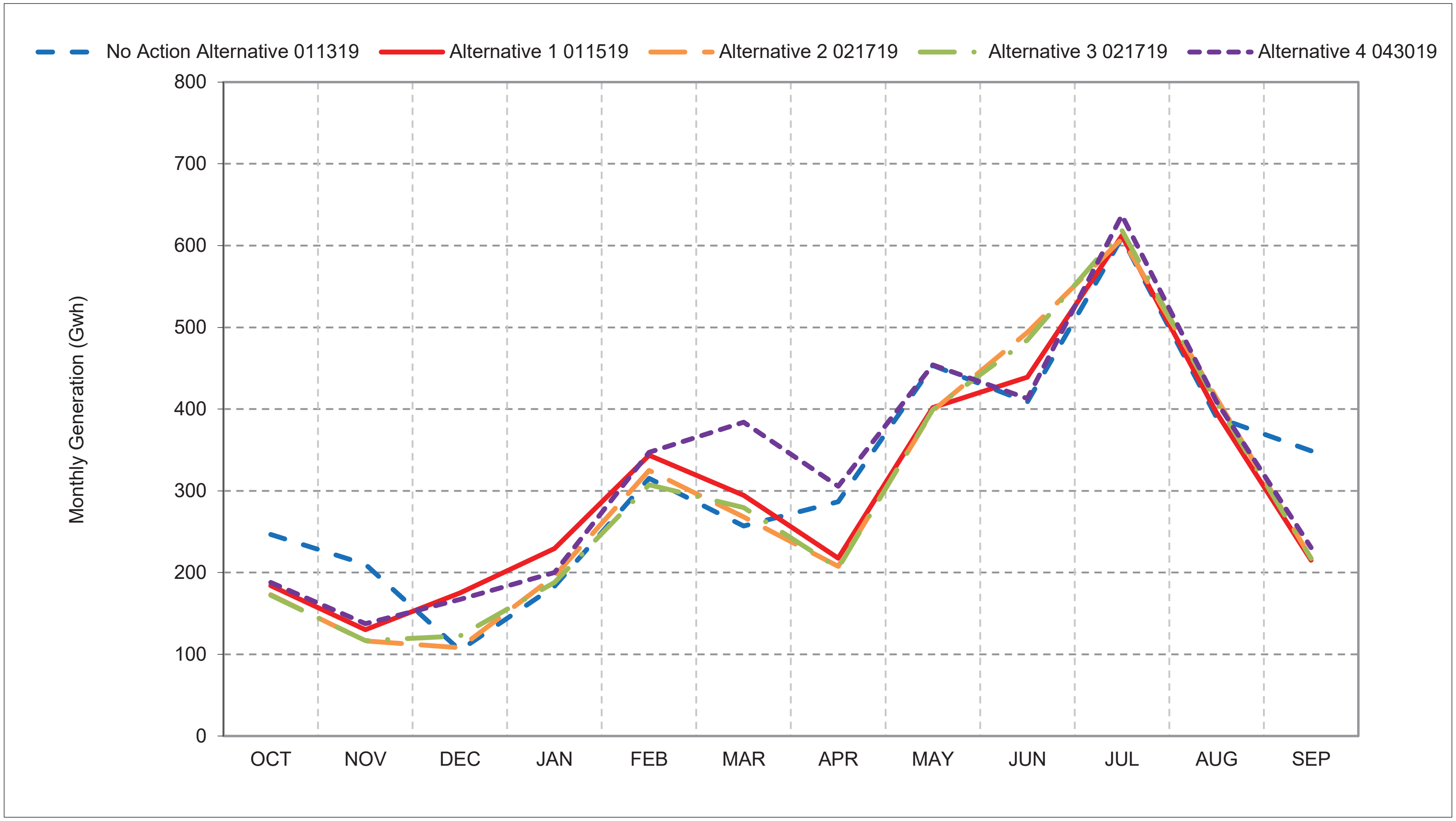
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 4-2. CVP Net Generation, Wet Year Average Generation



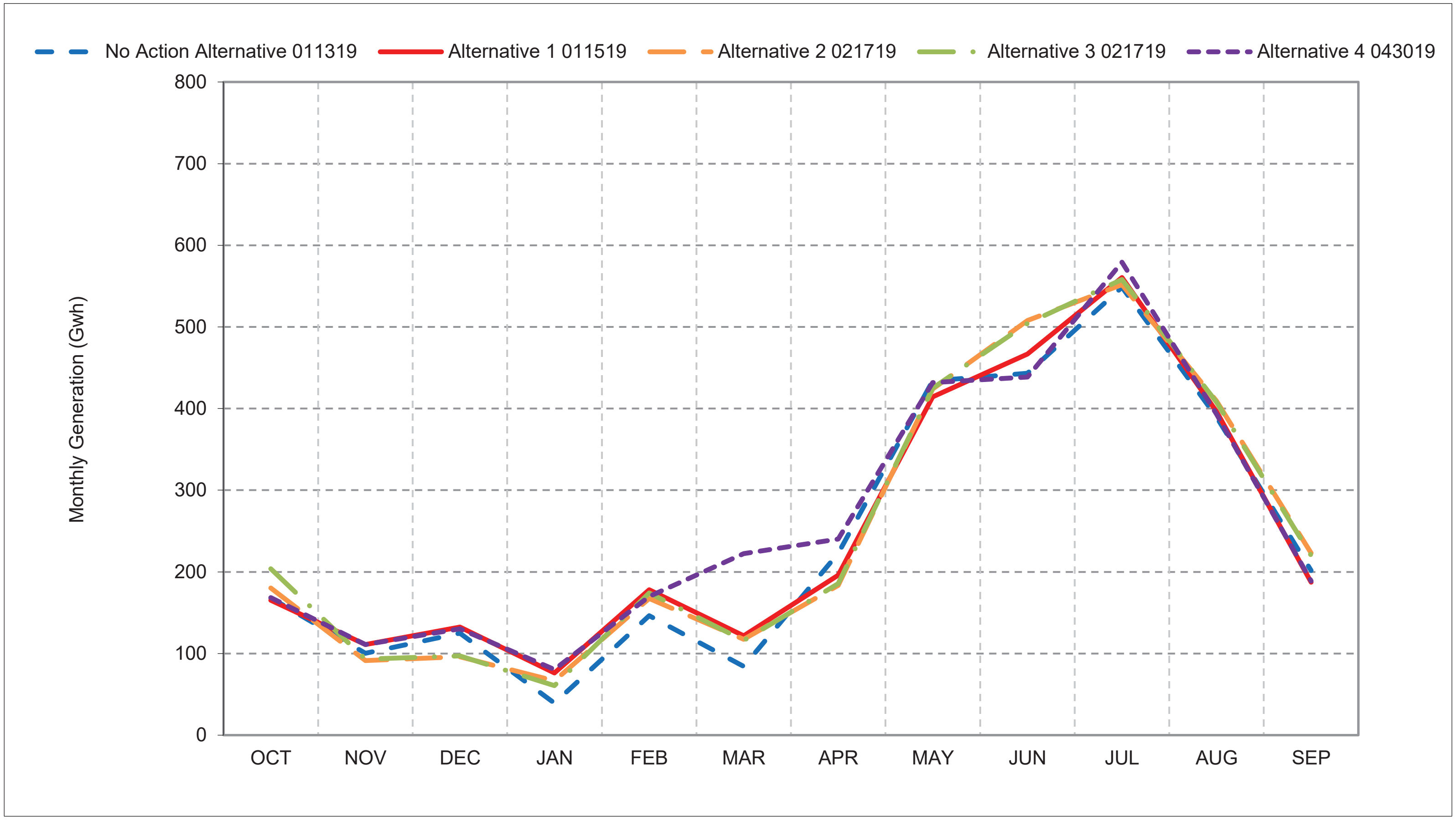
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 4-3. CVP Net Generation, Above Normal Year Average Generation



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 4-4. CVP Net Generation, Below Normal Year Average Generation



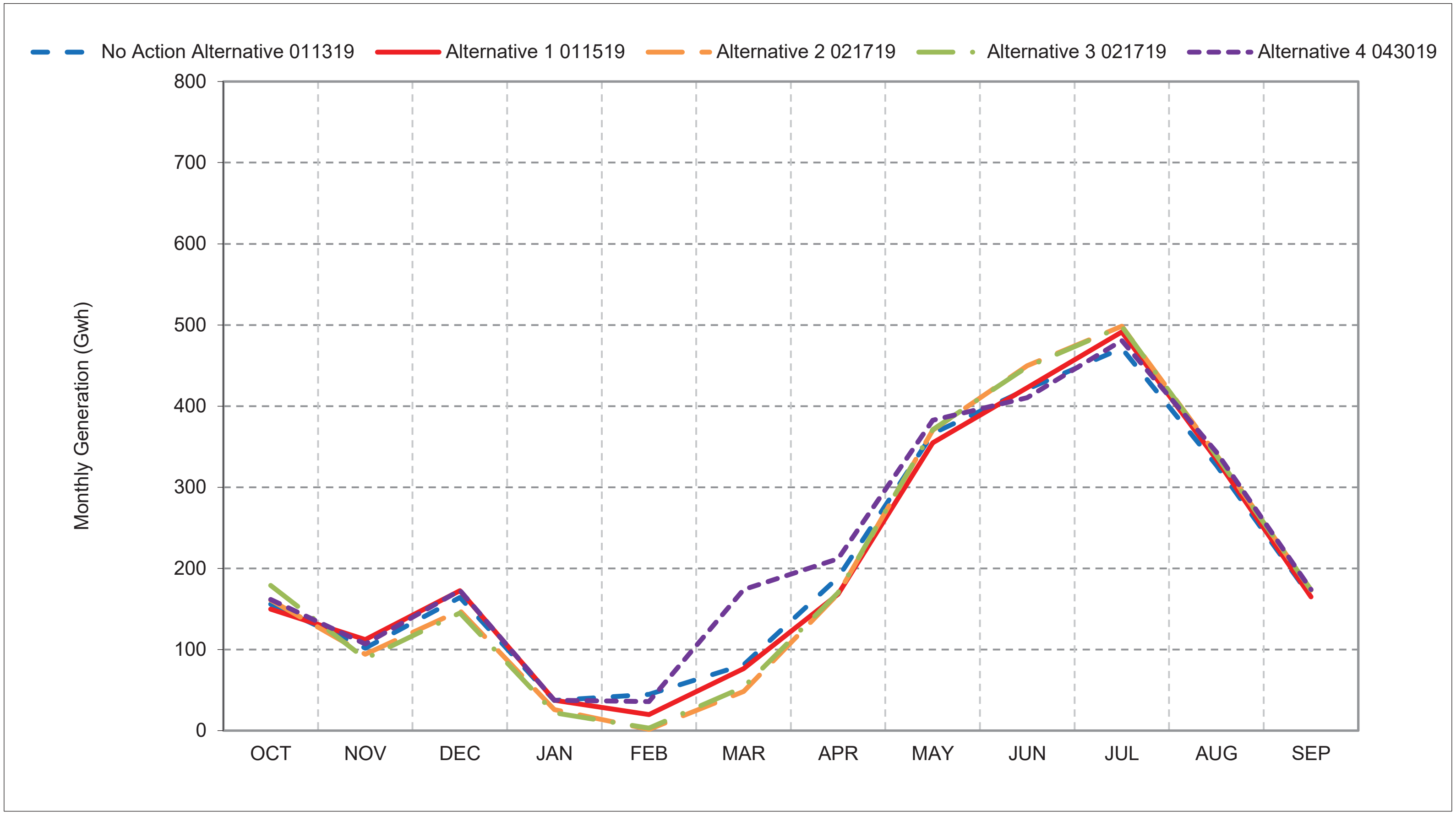
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 4-5. CVP Net Generation, Dry Year Average Generation



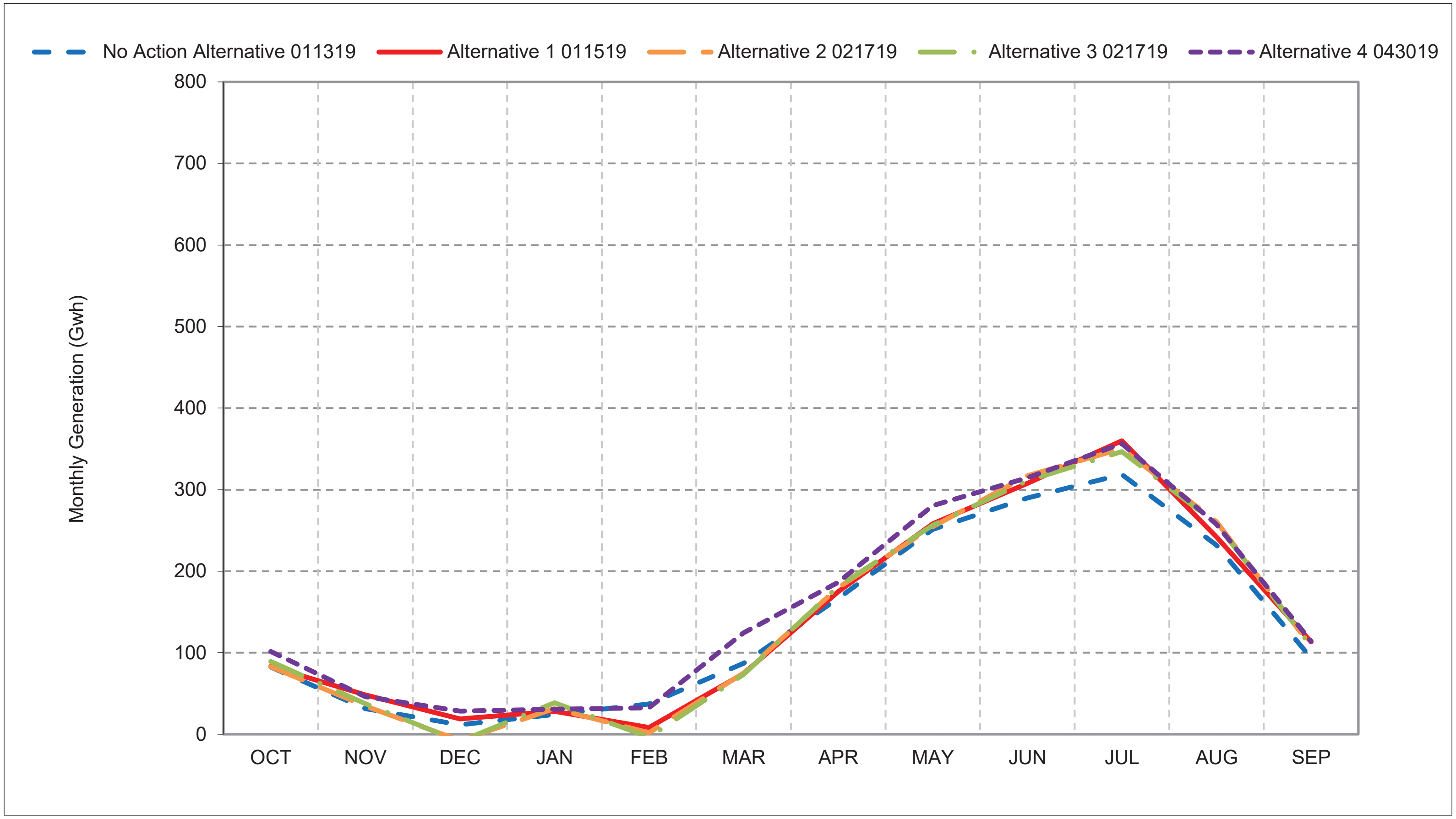
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

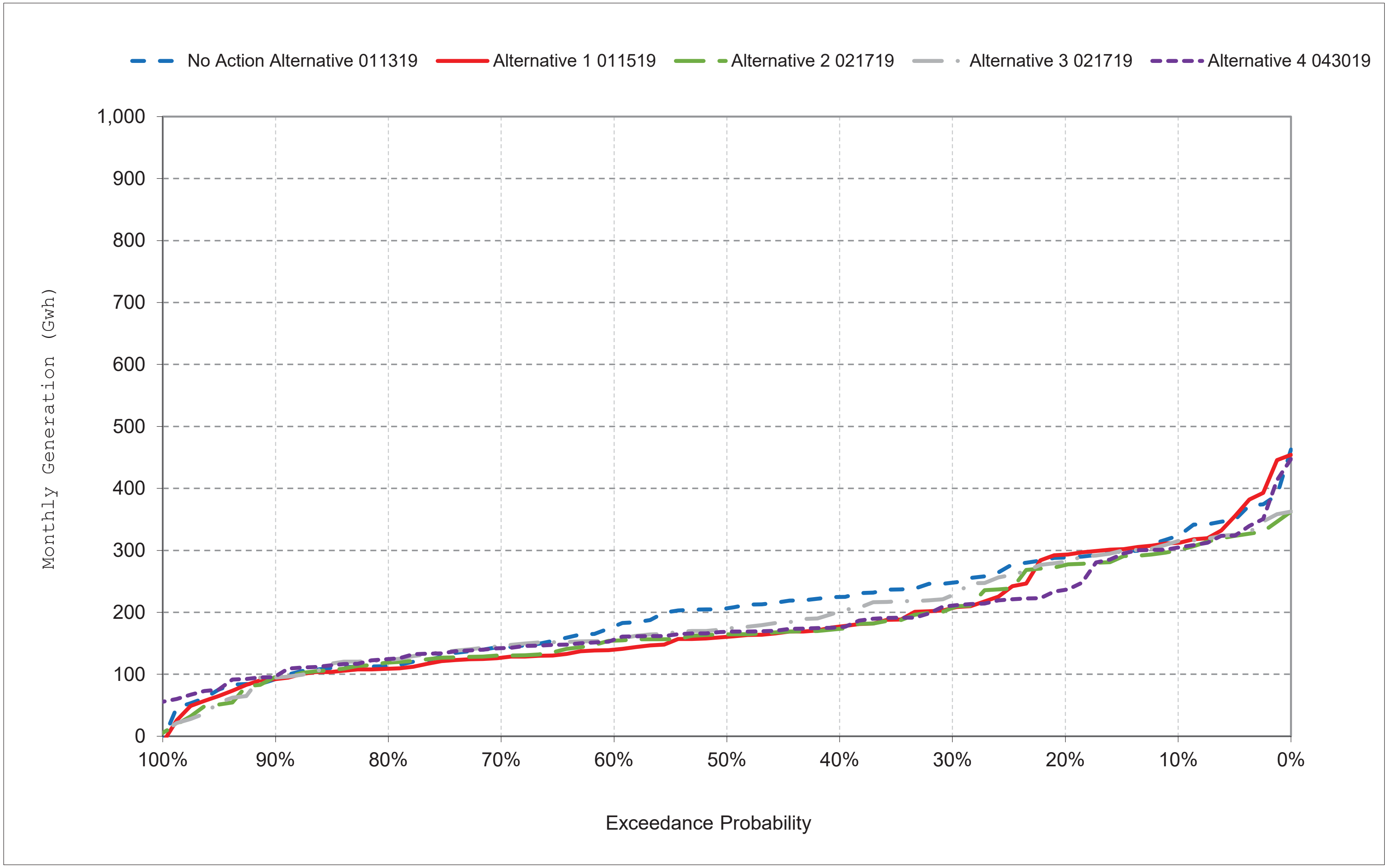
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 4-6. CVP Net Generation, Critical Year Average Generation



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

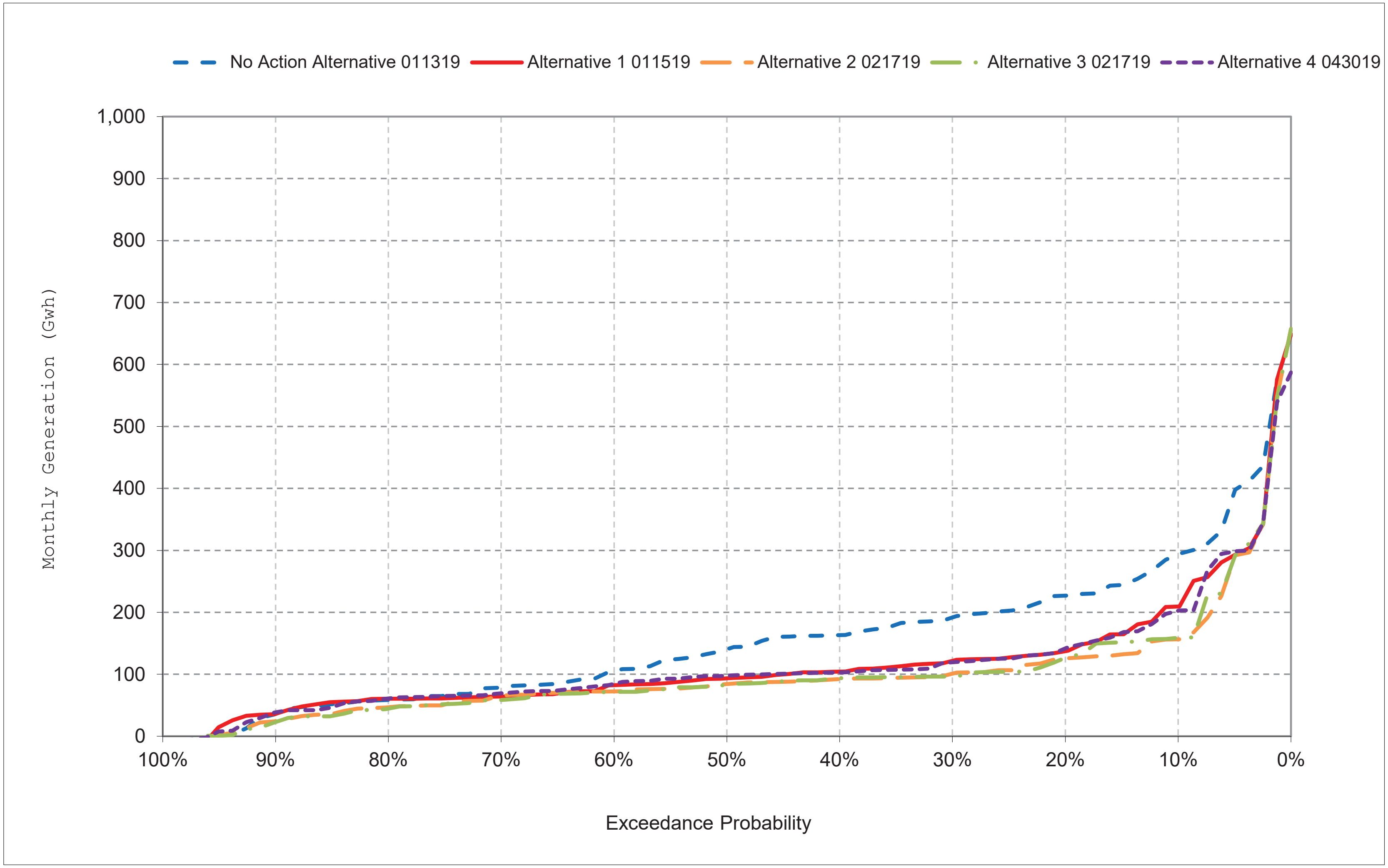
Figure 4-7. CVP Net Generation, October



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

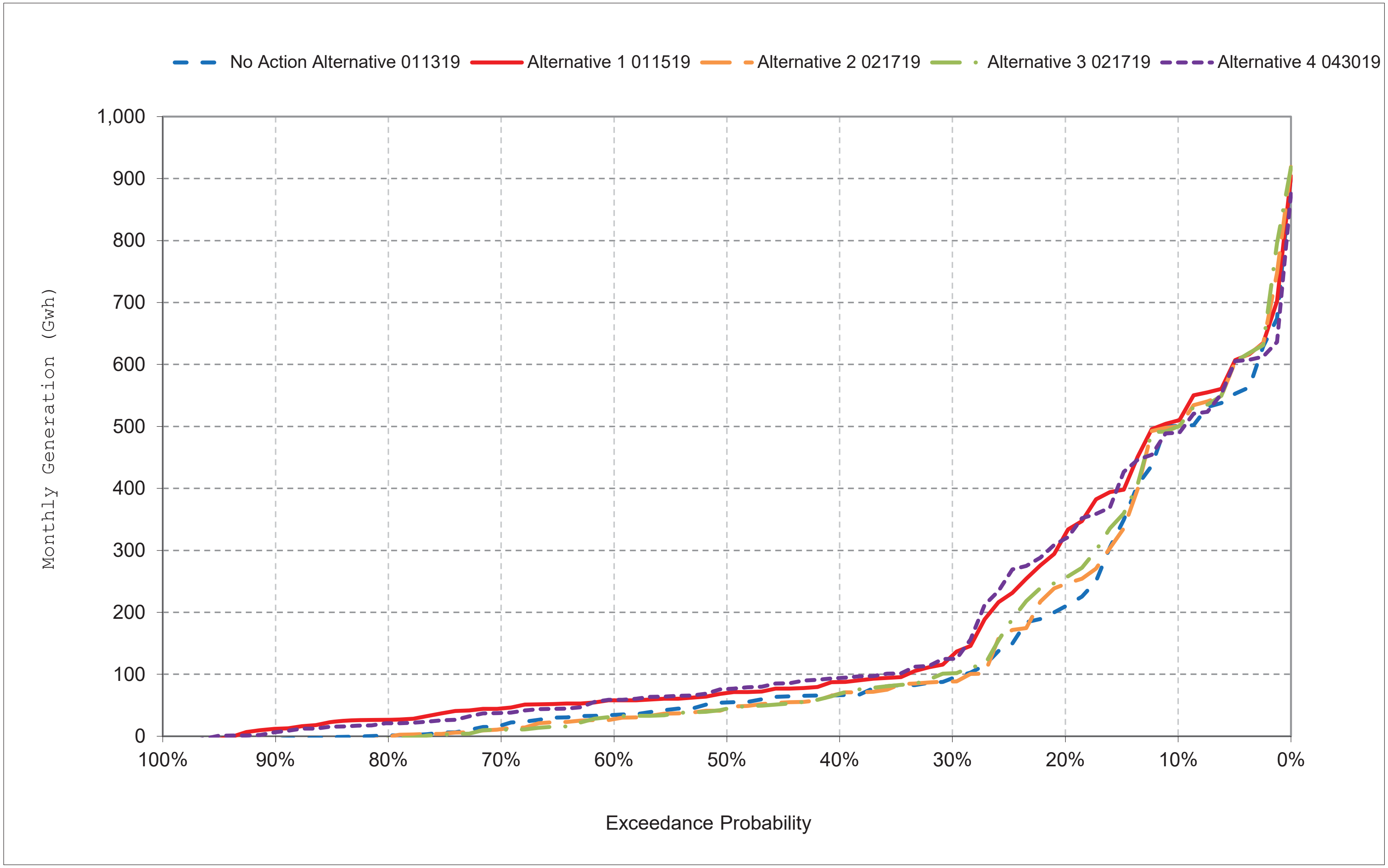
Figure 4-8. CVP Net Generation, November



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

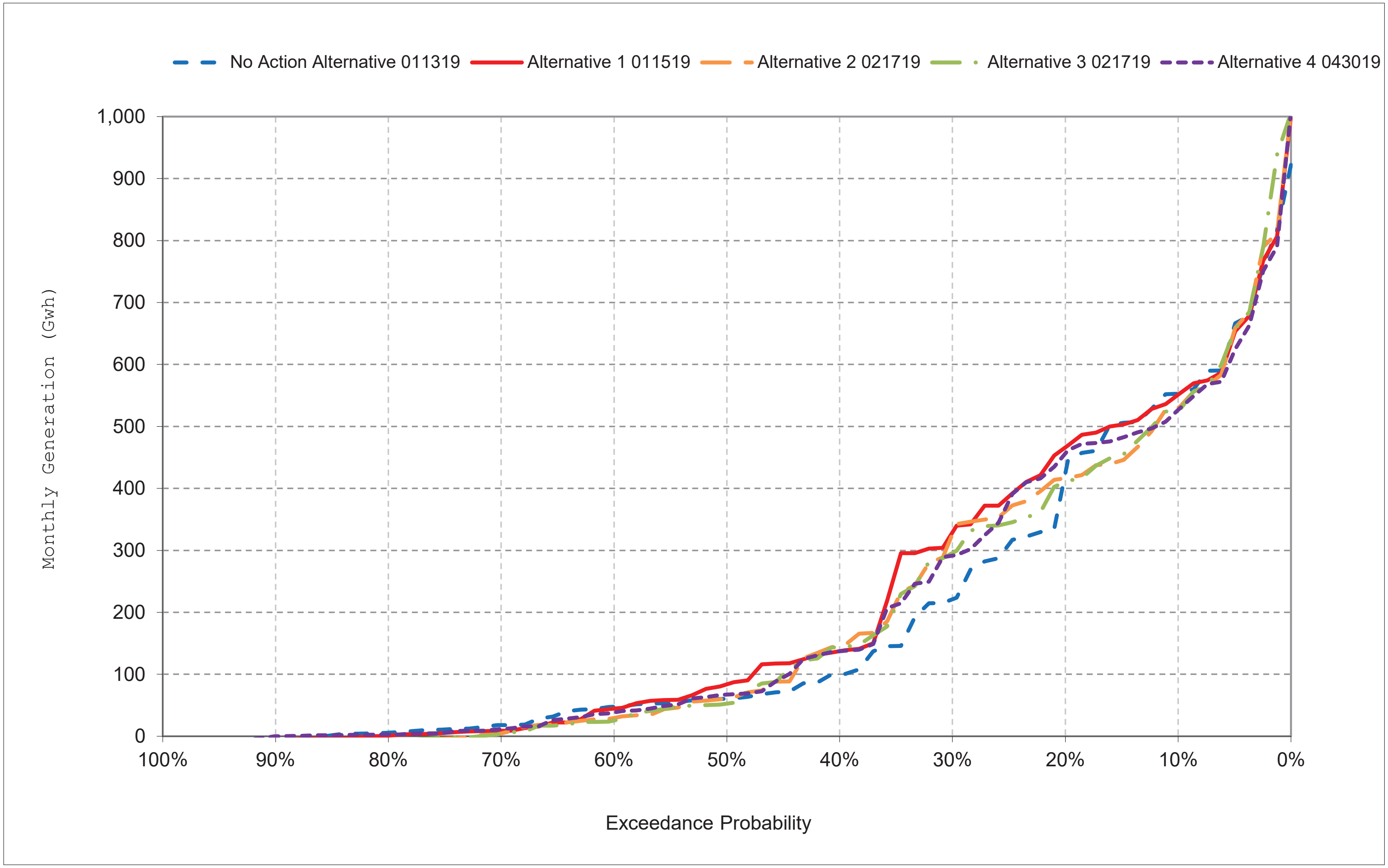
Figure 4-9. CVP Net Generation, December



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

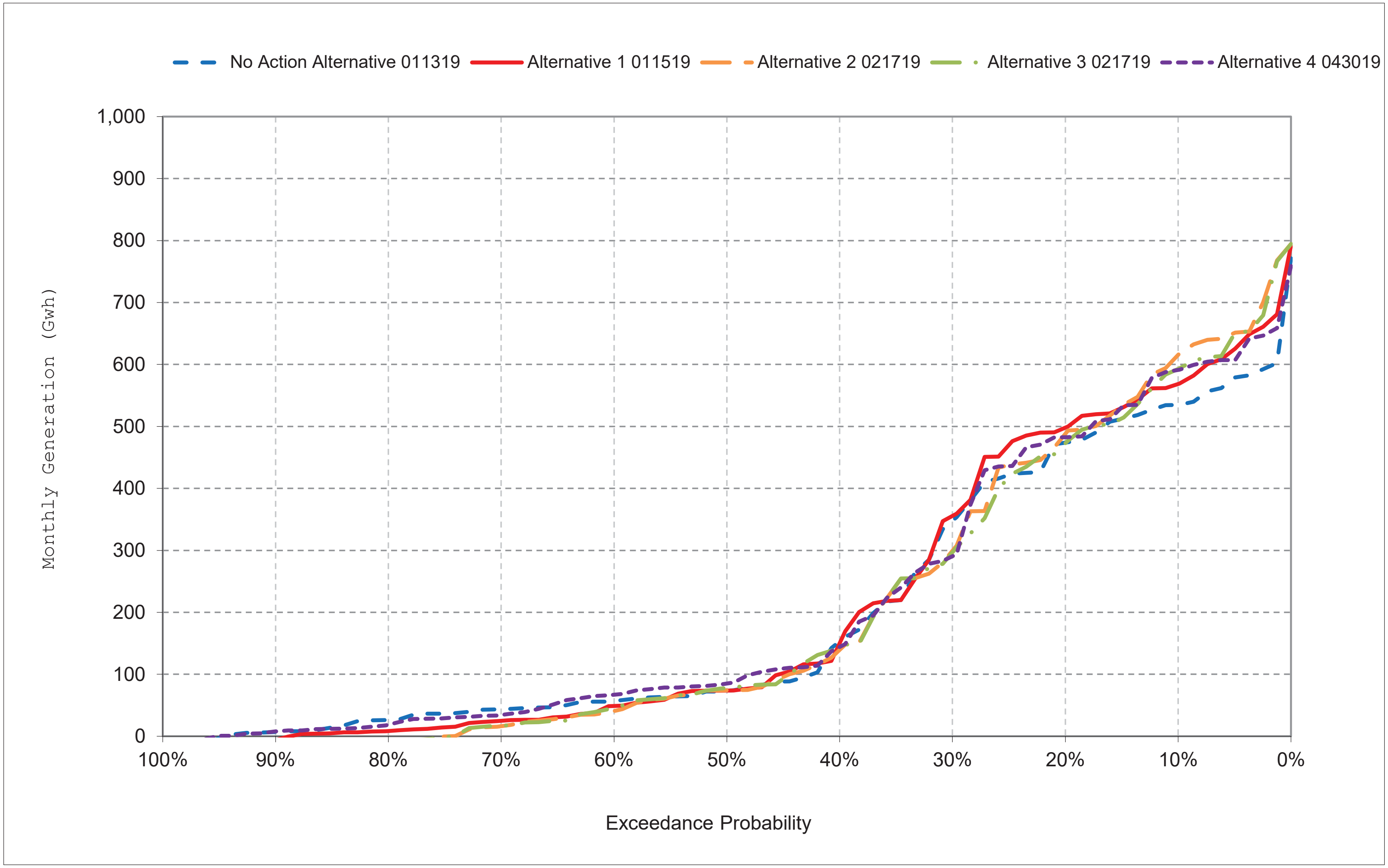
Figure 4-10. CVP Net Generation, January



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

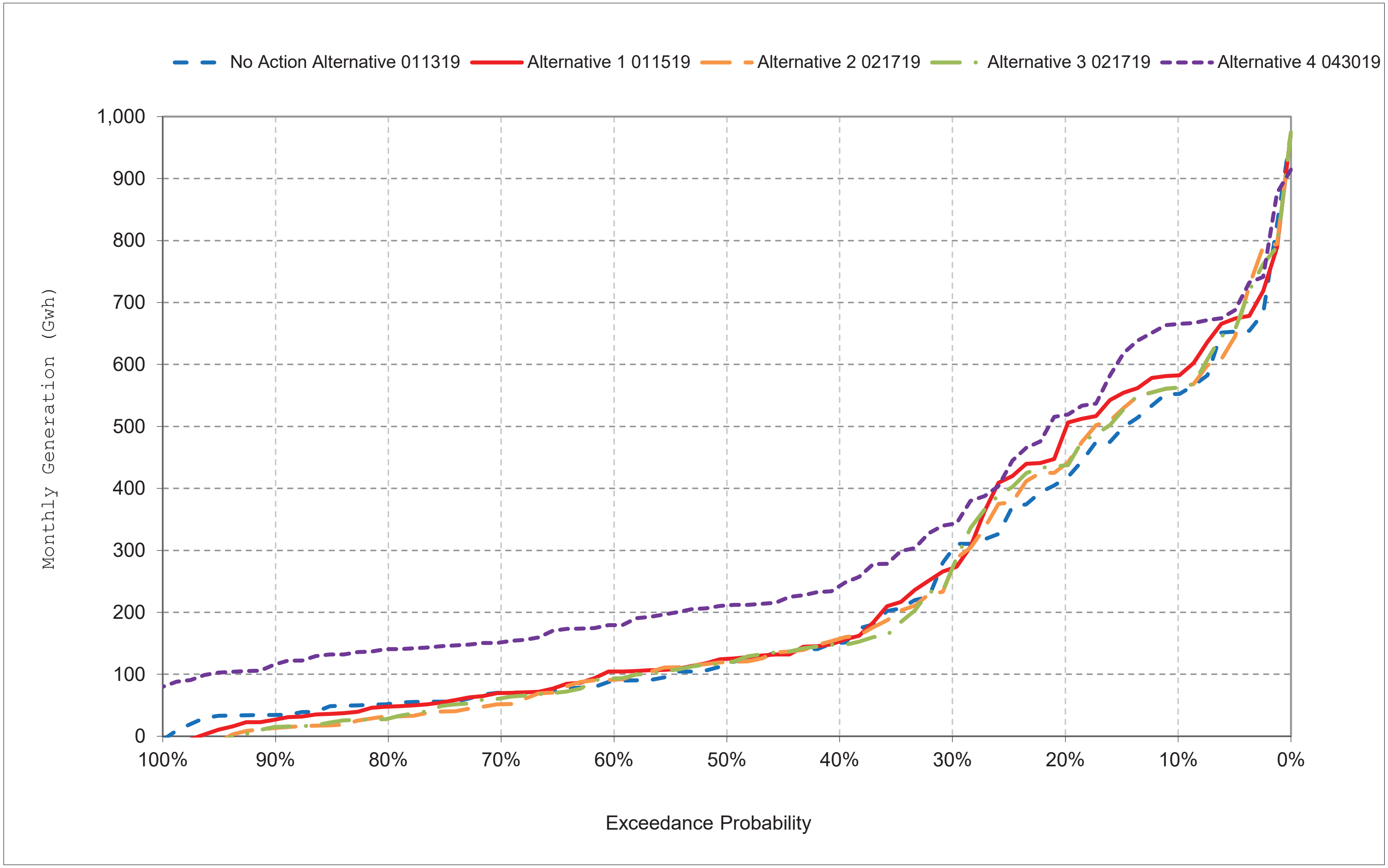
Figure 4-11. CVP Net Generation, February



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

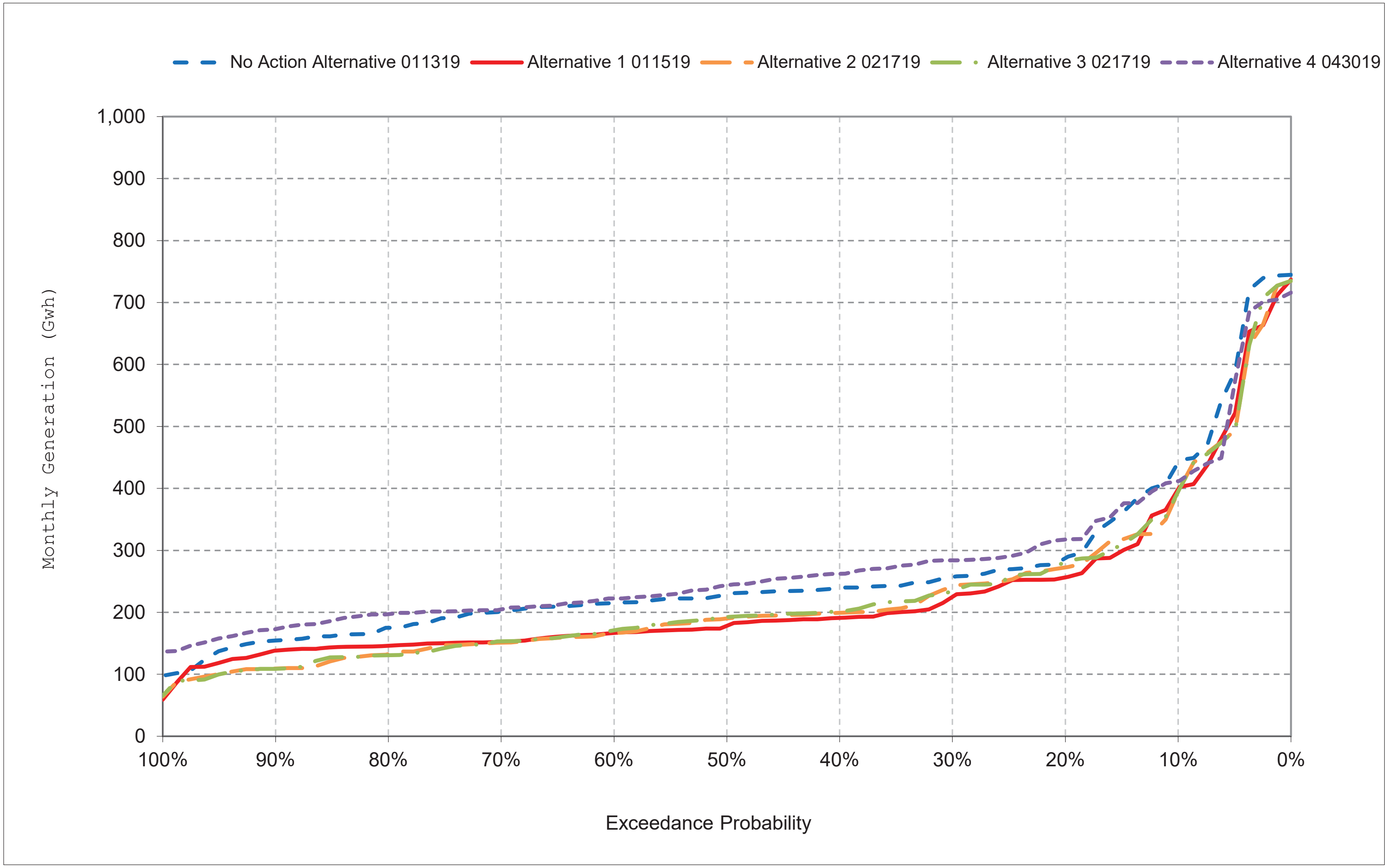
Figure 4-12. CVP Net Generation, March



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

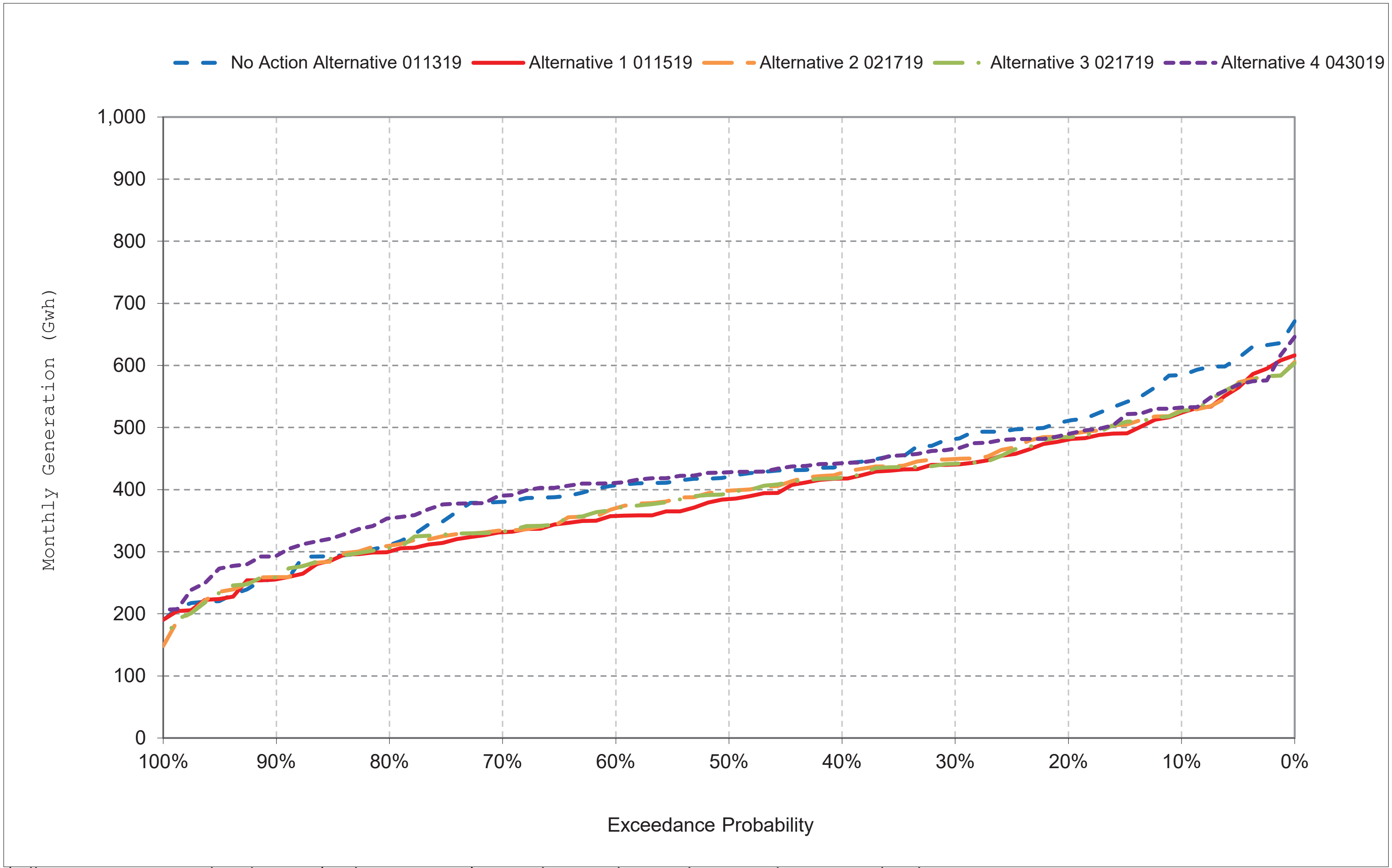
Figure 4-13. CVP Net Generation, April



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

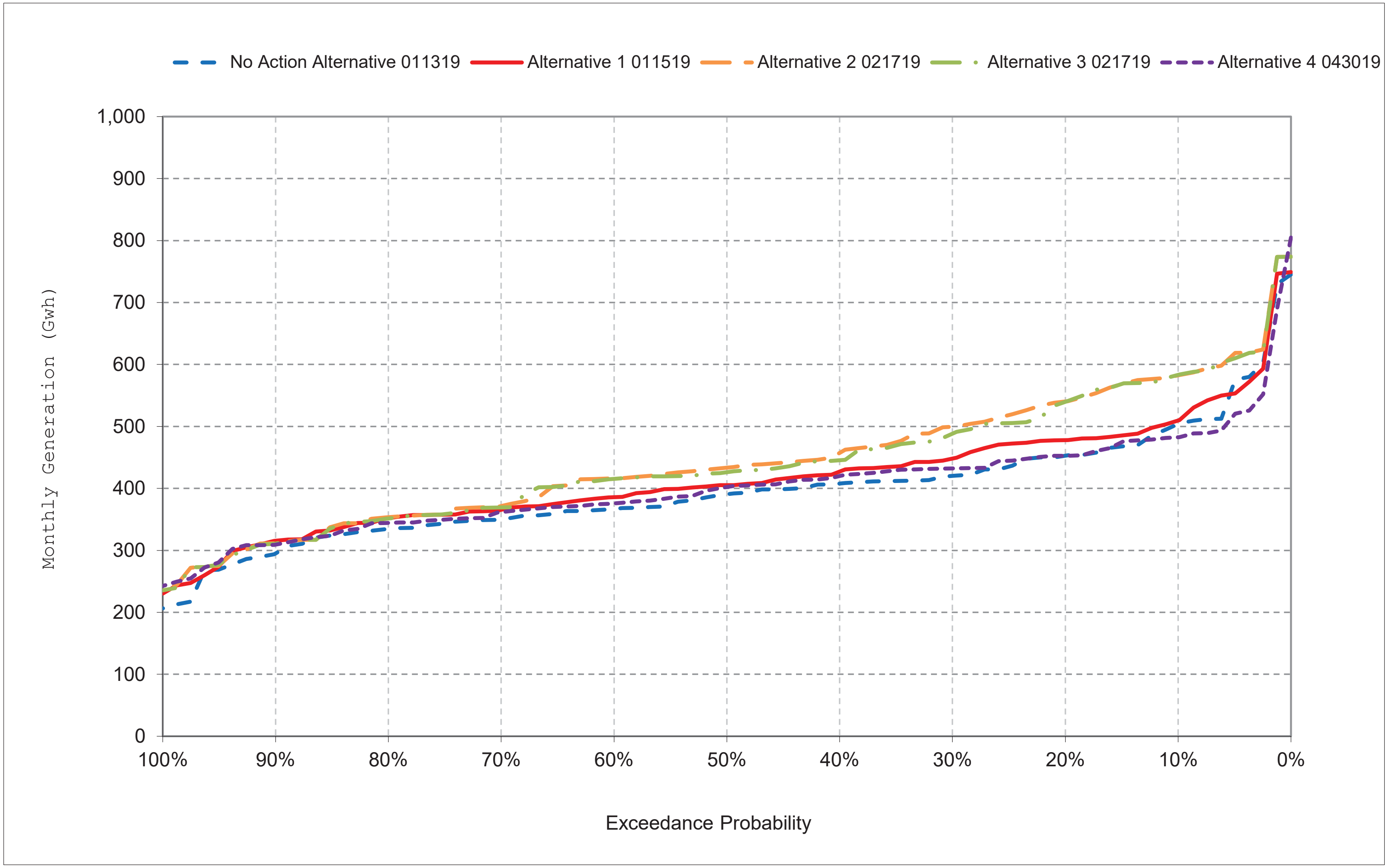
Figure 4-14. CVP Net Generation, May



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

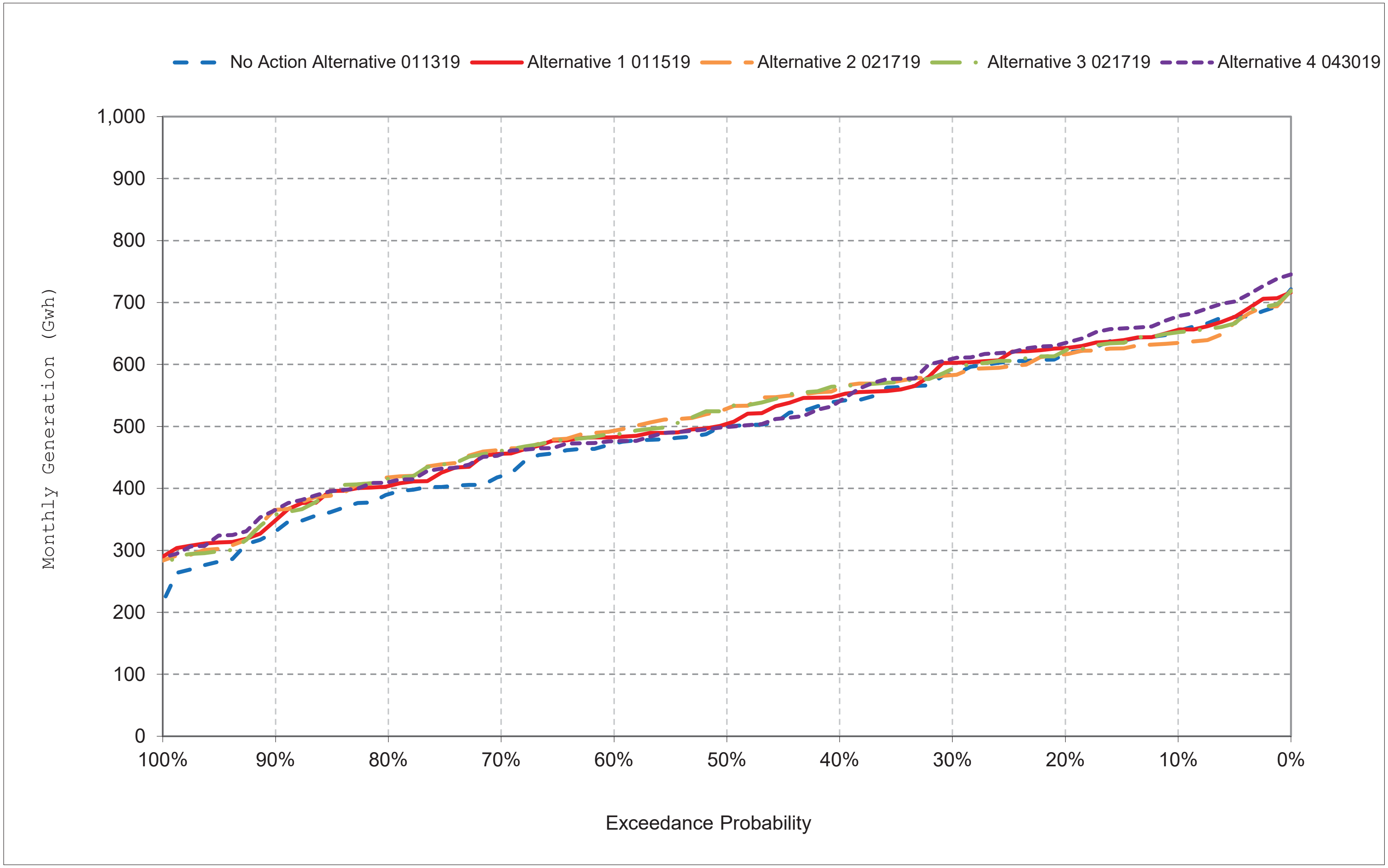
Figure 4-15. CVP Net Generation, June



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

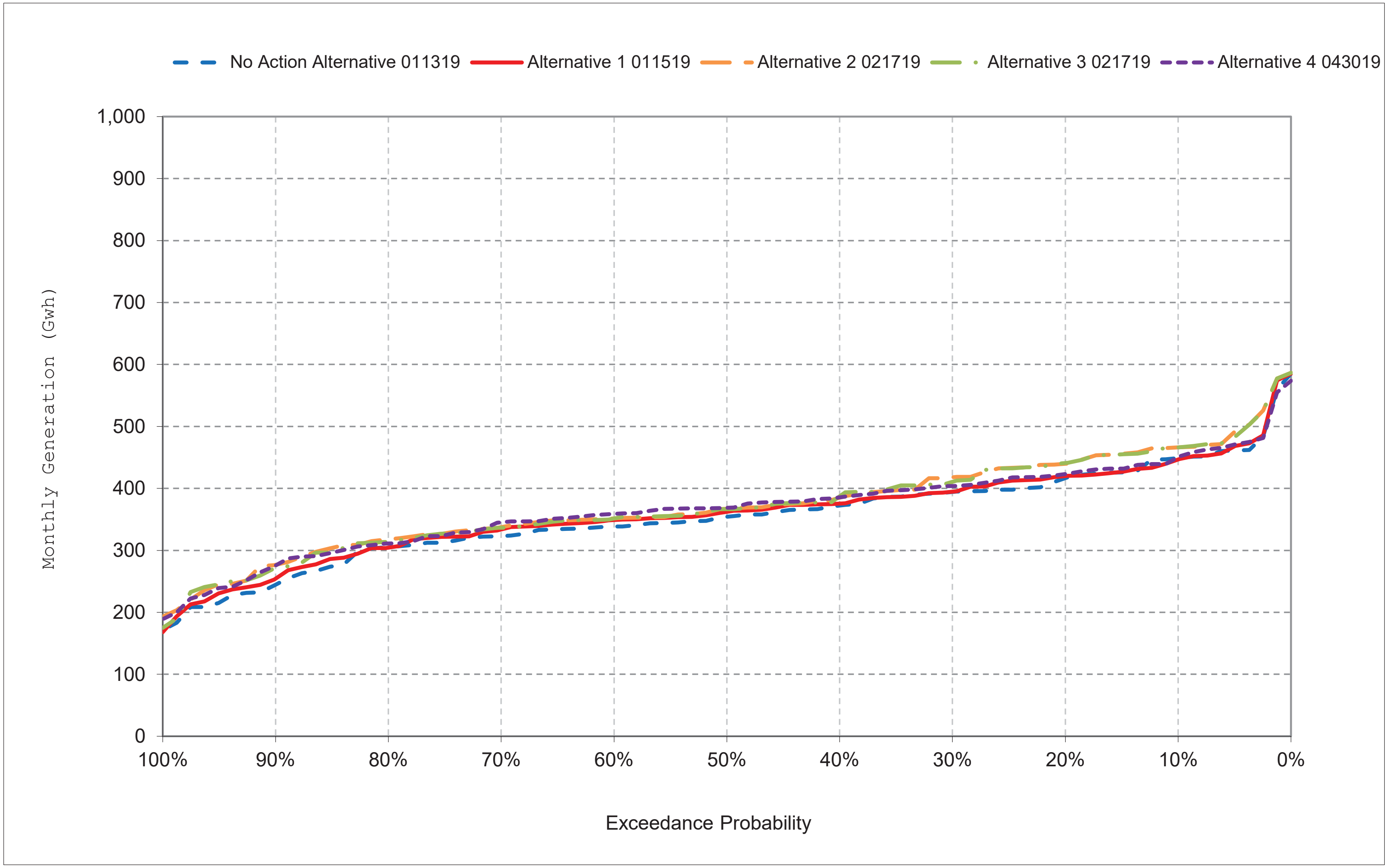
Figure 4-16. CVP Net Generation, July



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

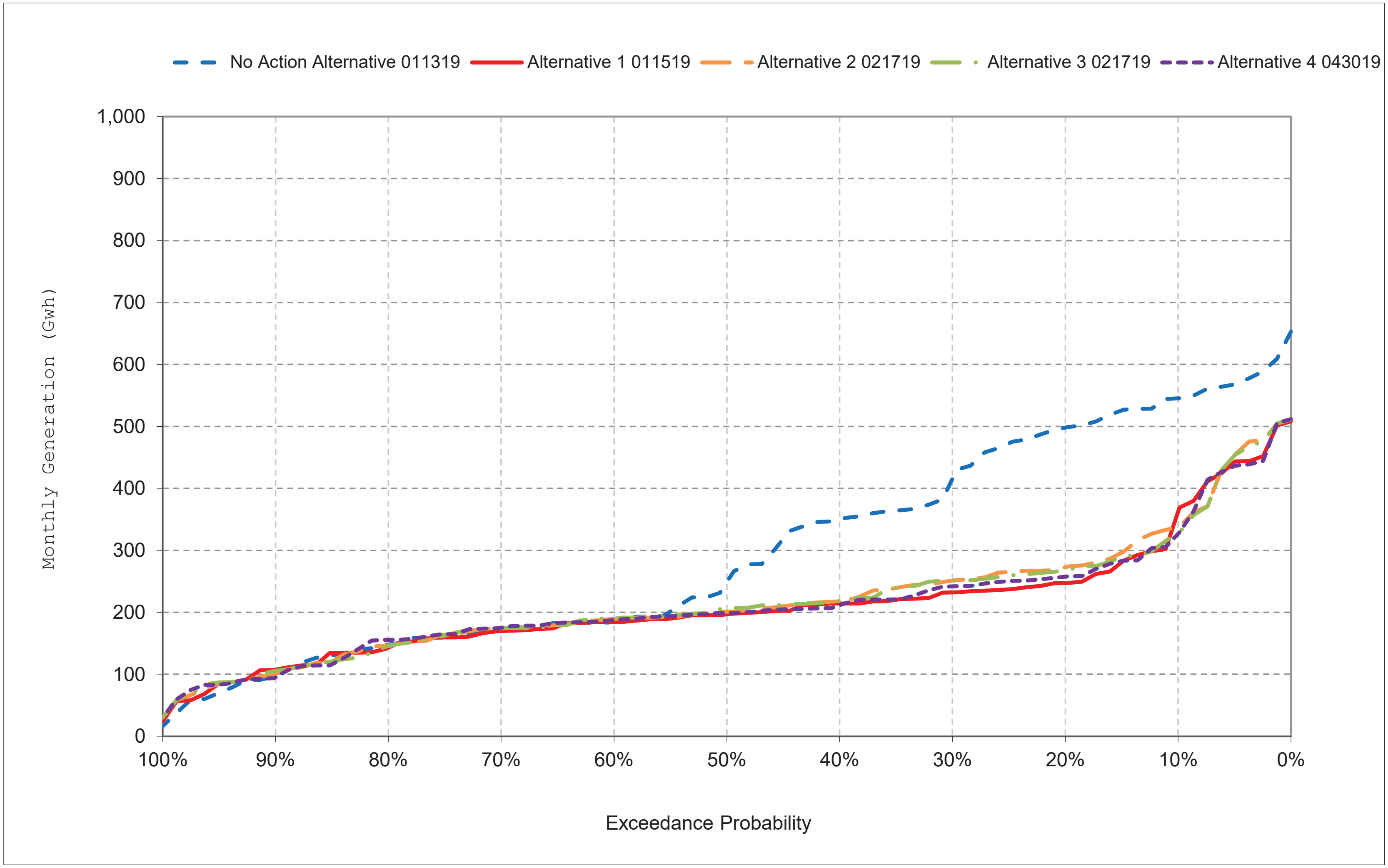
Figure 4-17. CVP Net Generation, August



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 4-18. CVP Net Generation, September



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Table 5-1. SWP Total Capacity, Monthly Capacity

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Capacity (MW)											
Probability of Exceedance												
10%	1,210	1,101	1,189	1,182	1,344	1,450	1,347	1,359	1,312	1,312	1,297	1,306
20%	1,082	1,023	1,037	1,010	1,181	1,277	1,294	1,309	1,232	1,269	1,277	1,233
30%	1,032	988	995	944	1,053	1,184	1,253	1,259	1,184	1,256	1,248	1,197
40%	994	939	966	833	994	1,037	1,213	1,202	1,165	1,247	1,225	1,137
50%	946	903	910	787	909	982	1,119	1,104	1,151	1,233	1,154	1,079
60%	878	822	843	679	793	935	1,071	1,066	1,131	1,167	1,032	972
70%	748	613	558	615	762	844	937	1,014	1,053	1,052	868	848
80%	453	409	376	323	674	769	864	976	1,003	907	753	796
90%	195	207	275	205	332	708	745	824	786	636	403	312
Long Term												
Full Simulation Period[a]	827	766	791	732	889	1,000	1,076	1,106	1,090	1,083	997	959
Water Year Types[b,c]												
Wet (32%)	1,129	1,045	1,094	1,067	1,210	1,297	1,313	1,316	1,246	1,290	1,279	1,258
Above Normal (16%)	1,024	973	944	737	981	1,130	1,199	1,185	1,182	1,258	1,235	1,164
Below Normal (13%)	866	823	726	709	890	943	1,076	1,097	1,126	1,171	1,038	990
Dry (24%)	648	573	650	543	684	811	958	1,037	1,060	1,004	837	818
Critical (15%)	221	204	261	337	433	586	627	690	668	497	359	298

Alternative 1 011519

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Capacity (MW)											
Probability of Exceedance												
10%	1,263	1,279	1,299	1,402	1,465	1,446	1,396	1,430	1,347	1,354	1,313	1,273
20%	1,190	1,204	1,208	1,149	1,269	1,348	1,363	1,379	1,319	1,331	1,283	1,229
30%	1,104	1,111	1,109	1,032	1,174	1,299	1,337	1,359	1,293	1,310	1,256	1,188
40%	1,039	1,041	1,054	952	1,104	1,243	1,302	1,313	1,245	1,294	1,205	1,135
50%	981	978	962	850	945	1,092	1,265	1,264	1,193	1,276	1,165	1,076
60%	913	883	846	694	820	947	1,169	1,160	1,150	1,217	1,113	1,010
70%	787	658	662	618	732	855	1,028	1,073	1,114	1,089	945	916
80%	457	395	465	311	671	805	881	1,004	1,018	944	819	762
90%	312	243	310	246	407	704	753	857	845	761	473	392
Long Term												
Full Simulation Period[a]	867	852	866	789	942	1,062	1,142	1,176	1,135	1,128	1,035	962
Water Year Types[b,c]												
Wet (32%)	1,191	1,219	1,220	1,137	1,279	1,352	1,363	1,376	1,295	1,325	1,281	1,241
Above Normal (16%)	1,094	1,059	1,013	810	1,062	1,275	1,301	1,285	1,232	1,312	1,247	1,165
Below Normal (13%)	902	888	796	812	989	1,048	1,195	1,240	1,209	1,247	1,129	1,006
Dry (24%)	664	606	700	575	718	833	1,010	1,088	1,108	1,042	911	840
Critical (15%)	225	210	283	352	413	598	659	715	660	537	395	301

Alternative 1 011519 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Capacity (MW)											
Probability of Exceedance												
10%	53	178	109	219	121	-3	49	71	35	42	17	-33
20%	108	181	171	138	88	71	69	70	87	63	7	-4
30%	72	123	114	88	121	115	84	100	108	54	7	-9
40%	45	102	88	119	110	206	89	111	80	47	-20	-2
50%	35	75	52	63	36	109	146	159	42	44	11	-3
60%	35	61	3	15	27	12	99	95	19	50	81	37
70%	40	45	103	3	-29	11	91	59	60	38	76	68
80%	4	-14	90	-12	-3	36	17	28	15	37	66	-34
90%	117	36	35	41	76	-5	8	33	60	126	71	80
Long Term												
Full Simulation Period[a]	40	87	76	57	53	62	65	70	45	45	38	3
Water Year Types[b,c]												
Wet (32%)	62	174	126	69	69	55	50	60	49	35	2	-17
Above Normal (16%)	69	86	68	73	81	145	103	101	50	54	12	1
Below Normal (13%)	36	65	70	103	100	105	119	143	84	76	91	16
Dry (24%)	16	33	50	32	34	22	52	51	48	37	74	22
Critical (15%)	4	6	22	15	-20	12	32	25	-8	40	36	2

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 5-2. SWP Total Capacity, Monthly Capacity

No Action Alternative 011319

	Monthly Capacity (MW)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	1,210	1,101	1,189	1,182	1,344	1,450	1,347	1,359	1,312	1,312	1,297	1,306
20%	1,082	1,023	1,037	1,010	1,181	1,277	1,294	1,309	1,232	1,269	1,277	1,233
30%	1,032	988	995	944	1,053	1,184	1,253	1,259	1,184	1,256	1,248	1,197
40%	994	939	966	833	994	1,037	1,213	1,202	1,165	1,247	1,225	1,137
50%	946	903	910	787	909	982	1,119	1,104	1,151	1,233	1,154	1,079
60%	878	822	843	679	793	935	1,071	1,066	1,131	1,167	1,032	972
70%	748	613	558	615	762	844	937	1,014	1,053	1,052	868	848
80%	453	409	376	323	674	769	864	976	1,003	907	753	796
90%	195	207	275	205	332	708	745	824	786	636	403	312
Long Term												
Full Simulation Period[a]	827	766	791	732	889	1,000	1,076	1,106	1,090	1,083	997	959
Water Year Types[b,c]												
Wet (32%)	1,129	1,045	1,094	1,067	1,210	1,297	1,313	1,316	1,246	1,290	1,279	1,258
Above Normal (16%)	1,024	973	944	737	981	1,130	1,199	1,185	1,182	1,258	1,235	1,164
Below Normal (13%)	866	823	726	709	890	943	1,076	1,097	1,126	1,171	1,038	990
Dry (24%)	648	573	650	543	684	811	958	1,037	1,060	1,004	837	818
Critical (15%)	221	204	261	337	433	586	627	690	668	497	359	298

Alternative 2 021719

	Monthly Capacity (MW)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	1,321	1,352	1,339	1,460	1,490	1,508	1,420	1,436	1,386	1,390	1,353	1,336
20%	1,224	1,206	1,242	1,331	1,469	1,476	1,387	1,411	1,358	1,373	1,308	1,271
30%	1,171	1,147	1,131	1,205	1,386	1,461	1,368	1,388	1,341	1,344	1,267	1,219
40%	1,095	1,092	1,084	1,082	1,273	1,404	1,344	1,358	1,321	1,324	1,228	1,166
50%	1,043	1,015	1,010	989	1,132	1,320	1,317	1,331	1,306	1,275	1,163	1,098
60%	941	927	929	778	989	1,179	1,267	1,290	1,272	1,211	1,092	1,037
70%	785	714	680	617	833	982	1,113	1,151	1,205	1,124	1,032	957
80%	529	441	487	367	714	867	949	1,021	1,083	1,021	923	838
90%	283	272	382	243	420	745	817	914	924	818	545	421
Long Term												
Full Simulation Period[a]	903	888	908	886	1,062	1,189	1,192	1,236	1,206	1,162	1,070	1,002
Water Year Types[b,c]												
Wet (32%)	1,256	1,254	1,254	1,247	1,405	1,475	1,390	1,403	1,347	1,361	1,310	1,284
Above Normal (16%)	1,126	1,095	1,062	937	1,266	1,422	1,365	1,380	1,336	1,343	1,262	1,195
Below Normal (13%)	956	902	826	947	1,077	1,222	1,273	1,327	1,301	1,227	1,090	1,037
Dry (24%)	678	664	753	640	793	966	1,070	1,139	1,167	1,099	993	889
Critical (15%)	222	232	320	399	530	659	710	798	734	577	449	338

Alternative 2 021719 minus No Action Alternative 011319

	Monthly Capacity (MW)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	110	251	150	278	146	58	73	76	74	78	57	30
20%	142	184	205	320	288	199	94	103	126	105	31	38
30%	140	158	136	261	333	277	115	129	157	88	19	21
40%	101	153	118	249	279	367	131	156	156	77	3	29
50%	96	112	100	202	224	337	199	227	155	42	9	19
60%	63	106	86	99	196	244	196	224	141	44	61	64
70%	37	101	121	3	71	138	176	137	152	72	164	109
80%	76	32	111	43	40	98	85	45	80	114	170	42
90%	88	65	107	38	88	37	72	90	138	182	142	109
Long Term												
Full Simulation Period[a]	76	123	117	154	173	188	116	130	116	78	72	43
Water Year Types[b,c]												
Wet (32%)	127	209	160	180	196	178	76	87	101	71	32	26
Above Normal (16%)	102	122	118	200	285	292	166	195	154	86	27	31
Below Normal (13%)	90	79	101	238	188	279	197	230	176	56	52	46
Dry (24%)	30	91	103	98	109	155	111	102	107	94	155	71
Critical (15%)	1	28	59	62	97	73	83	107	66	80	90	40

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 5-3. SWP Total Capacity, Monthly Capacity

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Capacity (MW)											
Probability of Exceedance												
10%	1,210	1,101	1,189	1,182	1,344	1,450	1,347	1,359	1,312	1,312	1,297	1,306
20%	1,082	1,023	1,037	1,010	1,181	1,277	1,294	1,309	1,232	1,269	1,277	1,233
30%	1,032	988	995	944	1,053	1,184	1,253	1,259	1,184	1,256	1,248	1,197
40%	994	939	966	833	994	1,037	1,213	1,202	1,165	1,247	1,225	1,137
50%	946	903	910	787	909	982	1,119	1,104	1,151	1,233	1,154	1,079
60%	878	822	843	679	793	935	1,071	1,066	1,131	1,167	1,032	972
70%	748	613	558	615	762	844	937	1,014	1,053	1,052	868	848
80%	453	409	376	323	674	769	864	976	1,003	907	753	796
90%	195	207	275	205	332	708	745	824	786	636	403	312
Long Term												
Full Simulation Period[a]	827	766	791	732	889	1,000	1,076	1,106	1,090	1,083	997	959
Water Year Types[b,c]												
Wet (32%)	1,129	1,045	1,094	1,067	1,210	1,297	1,313	1,316	1,246	1,290	1,279	1,258
Above Normal (16%)	1,024	973	944	737	981	1,130	1,199	1,185	1,182	1,258	1,235	1,164
Below Normal (13%)	866	823	726	709	890	943	1,076	1,097	1,126	1,171	1,038	990
Dry (24%)	648	573	650	543	684	811	958	1,037	1,060	1,004	837	818
Critical (15%)	221	204	261	337	433	586	627	690	668	497	359	298

Alternative 3 021719

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Capacity (MW)											
Probability of Exceedance												
10%	1,320	1,343	1,362	1,451	1,484	1,508	1,420	1,435	1,384	1,391	1,348	1,333
20%	1,230	1,199	1,237	1,325	1,462	1,478	1,386	1,409	1,356	1,362	1,299	1,260
30%	1,165	1,143	1,148	1,191	1,393	1,459	1,368	1,383	1,336	1,345	1,266	1,214
40%	1,098	1,088	1,079	1,107	1,267	1,422	1,339	1,349	1,316	1,318	1,231	1,164
50%	1,039	1,012	1,013	994	1,127	1,327	1,310	1,324	1,290	1,273	1,169	1,102
60%	943	916	919	745	1,014	1,211	1,265	1,290	1,267	1,203	1,094	1,028
70%	722	734	691	619	832	979	1,101	1,141	1,194	1,115	1,039	979
80%	502	459	488	354	718	844	943	1,014	1,074	1,018	944	846
90%	289	269	374	226	417	749	823	925	934	842	549	415
Long Term												
Full Simulation Period[a]	896	889	913	886	1,060	1,190	1,190	1,233	1,202	1,160	1,070	1,005
Water Year Types[b,c]												
Wet (32%)	1,258	1,256	1,265	1,248	1,405	1,480	1,385	1,397	1,343	1,356	1,301	1,280
Above Normal (16%)	1,124	1,097	1,078	929	1,255	1,422	1,363	1,378	1,331	1,345	1,268	1,193
Below Normal (13%)	942	897	826	947	1,082	1,228	1,265	1,324	1,297	1,231	1,114	1,032
Dry (24%)	657	674	752	637	789	958	1,067	1,134	1,162	1,097	990	902
Critical (15%)	222	220	323	414	534	663	715	802	736	577	450	354

Alternative 3 021719 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Capacity (MW)											
Probability of Exceedance												
10%	110	242	172	268	141	59	73	76	72	79	51	27
20%	148	177	201	314	281	201	93	101	124	94	22	27
30%	133	155	153	247	340	275	115	124	151	88	17	16
40%	105	150	112	274	273	385	126	147	152	71	6	27
50%	93	108	103	206	218	345	191	220	140	40	14	23
60%	65	94	76	66	221	276	194	224	136	36	62	55
70%	-26	121	133	5	70	135	164	127	141	64	171	131
80%	49	50	112	31	44	76	79	37	71	111	191	50
90%	94	62	99	21	85	40	78	101	149	206	146	103
Long Term												
Full Simulation Period[a]	69	123	123	154	172	190	114	127	112	77	73	46
Water Year Types[b,c]												
Wet (32%)	129	211	170	181	195	183	71	81	97	66	23	22
Above Normal (16%)	100	124	133	192	273	292	165	193	149	87	33	29
Below Normal (13%)	76	74	100	237	193	285	189	227	171	60	76	42
Dry (24%)	9	101	102	94	105	147	109	96	102	92	152	84
Critical (15%)	1	16	62	77	102	77	88	111	68	80	91	56

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 5-4. SWP Total Capacity, Monthly Capacity

No Action Alternative 011319

	Monthly Capacity (MW)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,210	1,101	1,189	1,182	1,344	1,450	1,347	1,359	1,312	1,312	1,297	1,306
20%	1,082	1,023	1,037	1,010	1,181	1,277	1,294	1,309	1,232	1,269	1,277	1,233
30%	1,032	988	995	944	1,053	1,184	1,253	1,259	1,184	1,256	1,248	1,197
40%	994	939	966	833	994	1,037	1,213	1,202	1,165	1,247	1,225	1,137
50%	946	903	910	787	909	982	1,119	1,104	1,151	1,233	1,154	1,079
60%	878	822	843	679	793	935	1,071	1,066	1,131	1,167	1,032	972
70%	748	613	558	615	762	844	937	1,014	1,053	1,052	868	848
80%	453	409	376	323	674	769	864	976	1,003	907	753	796
90%	195	207	275	205	332	708	745	824	786	636	403	312
Long Term												
Full Simulation Period[a]	827	766	791	732	889	1,000	1,076	1,106	1,090	1,083	997	959
Water Year Types[b,c]												
Wet (32%)	1,129	1,045	1,094	1,067	1,210	1,297	1,313	1,316	1,246	1,290	1,279	1,258
Above Normal (16%)	1,024	973	944	737	981	1,130	1,199	1,185	1,182	1,258	1,235	1,164
Below Normal (13%)	866	823	726	709	890	943	1,076	1,097	1,126	1,171	1,038	990
Dry (24%)	648	573	650	543	684	811	958	1,037	1,060	1,004	837	818
Critical (15%)	221	204	261	337	433	586	627	690	668	497	359	298

Alternative 4 043019

	Monthly Capacity (MW)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,273	1,274	1,268	1,378	1,461	1,456	1,356	1,393	1,324	1,332	1,295	1,271
20%	1,111	1,071	1,084	1,143	1,288	1,259	1,295	1,296	1,228	1,266	1,251	1,188
30%	1,048	1,004	998	997	1,169	1,180	1,219	1,243	1,181	1,253	1,216	1,126
40%	975	942	949	925	1,050	1,065	1,182	1,140	1,162	1,228	1,163	1,074
50%	899	863	889	829	967	997	1,117	1,081	1,139	1,181	1,090	990
60%	812	738	789	716	876	921	970	1,052	1,103	1,115	933	901
70%	667	468	480	645	780	840	912	1,006	1,029	930	859	825
80%	425	340	361	275	678	779	834	924	946	867	793	720
90%	213	232	267	216	327	706	755	804	792	701	377	284
Long Term												
Full Simulation Period[a]	812	767	793	782	939	1,009	1,055	1,093	1,081	1,062	977	905
Water Year Types[b,c]												
Wet (32%)	1,169	1,153	1,148	1,128	1,278	1,318	1,300	1,315	1,252	1,290	1,265	1,214
Above Normal (16%)	999	962	934	840	1,054	1,123	1,220	1,189	1,181	1,254	1,192	1,107
Below Normal (13%)	843	700	650	808	980	984	1,060	1,057	1,112	1,119	996	946
Dry (24%)	579	508	622	546	695	809	888	999	1,014	931	820	735
Critical (15%)	198	210	286	339	449	575	623	697	686	523	362	263

Alternative 4 043019 minus No Action Alternative 011319

	Monthly Capacity (MW)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	63	173	78	195	117	7	8	34	12	20	-1	-35
20%	29	48	47	132	107	-18	2	-13	-4	-2	-26	-45
30%	17	16	3	53	116	-3	-34	-15	-3	-3	-33	-72
40%	-19	3	-18	92	56	28	-30	-62	-2	-19	-62	-63
50%	-47	-41	-22	42	58	15	-1	-23	-12	-51	-64	-89
60%	-66	-84	-54	37	83	-15	-100	-13	-29	-52	-99	-71
70%	-81	-145	-78	30	18	-5	-25	-8	-24	-121	-10	-23
80%	-28	-69	-14	-48	4	11	-30	-52	-57	-40	40	-76
90%	18	25	-8	11	-5	-2	10	-21	6	65	-25	-28
Long Term												
Full Simulation Period[a]	-14	1	2	50	50	9	-21	-13	-9	-22	-21	-54
Water Year Types[b,c]												
Wet (32%)	40	108	54	61	68	21	-14	-1	6	0	-13	-44
Above Normal (16%)	-25	-11	-11	103	72	-7	22	5	-1	-4	-43	-56
Below Normal (13%)	-24	-123	-76	99	90	41	-16	-40	-14	-52	-42	-45
Dry (24%)	-68	-65	-28	4	11	-2	-70	-38	-46	-73	-18	-83
Critical (15%)	-23	6	25	1	16	-11	-4	7	19	26	3	-35

a Based on the 82-year simulation period.

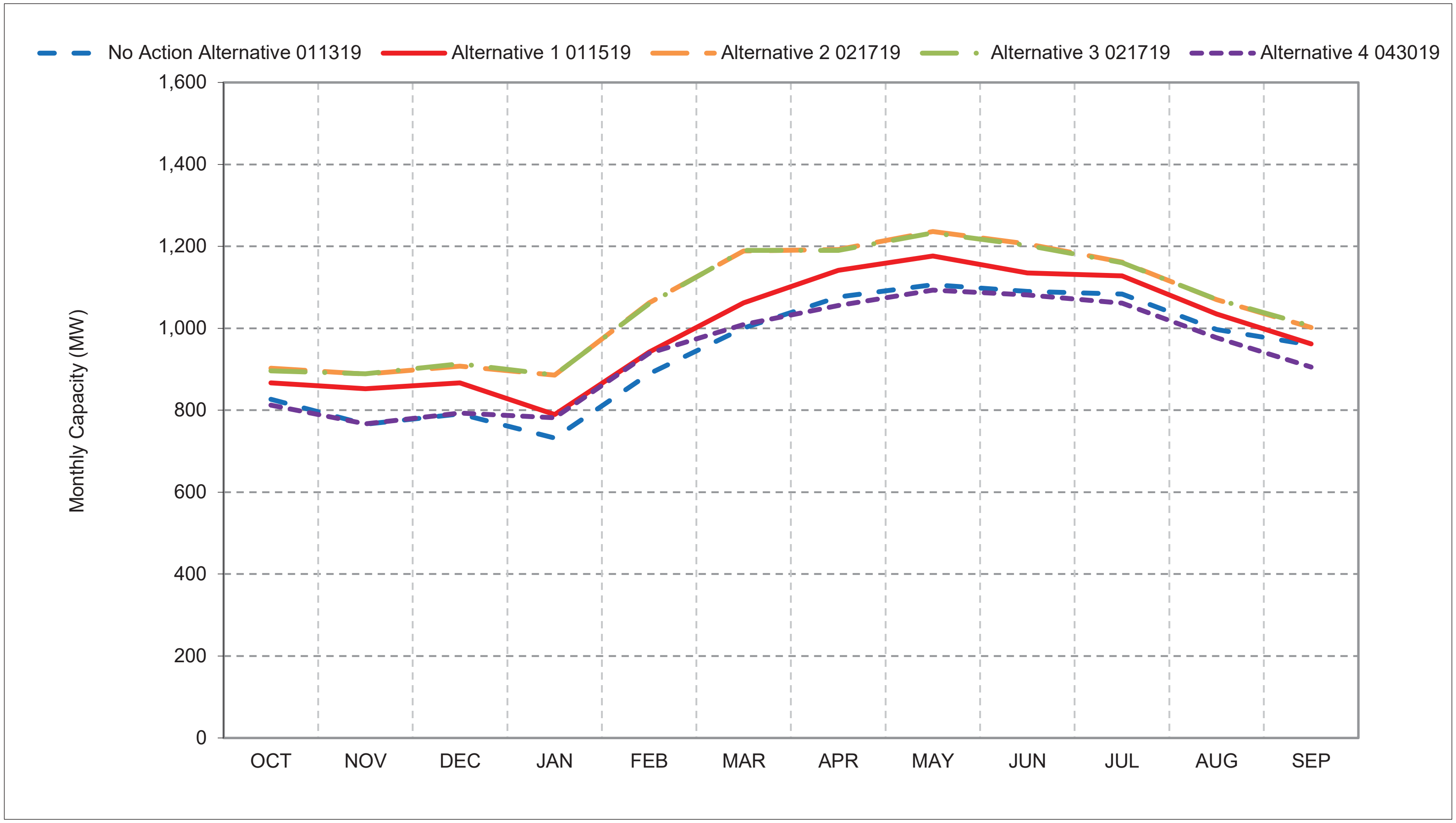
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Figure 5-1. SWP Total Capacity, Long-Term Average Capacity



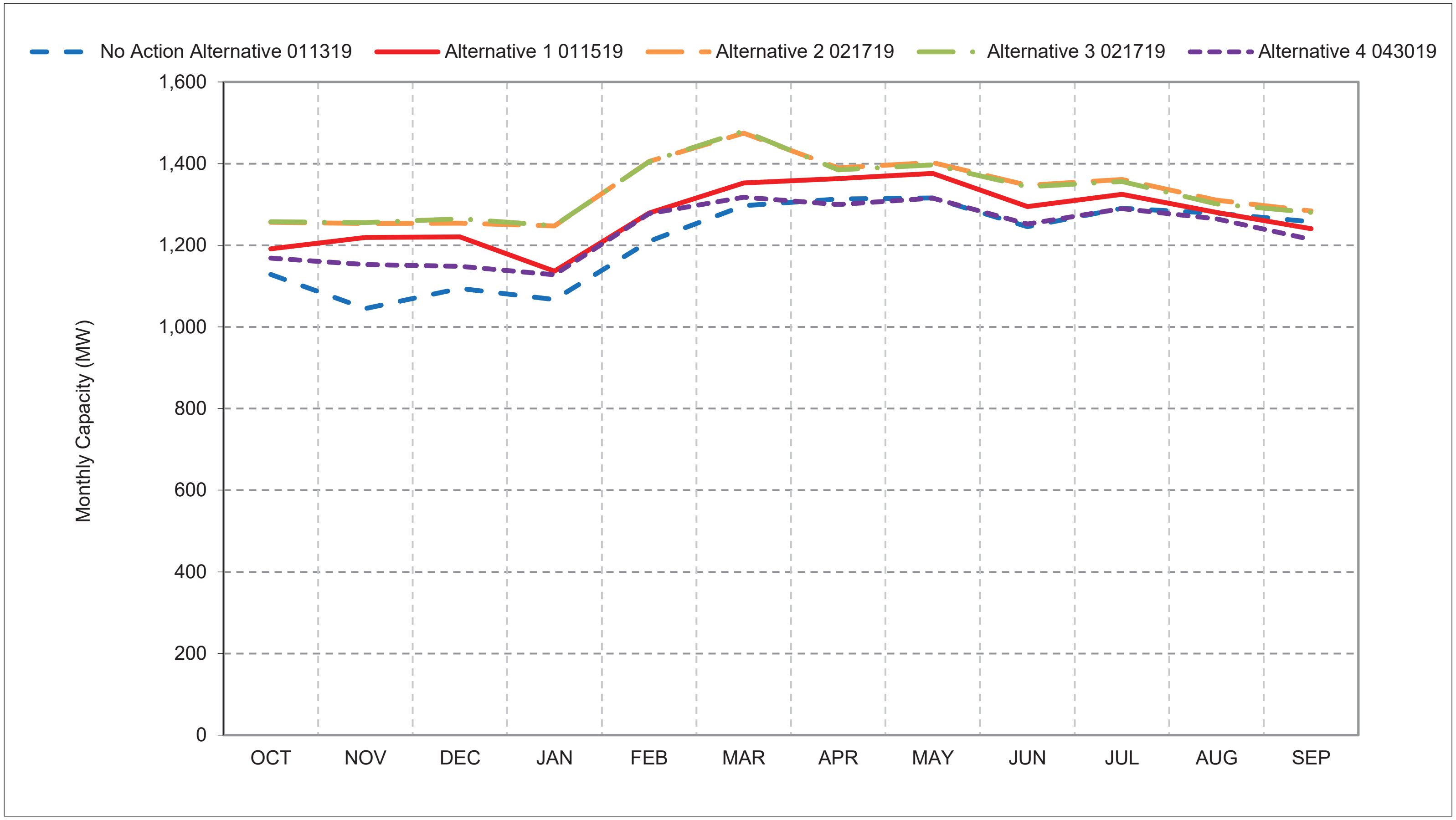
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

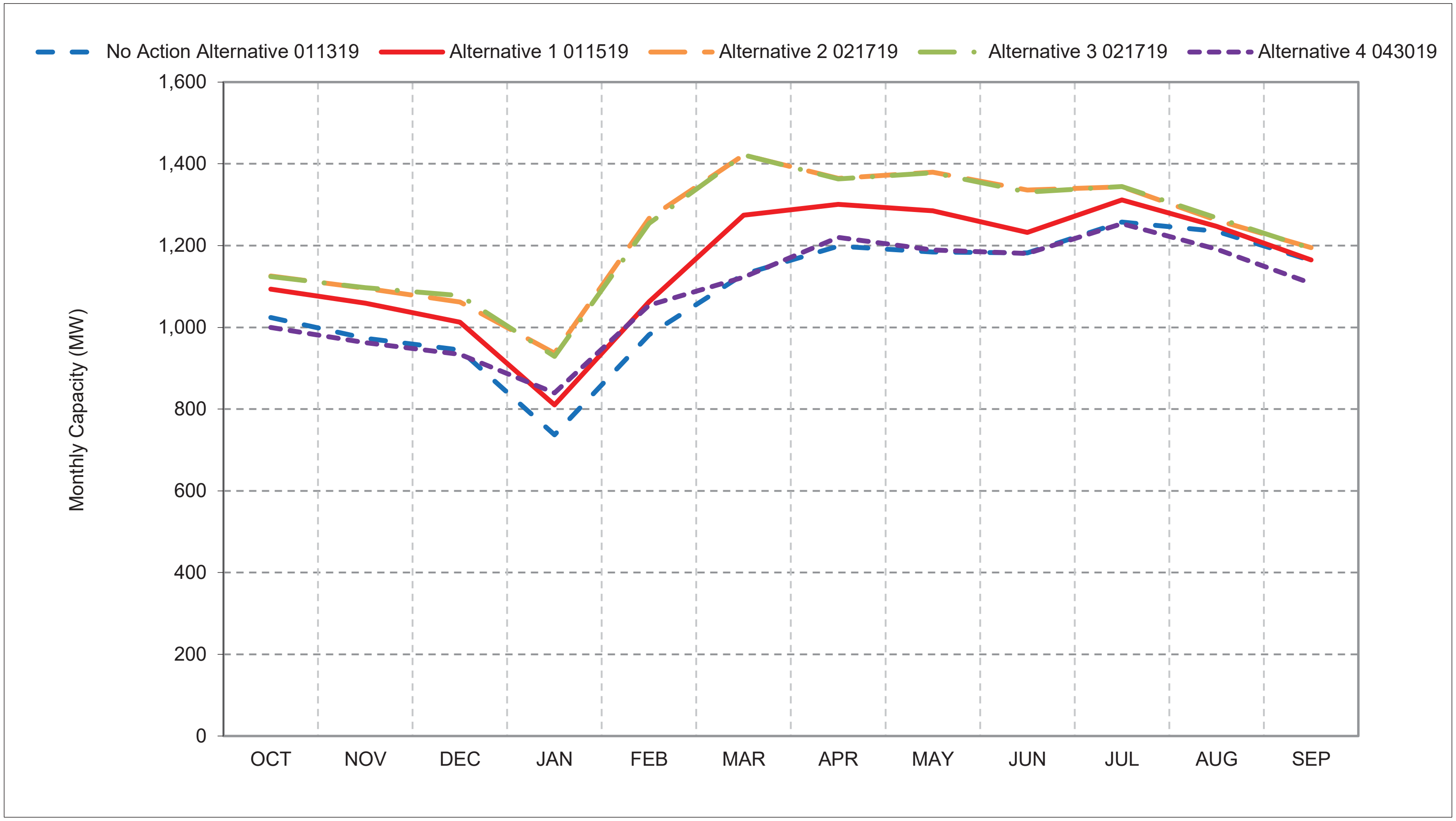
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 5-2. SWP Total Capacity, Wet Year Average Capacity



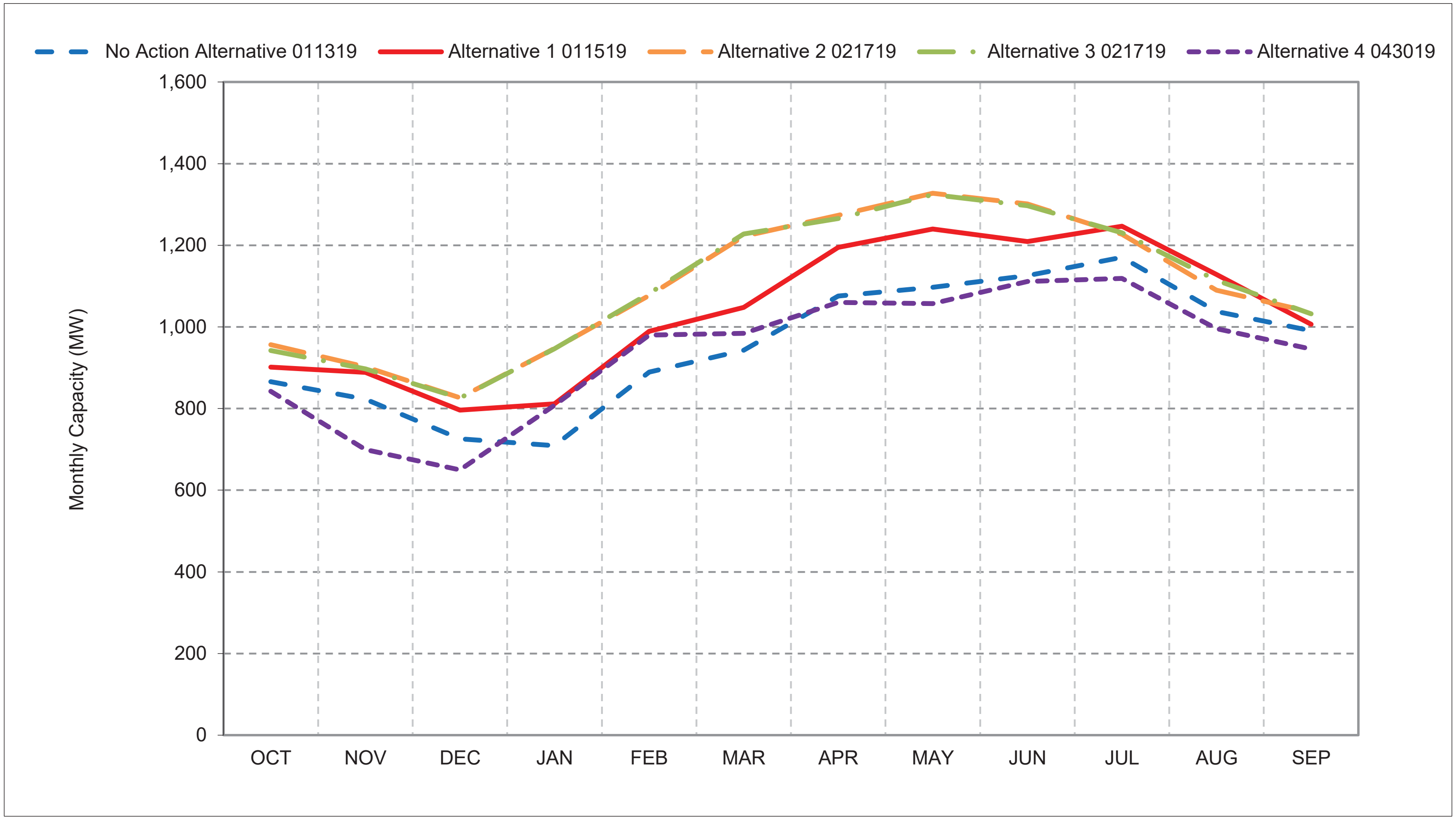
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 5-3. SWP Total Capacity, Above Normal Year Average Capacity



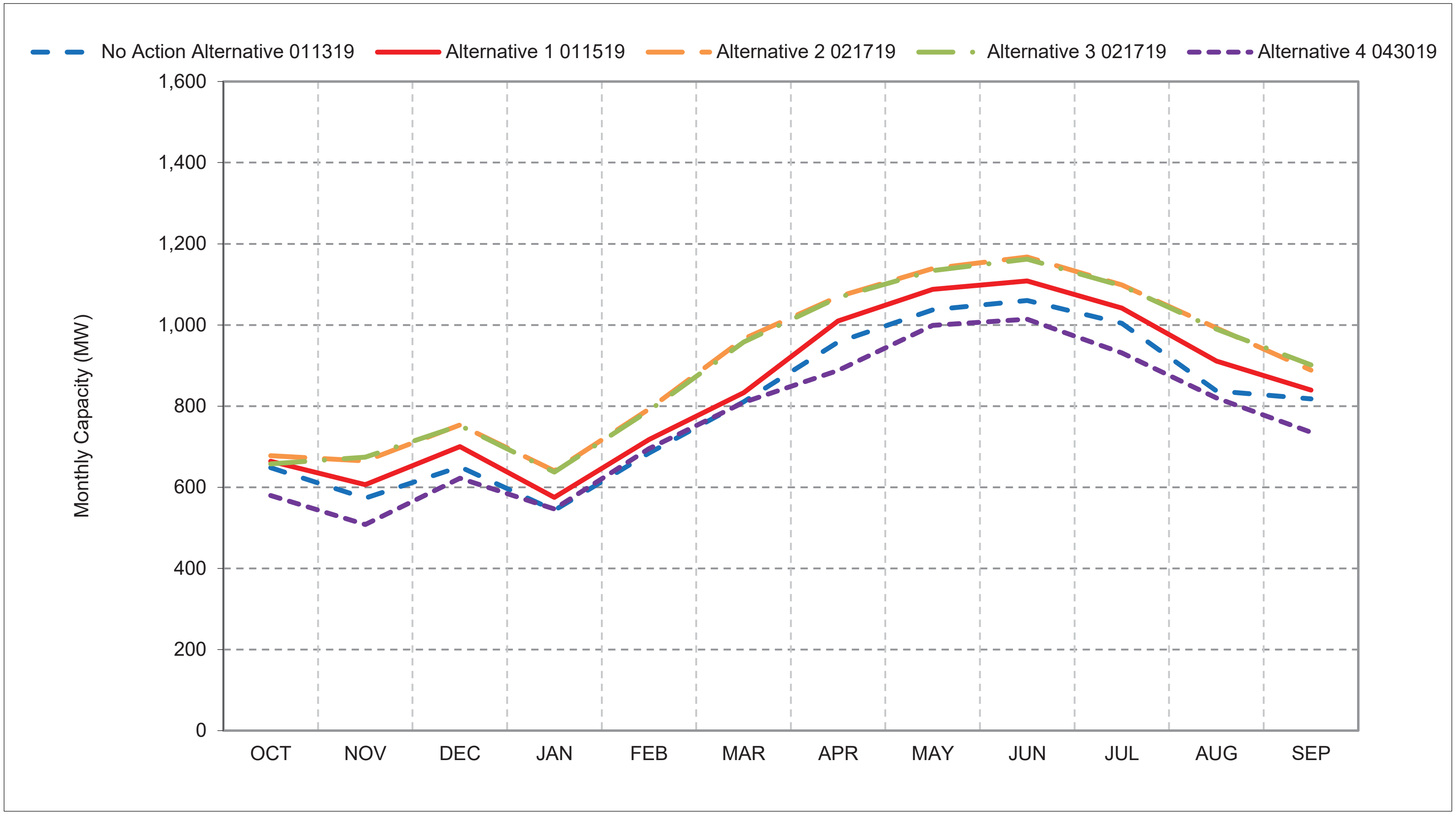
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 5-4. SWP Total Capacity, Below Normal Year Average Capacity



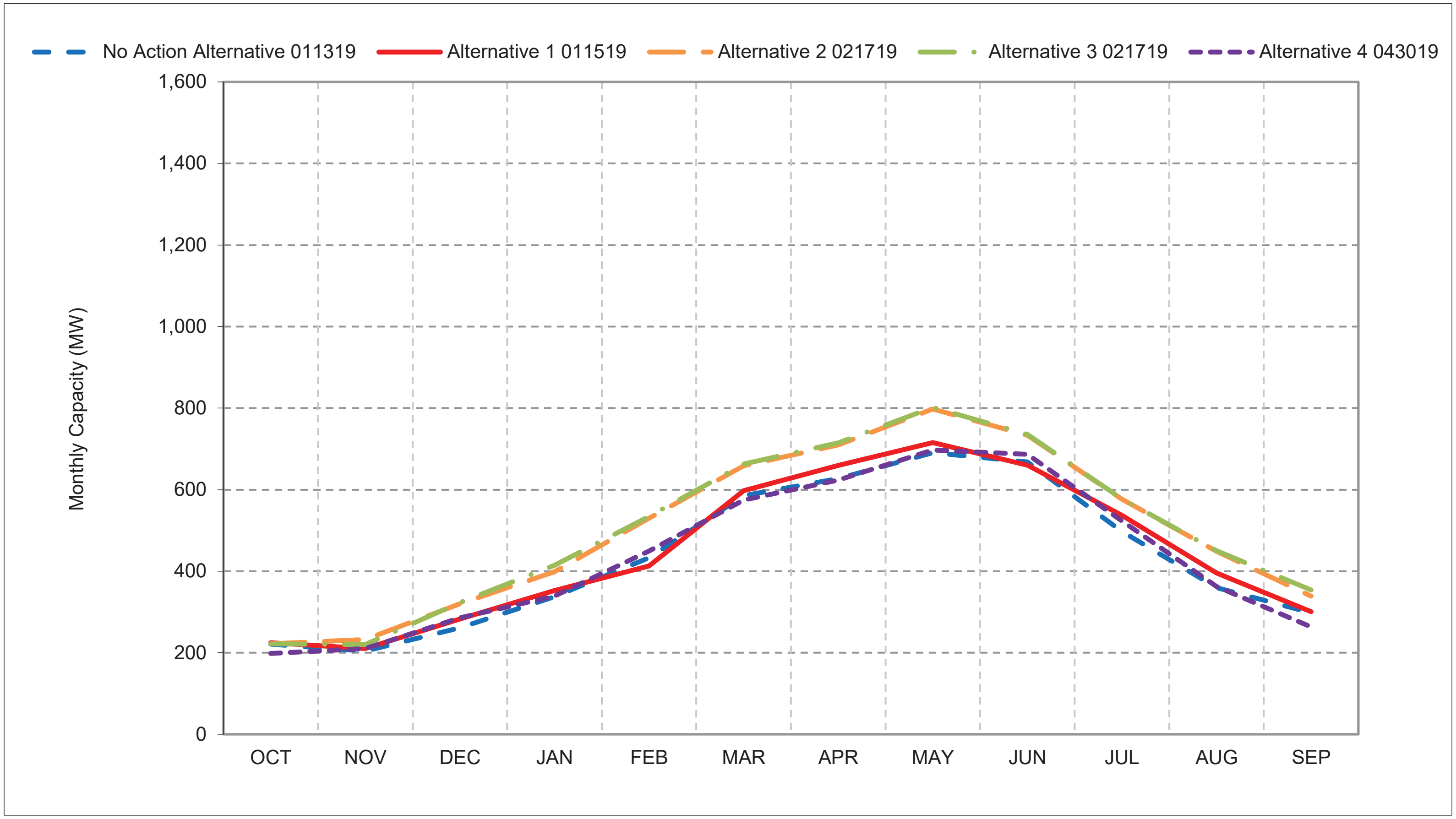
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 5-5. SWP Total Capacity, Dry Year Average Capacity



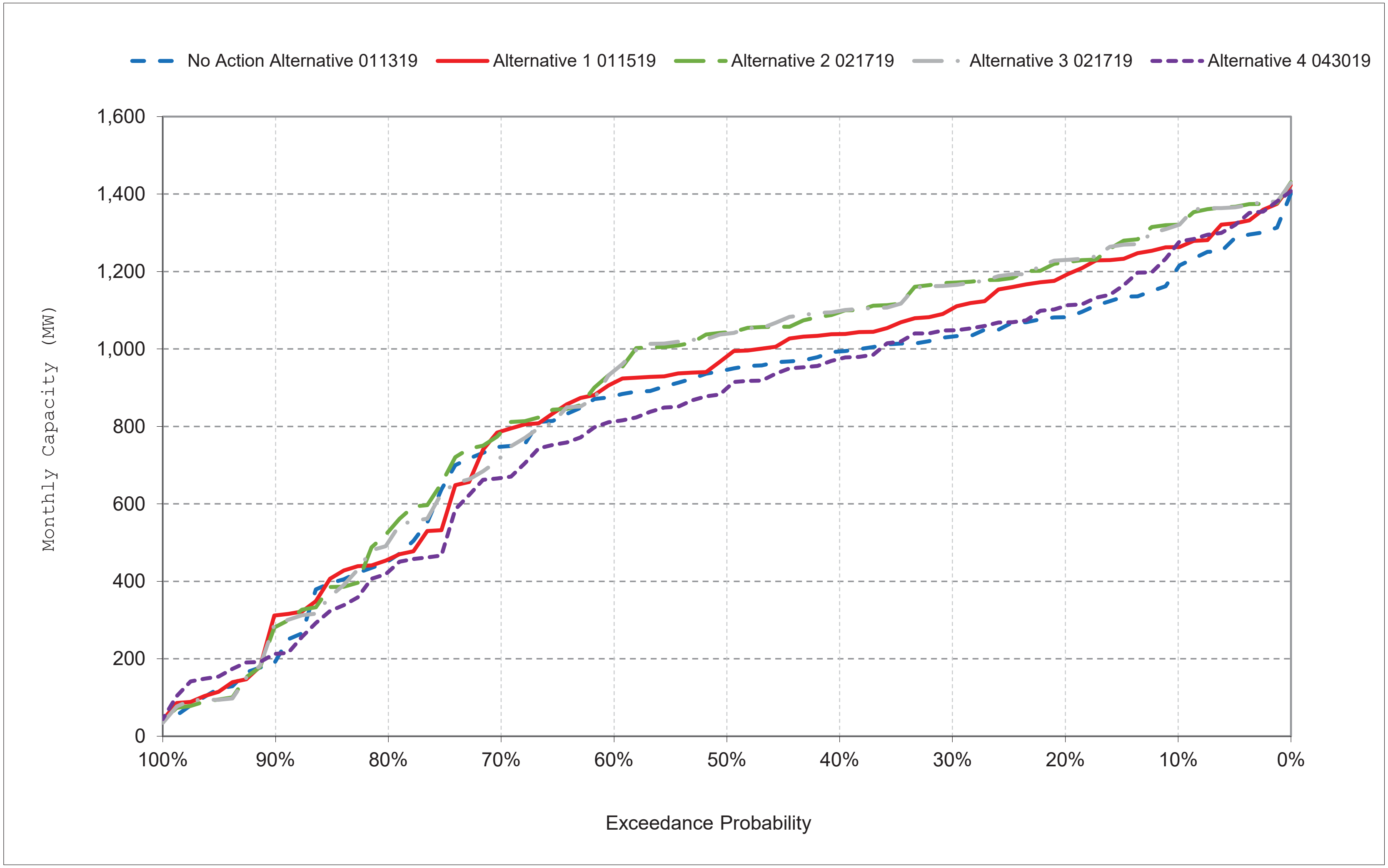
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 5-6. SWP Total Capacity, Critical Year Average Capacity



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

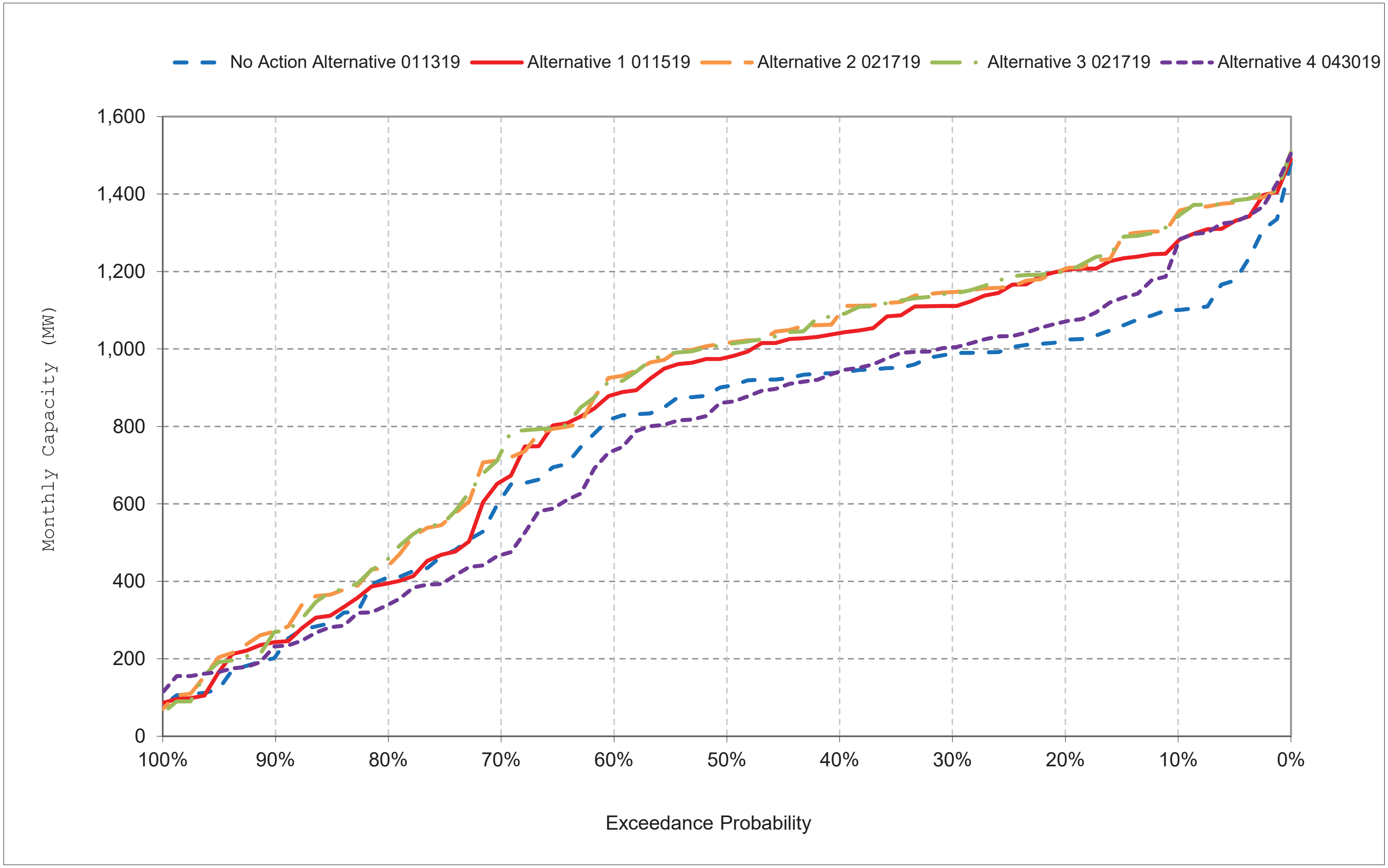
Figure 5-7. SWP Total Capacity, October



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

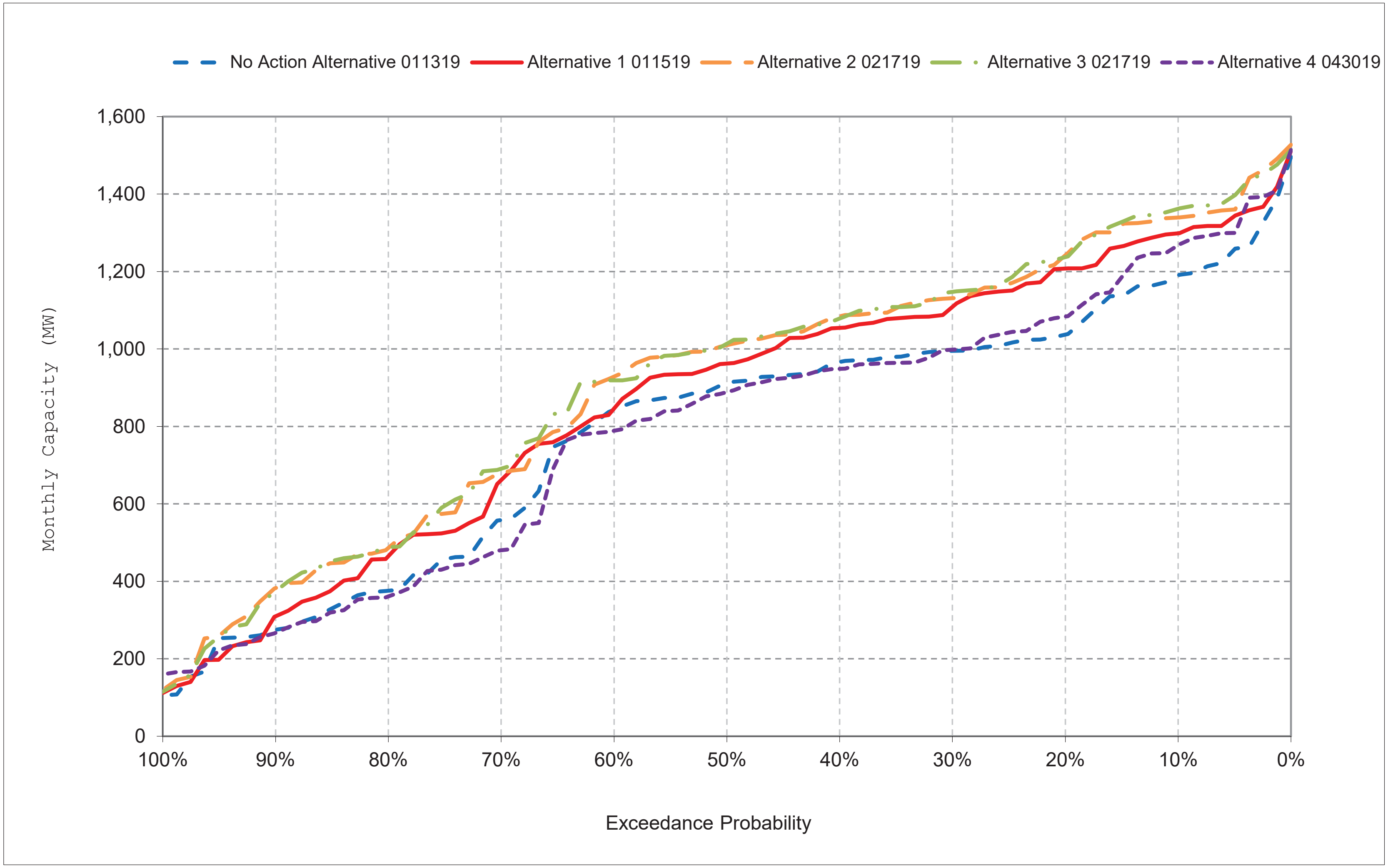
Figure 5-8. SWP Total Capacity, November



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

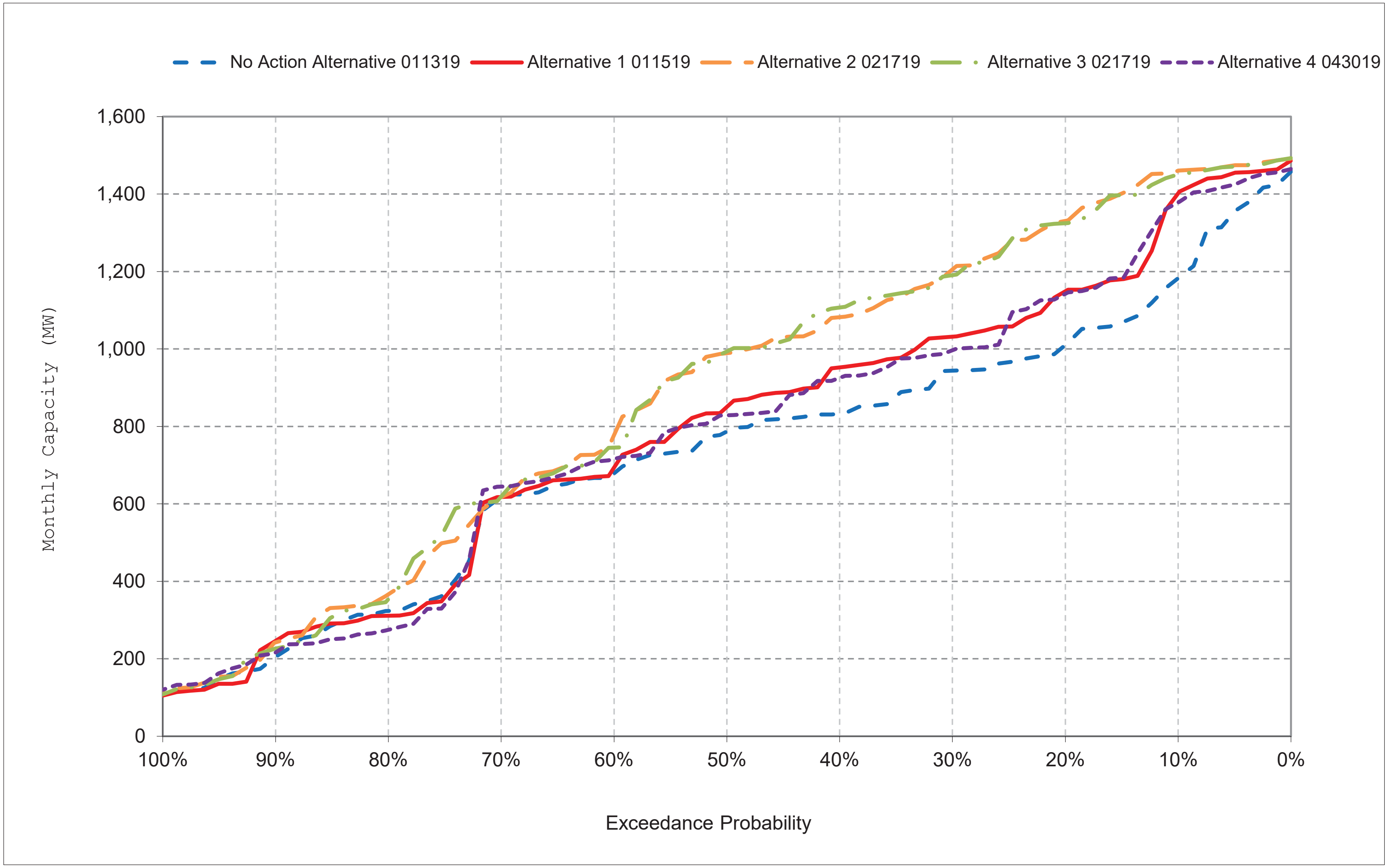
Figure 5-9. SWP Total Capacity, December



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

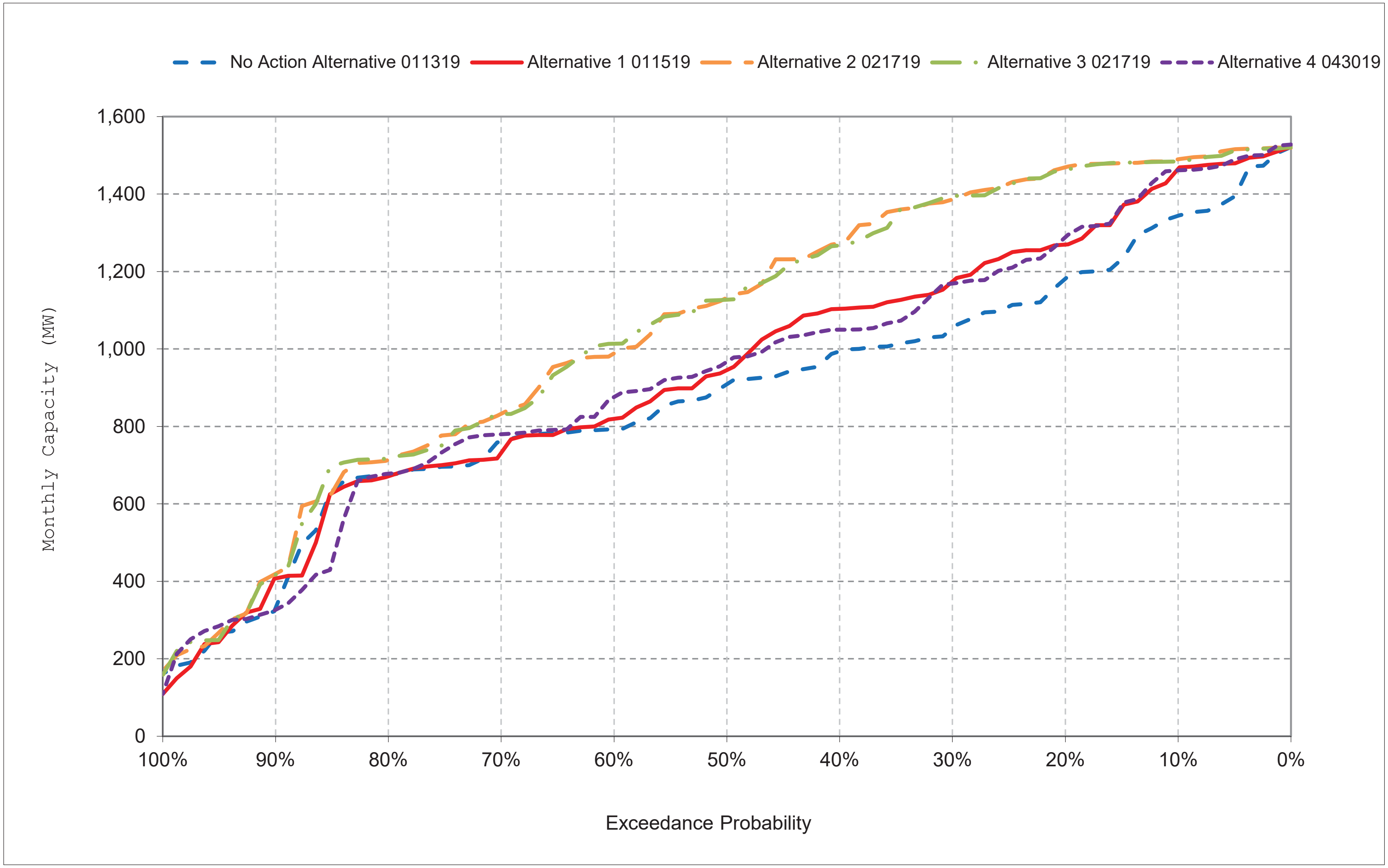
Figure 5-10. SWP Total Capacity, January



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

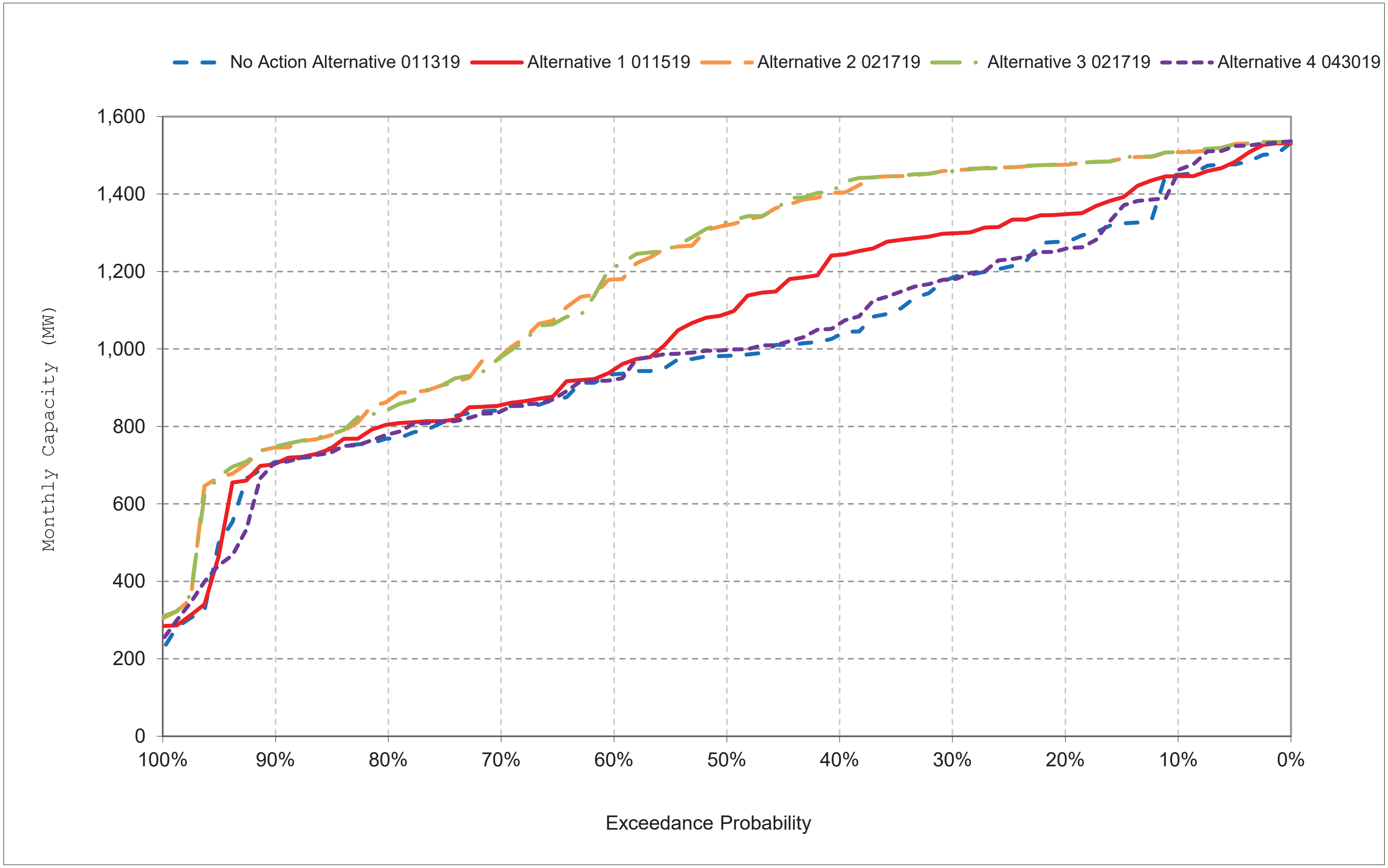
Figure 5-11. SWP Total Capacity, February



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

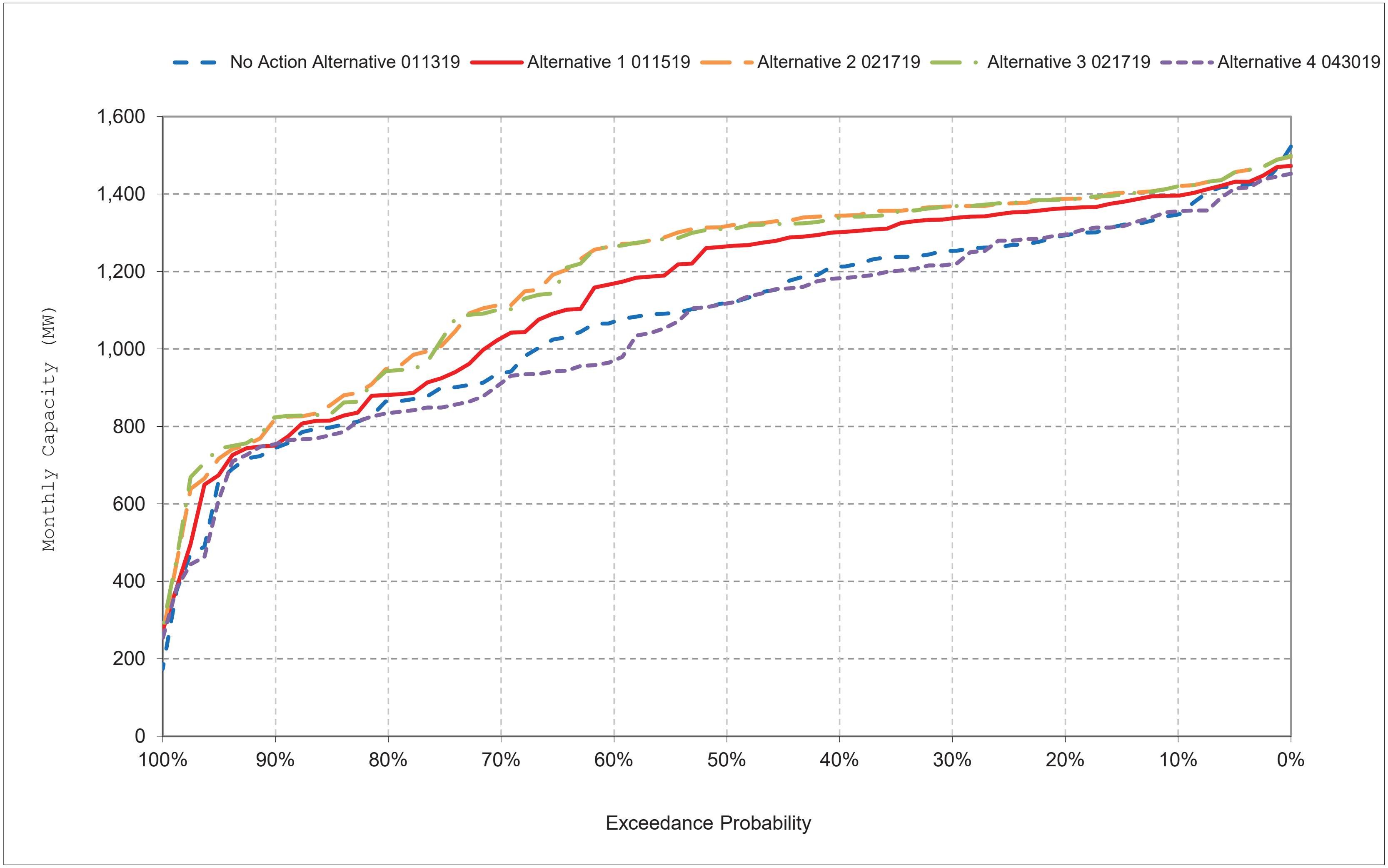
Figure 5-12. SWP Total Capacity, March



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

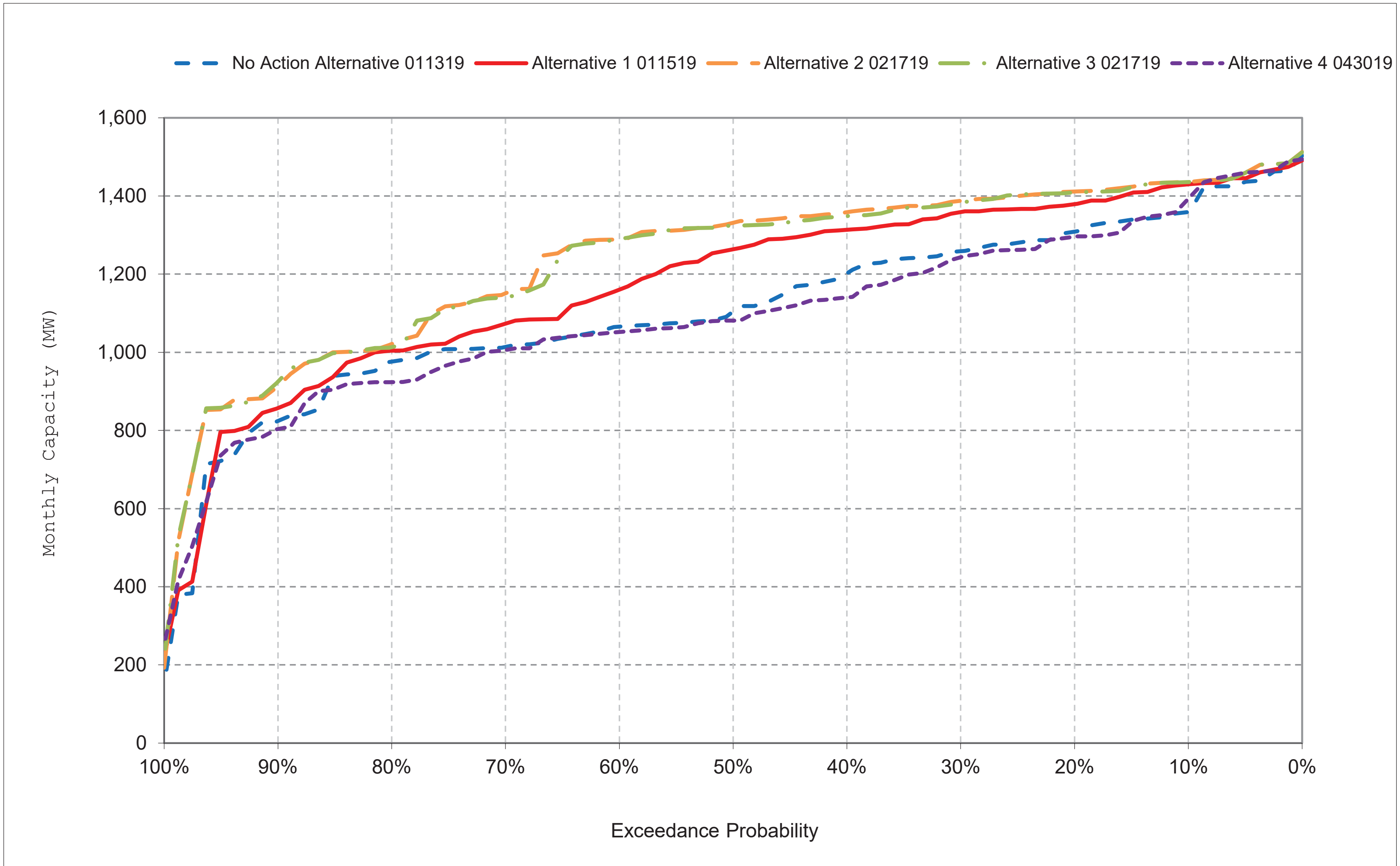
Figure 5-13. SWP Total Capacity, April



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

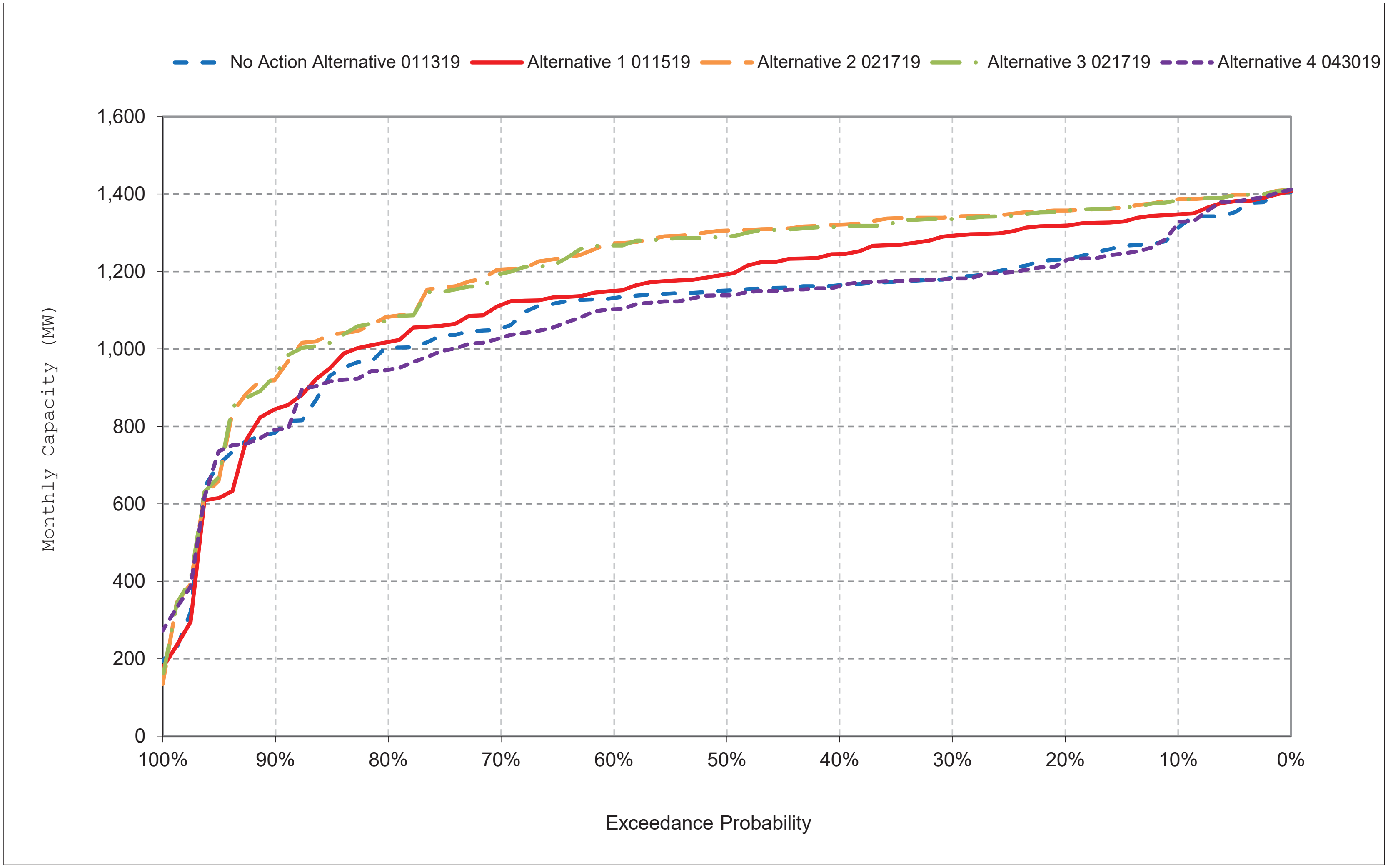
Figure 5-14. SWP Total Capacity, May



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

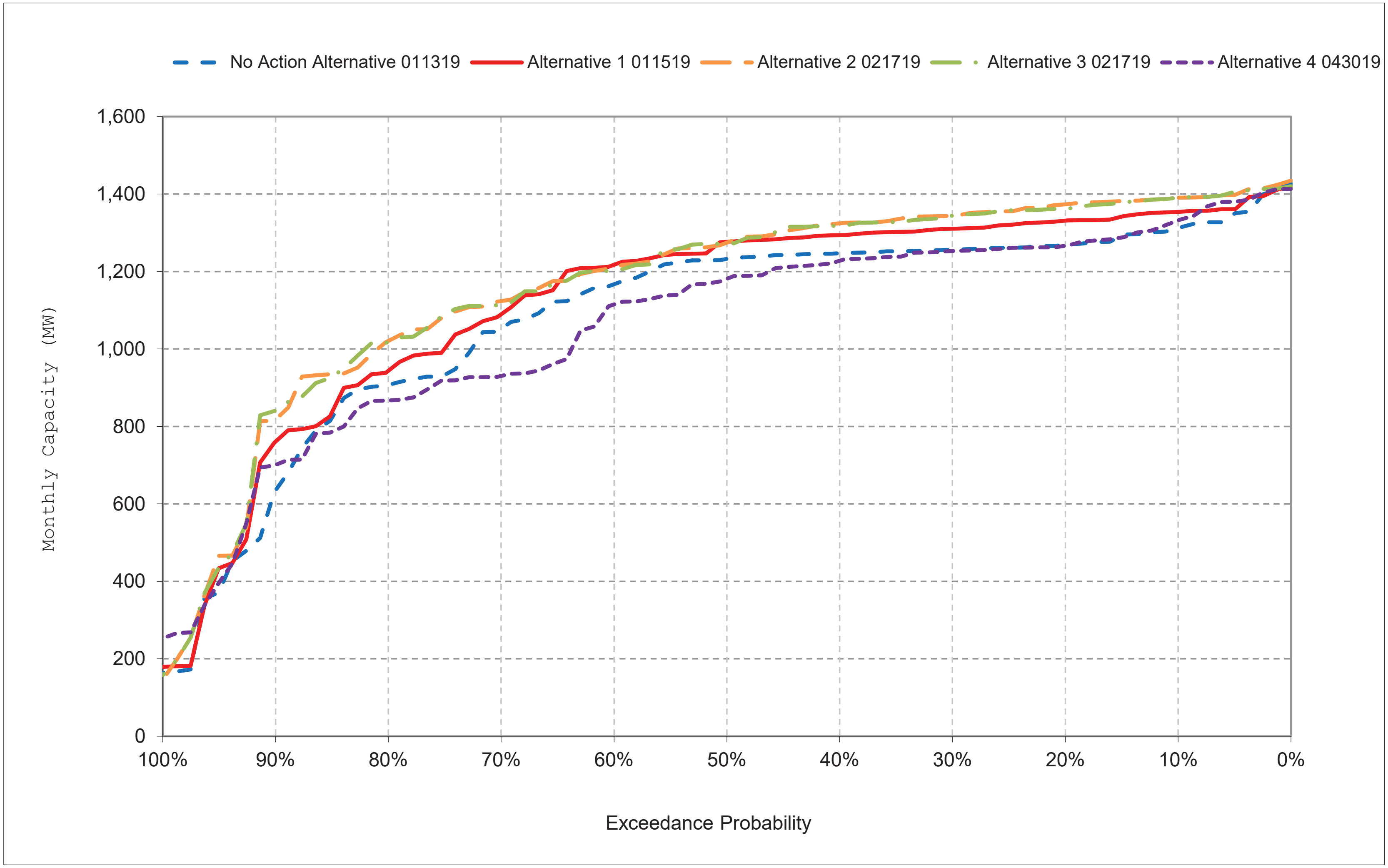
Figure 5-15. SWP Total Capacity, June



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

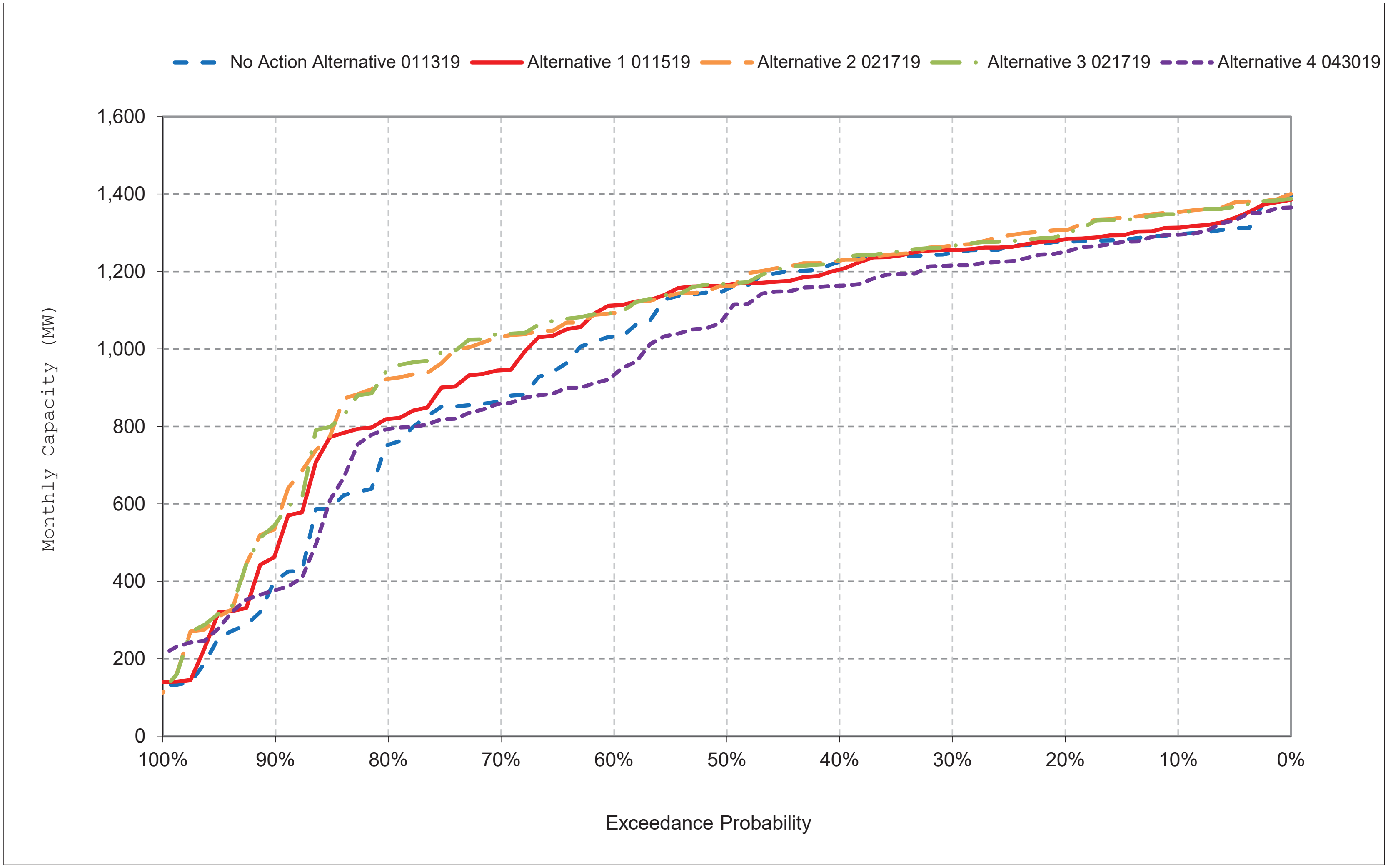
Figure 5-16. SWP Total Capacity, July



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

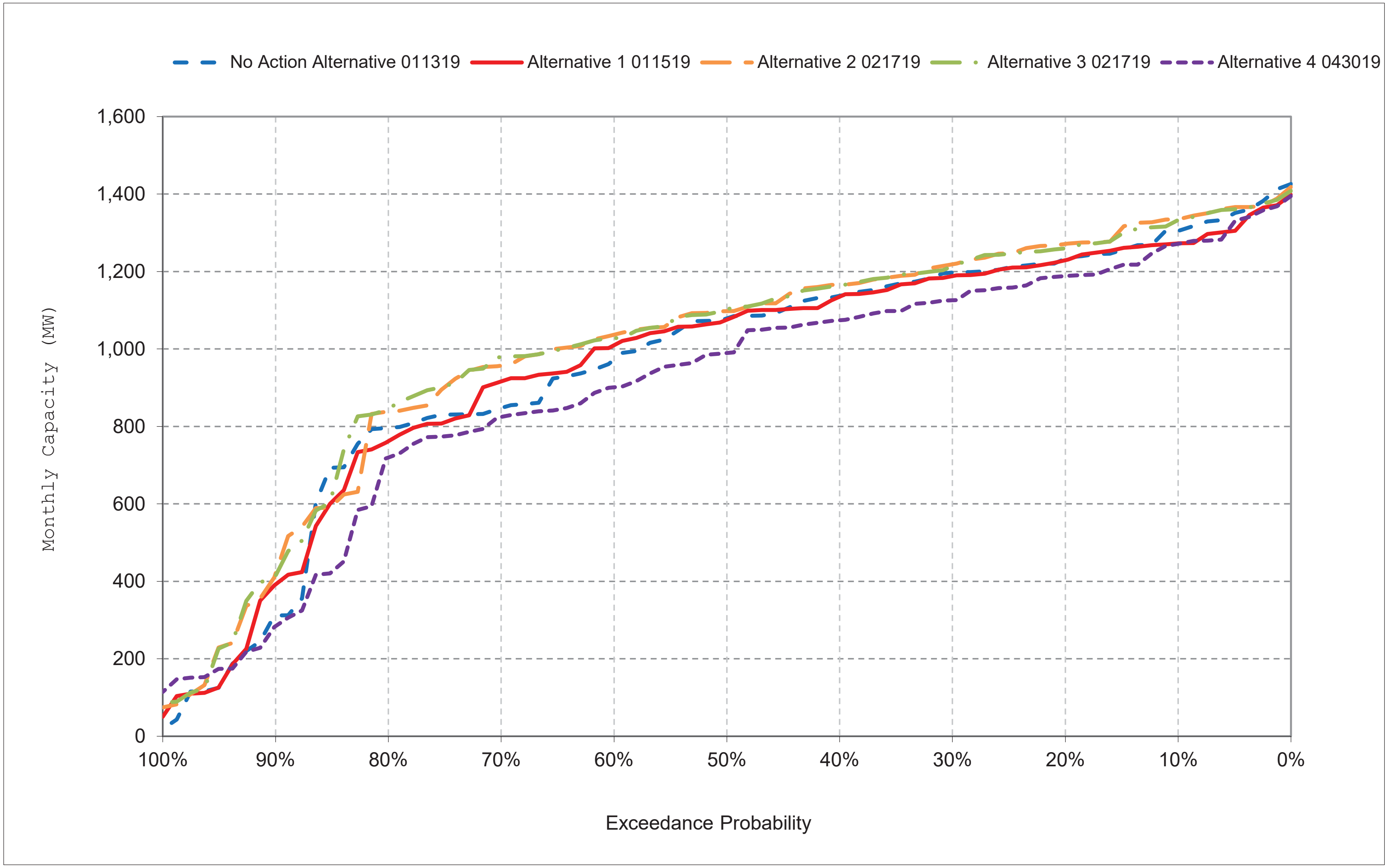
Figure 5-17. SWP Total Capacity, August



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 5-18. SWP Total Capacity, September



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Table 6-1. SWP Total Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	488	393	452	663	683	688	599	719	538	697	619	656
20%	422	344	355	242	552	560	418	495	469	680	605	611
30%	396	323	302	183	214	378	352	427	437	658	576	577
40%	368	310	277	142	165	273	335	396	428	649	548	524
50%	338	283	263	102	121	134	281	355	415	632	506	458
60%	283	254	249	75	75	96	232	286	401	576	417	347
70%	235	208	211	57	59	84	175	263	368	469	313	285
80%	193	156	170	47	48	59	121	237	352	359	227	234
90%	97	93	123	36	32	48	93	214	266	264	153	146
Long Term												
Full Simulation Period[a]	312	268	278	198	235	284	306	396	407	537	433	419
Water Year Types[b,c]												
Wet (32%)	441	365	386	416	511	591	521	620	487	624	552	617
Above Normal (16%)	392	326	297	149	208	329	328	383	413	668	607	557
Below Normal (13%)	298	271	245	117	112	116	242	317	390	625	479	366
Dry (24%)	230	210	237	81	76	76	170	284	405	473	304	274
Critical (15%)	97	92	121	51	44	69	106	184	243	232	157	133

Alternative 1 011519

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	486	420	493	758	731	769	617	714	582	719	632	514
20%	441	399	400	275	609	607	460	576	525	699	612	481
30%	421	386	363	224	386	511	379	504	500	693	597	437
40%	373	359	330	180	192	344	353	440	481	667	559	395
50%	334	326	311	95	160	254	323	413	464	648	502	379
60%	295	290	271	78	77	118	266	356	433	568	453	353
70%	243	220	239	65	63	90	186	307	418	471	355	289
80%	193	181	183	48	47	60	130	253	370	379	281	250
90%	108	121	116	36	31	47	102	203	288	282	215	168
Long Term												
Full Simulation Period[a]	318	300	320	227	274	332	330	431	447	558	457	356
Water Year Types[b,c]												
Wet (32%)	419	415	462	472	562	647	526	632	516	642	554	420
Above Normal (16%)	438	371	348	177	270	469	390	450	455	712	623	510
Below Normal (13%)	314	308	290	143	199	170	300	418	466	665	550	366
Dry (24%)	238	221	246	90	83	76	184	303	447	481	339	291
Critical (15%)	105	99	132	54	44	78	109	197	269	238	178	147

Alternative 1 011519 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	-2	27	41	95	49	81	17	-5	44	23	14	-142
20%	19	55	46	33	57	47	42	81	56	19	7	-130
30%	25	63	60	41	172	132	28	77	62	35	21	-140
40%	5	48	53	38	27	71	18	44	53	18	11	-129
50%	-3	43	48	-7	39	121	41	58	49	16	-4	-79
60%	12	35	21	3	2	23	35	70	32	-8	35	7
70%	8	13	29	8	4	5	11	45	50	2	42	4
80%	-1	25	13	1	-1	1	9	16	18	20	54	17
90%	11	28	-6	0	-1	-1	9	-11	22	18	62	22
Long Term												
Full Simulation Period[a]	6	32	42	28	39	49	23	34	40	21	24	-64
Water Year Types[b,c]												
Wet (32%)	-22	51	76	56	52	57	5	12	30	18	2	-198
Above Normal (16%)	46	45	51	28	62	140	62	67	42	44	16	-47
Below Normal (13%)	17	37	45	26	87	54	58	101	75	40	71	0
Dry (24%)	7	10	9	9	6	0	15	18	42	8	36	17
Critical (15%)	8	7	11	2	0	9	3	13	26	6	21	13

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 6-2. SWP Total Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	488	393	452	663	683	688	599	719	538	697	619	656
20%	422	344	355	242	552	560	418	495	469	680	605	611
30%	396	323	302	183	214	378	352	427	437	658	576	577
40%	368	310	277	142	165	273	335	396	428	649	548	524
50%	338	283	263	102	121	134	281	355	415	632	506	458
60%	283	254	249	75	75	96	232	286	401	576	417	347
70%	235	208	211	57	59	84	175	263	368	469	313	285
80%	193	156	170	47	48	59	121	237	352	359	227	234
90%	97	93	123	36	32	48	93	214	266	264	153	146
Long Term												
Full Simulation Period[a]	312	268	278	198	235	284	306	396	407	537	433	419
Water Year Types[b,c]												
Wet (32%)	441	365	386	416	511	591	521	620	487	624	552	617
Above Normal (16%)	392	326	297	149	208	329	328	383	413	668	607	557
Below Normal (13%)	298	271	245	117	112	116	242	317	390	625	479	366
Dry (24%)	230	210	237	81	76	76	170	284	405	473	304	274
Critical (15%)	97	92	121	51	44	69	106	184	243	232	157	133

Alternative 2 021719

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	485	422	511	806	779	853	601	685	626	726	632	511
20%	466	404	379	382	617	660	440	611	605	703	600	468
30%	439	393	348	314	463	564	396	534	582	681	542	436
40%	422	377	334	231	316	463	356	471	560	663	496	396
50%	381	346	320	203	198	325	334	443	528	582	468	387
60%	330	308	295	158	177	252	302	399	494	544	437	370
70%	260	264	267	66	121	153	239	337	474	492	396	343
80%	217	220	221	53	58	106	141	277	410	426	356	296
90%	145	147	171	38	40	57	117	241	362	354	285	217
Long Term												
Full Simulation Period[a]	340	321	334	276	322	395	340	455	508	559	458	372
Water Year Types[b,c]												
Wet (32%)	455	420	451	530	607	707	523	629	543	633	524	425
Above Normal (16%)	445	387	355	236	368	533	389	492	561	706	600	496
Below Normal (13%)	347	340	316	229	239	270	333	483	604	619	474	379
Dry (24%)	258	258	278	122	123	151	208	333	496	502	406	337
Critical (15%)	107	121	168	69	60	89	119	217	304	282	234	173

Alternative 2 021719 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	-3	30	60	143	97	165	1	-34	88	30	14	-145
20%	43	60	24	140	65	100	22	116	135	22	-4	-143
30%	42	70	46	131	249	186	45	107	145	23	-33	-141
40%	54	67	57	89	150	190	21	76	133	14	-52	-128
50%	43	63	58	102	77	192	52	89	113	-50	-39	-70
60%	48	54	46	83	101	156	71	113	93	-33	20	23
70%	25	57	56	9	62	68	64	74	106	23	84	58
80%	23	63	51	7	10	47	19	40	57	67	129	62
90%	48	54	49	2	8	10	24	27	96	90	132	71
Long Term												
Full Simulation Period[a]	27	53	56	77	87	111	34	59	101	22	26	-48
Water Year Types[b,c]												
Wet (32%)	13	56	66	114	97	116	2	9	57	9	-27	-193
Above Normal (16%)	53	62	58	87	159	205	61	109	148	37	-7	-60
Below Normal (13%)	49	69	71	112	127	154	91	166	214	-6	-5	13
Dry (24%)	27	48	41	41	47	75	39	48	91	29	102	63
Critical (15%)	10	30	47	17	16	21	12	33	61	50	77	39

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 6-3. SWP Total Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	488	393	452	663	683	688	599	719	538	697	619	656
20%	422	344	355	242	552	560	418	495	469	680	605	611
30%	396	323	302	183	214	378	352	427	437	658	576	577
40%	368	310	277	142	165	273	335	396	428	649	548	524
50%	338	283	263	102	121	134	281	355	415	632	506	458
60%	283	254	249	75	75	96	232	286	401	576	417	347
70%	235	208	211	57	59	84	175	263	368	469	313	285
80%	193	156	170	47	48	59	121	237	352	359	227	234
90%	97	93	123	36	32	48	93	214	266	264	153	146
Long Term												
Full Simulation Period[a]	312	268	278	198	235	284	306	396	407	537	433	419
Water Year Types[b,c]												
Wet (32%)	441	365	386	416	511	591	521	620	487	624	552	617
Above Normal (16%)	392	326	297	149	208	329	328	383	413	668	607	557
Below Normal (13%)	298	271	245	117	112	116	242	317	390	625	479	366
Dry (24%)	230	210	237	81	76	76	170	284	405	473	304	274
Critical (15%)	97	92	121	51	44	69	106	184	243	232	157	133

Alternative 3 021719

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	485	430	511	807	779	853	601	686	624	713	627	501
20%	463	409	388	378	616	693	437	600	590	701	588	468
30%	442	387	364	319	469	560	396	527	569	677	533	429
40%	416	369	335	232	312	487	355	467	552	652	488	396
50%	384	348	320	204	211	314	328	427	527	584	467	385
60%	329	314	298	137	173	255	303	383	489	543	438	369
70%	257	255	273	67	125	154	237	343	459	495	400	328
80%	195	218	229	54	56	104	147	280	424	425	367	292
90%	114	134	172	39	40	58	117	240	367	355	295	243
Long Term												
Full Simulation Period[a]	335	320	338	275	321	396	338	450	501	557	456	371
Water Year Types[b,c]												
Wet (32%)	452	419	460	533	607	714	522	616	540	628	507	426
Above Normal (16%)	448	387	362	230	359	534	388	489	549	708	603	497
Below Normal (13%)	337	336	306	225	245	275	327	478	589	622	491	370
Dry (24%)	245	260	281	116	120	145	207	333	493	499	410	338
Critical (15%)	107	115	170	75	64	86	114	217	298	279	232	173

Alternative 3 021719 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	-3	38	60	143	97	165	1	-33	87	17	8	-155
20%	40	65	33	136	64	132	19	105	120	21	-17	-143
30%	46	63	61	137	255	182	44	100	132	18	-43	-148
40%	49	59	58	90	147	213	20	71	124	3	-60	-129
50%	46	65	58	102	90	180	47	72	111	-48	-39	-73
60%	46	60	48	62	98	159	72	96	88	-33	21	22
70%	22	47	62	9	66	70	62	80	91	26	87	43
80%	2	61	59	7	8	45	26	43	72	66	140	58
90%	18	41	50	3	8	10	24	27	101	92	141	97
Long Term												
Full Simulation Period[a]	23	51	60	77	86	113	31	54	95	20	24	-48
Water Year Types[b,c]												
Wet (32%)	11	55	74	117	96	124	1	-4	53	4	-44	-191
Above Normal (16%)	56	61	65	81	151	205	60	106	136	40	-5	-60
Below Normal (13%)	39	65	61	108	133	160	86	161	198	-4	11	4
Dry (24%)	15	50	45	35	44	69	37	48	88	26	106	63
Critical (15%)	10	23	49	24	20	18	8	33	55	47	75	40

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 6-4. SWP Total Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	488	393	452	663	683	688	599	719	538	697	619	656
20%	422	344	355	242	552	560	418	495	469	680	605	611
30%	396	323	302	183	214	378	352	427	437	658	576	577
40%	368	310	277	142	165	273	335	396	428	649	548	524
50%	338	283	263	102	121	134	281	355	415	632	506	458
60%	283	254	249	75	75	96	232	286	401	576	417	347
70%	235	208	211	57	59	84	175	263	368	469	313	285
80%	193	156	170	47	48	59	121	237	352	359	227	234
90%	97	93	123	36	32	48	93	214	266	264	153	146
Long Term												
Full Simulation Period[a]	312	268	278	198	235	284	306	396	407	537	433	419
Water Year Types[b,c]												
Wet (32%)	441	365	386	416	511	591	521	620	487	624	552	617
Above Normal (16%)	392	326	297	149	208	329	328	383	413	668	607	557
Below Normal (13%)	298	271	245	117	112	116	242	317	390	625	479	366
Dry (24%)	230	210	237	81	76	76	170	284	405	473	304	274
Critical (15%)	97	92	121	51	44	69	106	184	243	232	157	133

Alternative 4 043019

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	471	383	439	682	705	711	583	689	488	682	616	468
20%	394	336	352	294	547	538	492	561	456	654	594	429
30%	342	313	281	210	297	389	445	480	442	639	559	396
40%	326	289	267	163	211	299	395	402	426	616	499	366
50%	306	263	244	116	139	198	327	326	410	563	449	326
60%	244	217	224	84	113	136	253	299	384	476	351	290
70%	197	181	181	62	77	99	133	259	364	426	290	247
80%	158	132	146	50	49	67	111	237	341	361	251	204
90%	109	99	104	35	38	51	99	202	286	263	176	136
Long Term												
Full Simulation Period[a]	284	255	272	221	265	304	332	399	399	508	418	314
Water Year Types[b,c]												
Wet (32%)	397	373	410	450	533	609	548	626	470	614	545	402
Above Normal (16%)	358	307	282	171	235	342	436	426	421	642	591	460
Below Normal (13%)	292	234	222	171	196	194	305	304	396	584	406	305
Dry (24%)	200	175	200	87	103	88	136	266	378	404	288	232
Critical (15%)	91	92	131	45	48	65	105	189	256	235	185	112

Alternative 4 043019 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	-16	-10	-13	19	22	23	-17	-30	-49	-14	-3	-188
20%	-28	-8	-2	52	-5	-22	74	66	-14	-26	-11	-182
30%	-54	-10	-21	28	84	11	93	53	5	-19	-17	-181
40%	-42	-21	-10	21	46	26	60	6	-2	-33	-49	-158
50%	-32	-20	-19	15	18	65	45	-28	-6	-69	-57	-132
60%	-38	-37	-26	9	37	41	21	12	-17	-100	-66	-57
70%	-38	-27	-30	4	18	15	-42	-4	-4	-44	-22	-37
80%	-35	-24	-25	4	1	8	-10	0	-12	2	24	-30
90%	12	6	-19	0	6	4	6	-12	21	0	23	-10
Long Term												
Full Simulation Period[a]	-29	-14	-5	22	30	21	26	3	-8	-29	-14	-105
Water Year Types[b,c]												
Wet (32%)	-44	9	24	35	22	19	27	6	-17	-10	-7	-216
Above Normal (16%)	-34	-19	-15	22	27	13	109	42	8	-26	-16	-96
Below Normal (13%)	-6	-38	-23	54	84	78	63	-13	5	-42	-73	-60
Dry (24%)	-30	-35	-37	6	27	12	-34	-18	-27	-69	-16	-42
Critical (15%)	-6	0	10	-6	4	-4	-1	5	13	3	28	-22

a Based on the 82-year simulation period.

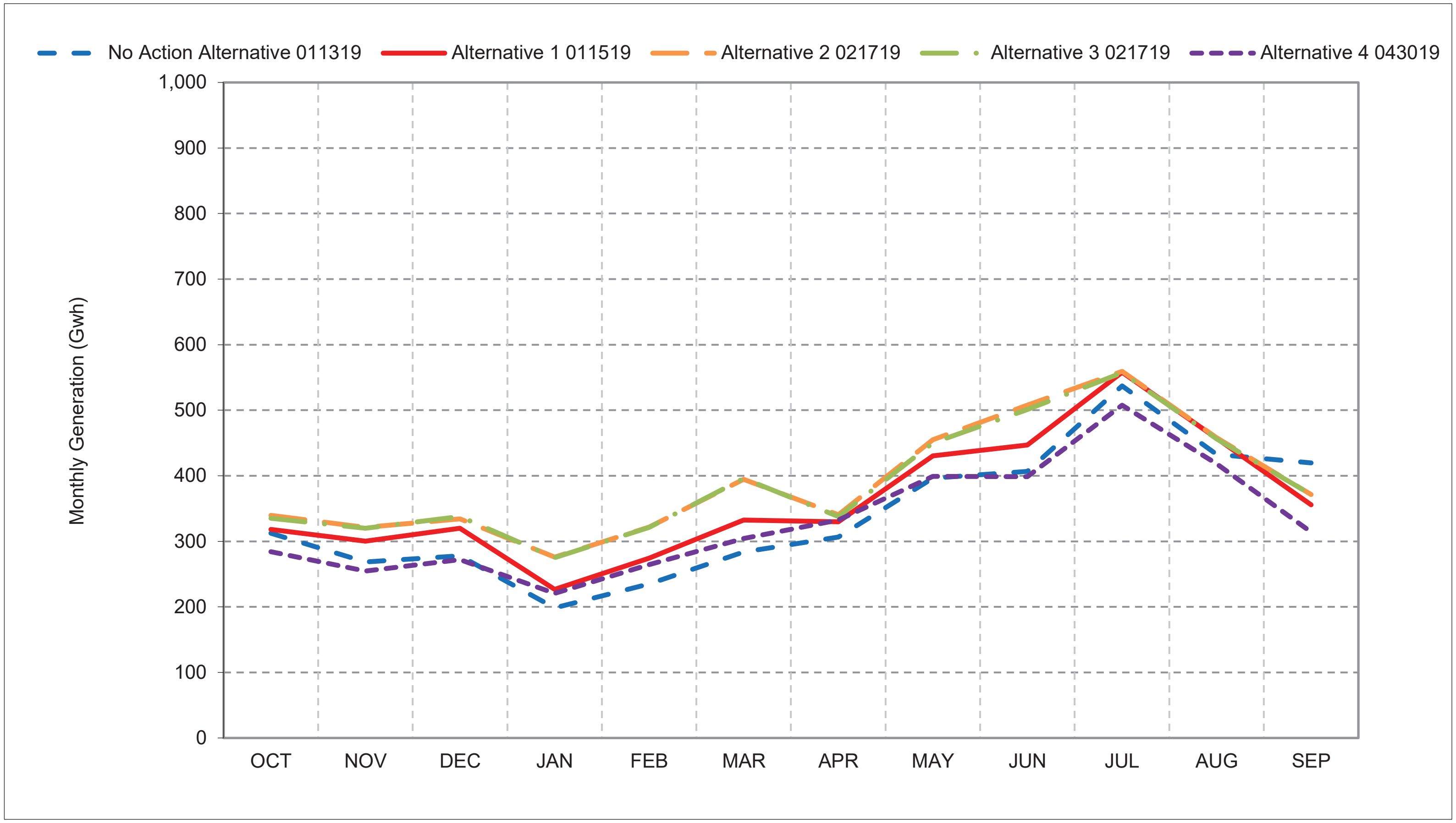
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

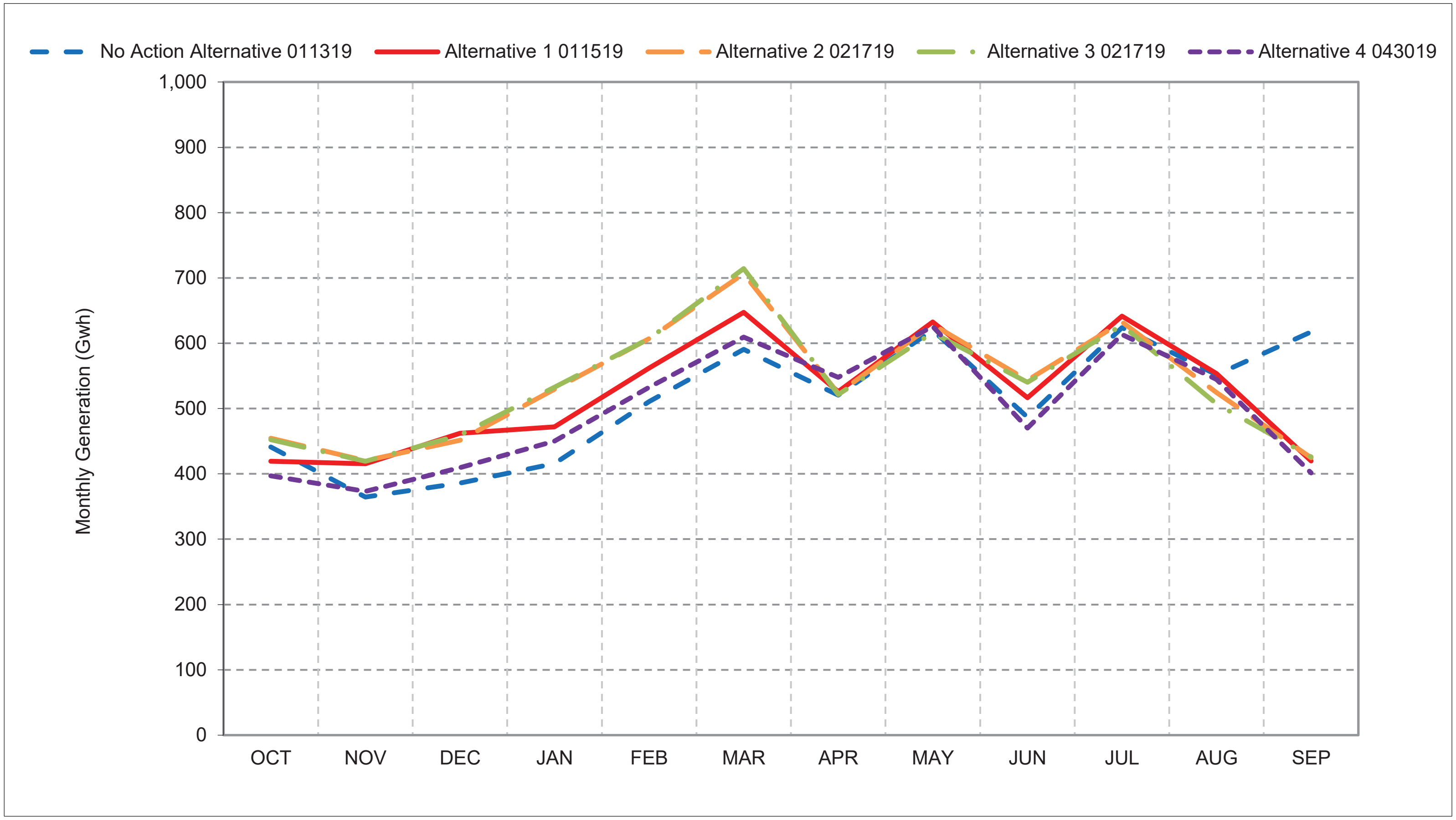
e These are draft results meant for qualitative analysis and are subject to revision.

Figure 6-1. SWP Total Generation, Long-Term Average Generation



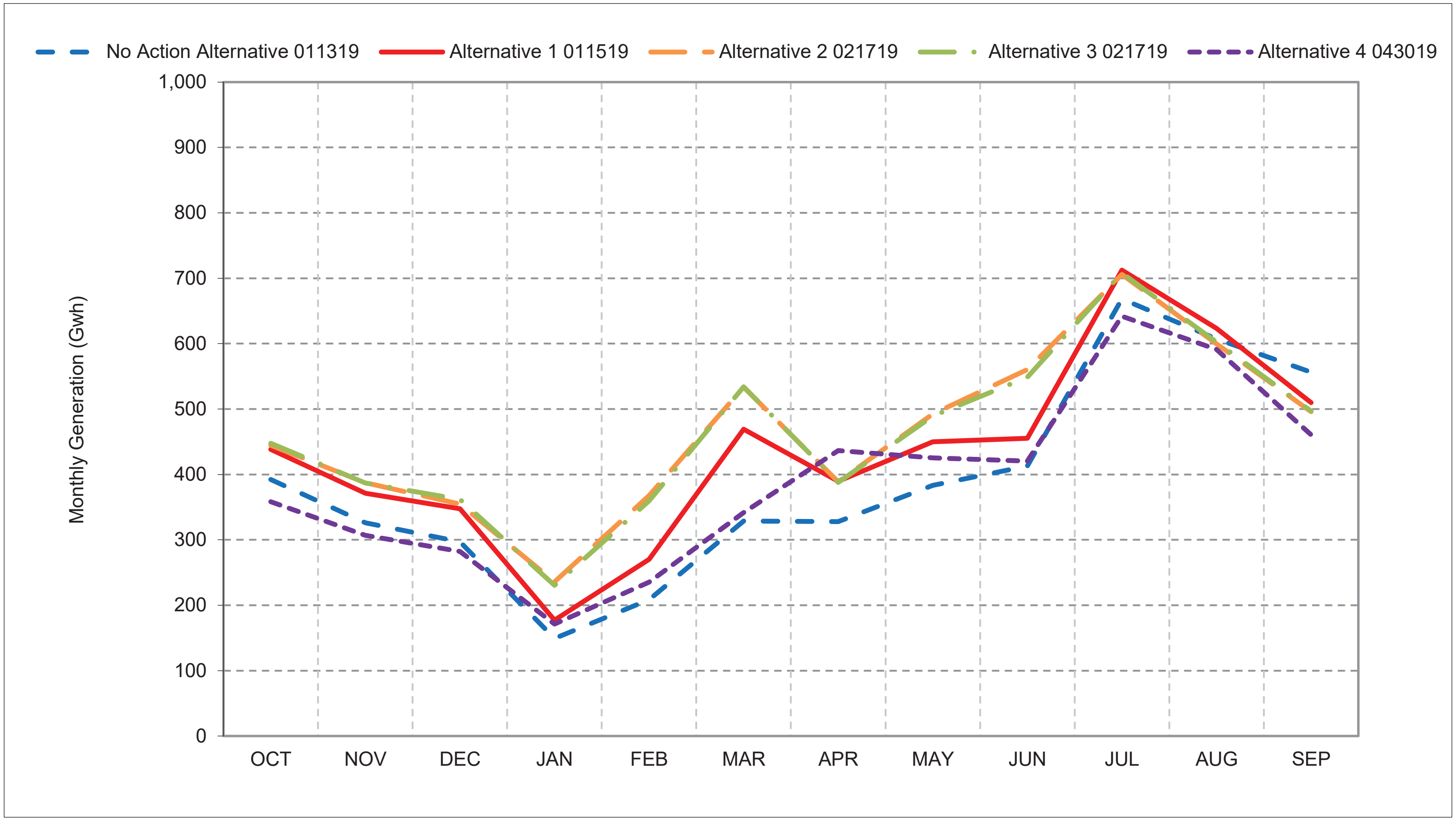
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 6-2. SWP Total Generation, Wet Year Average Generation



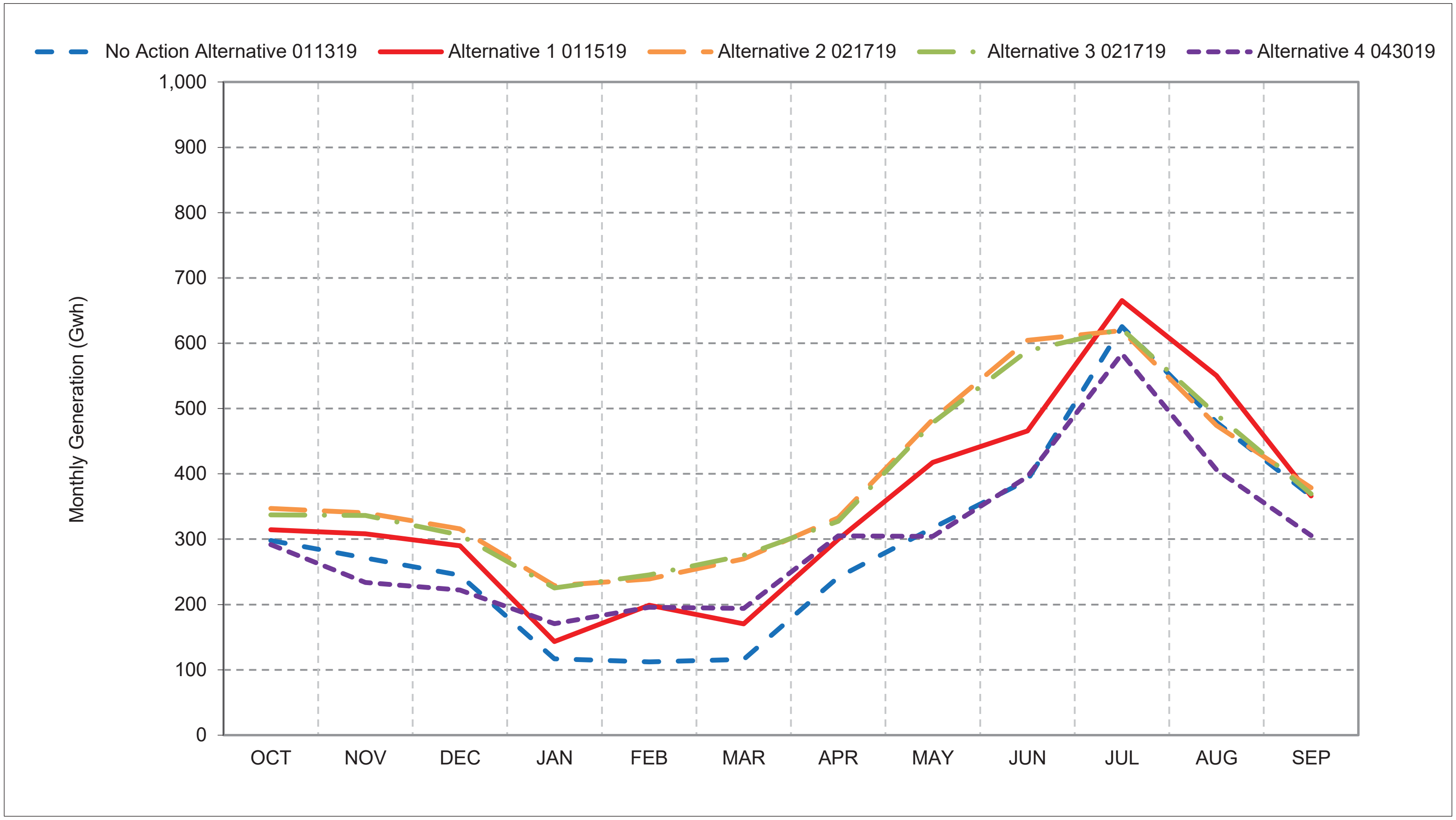
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 6-3. SWP Total Generation, Above Normal Year Average Generation



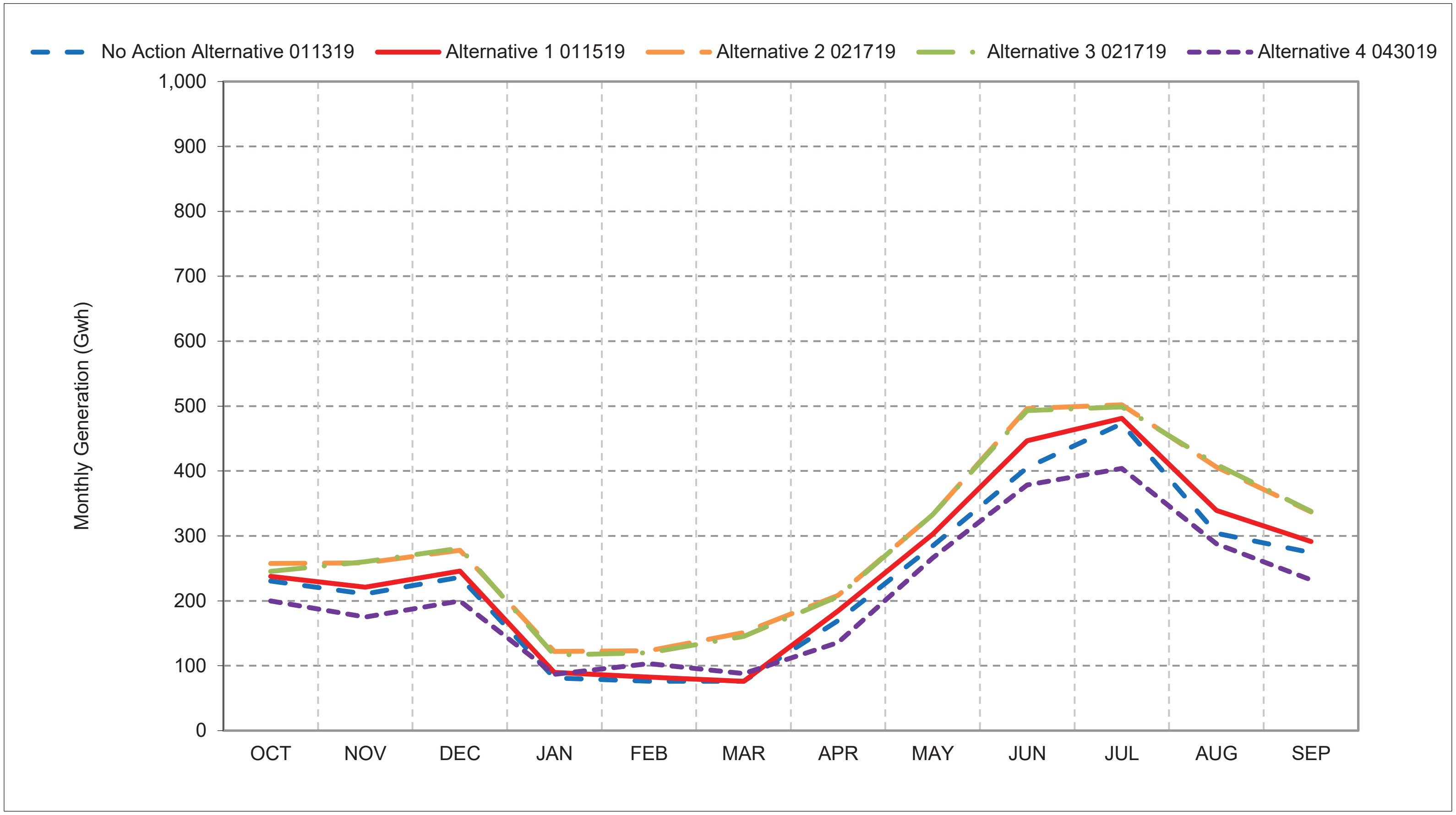
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 6-4. SWP Total Generation, Below Normal Year Average Generation



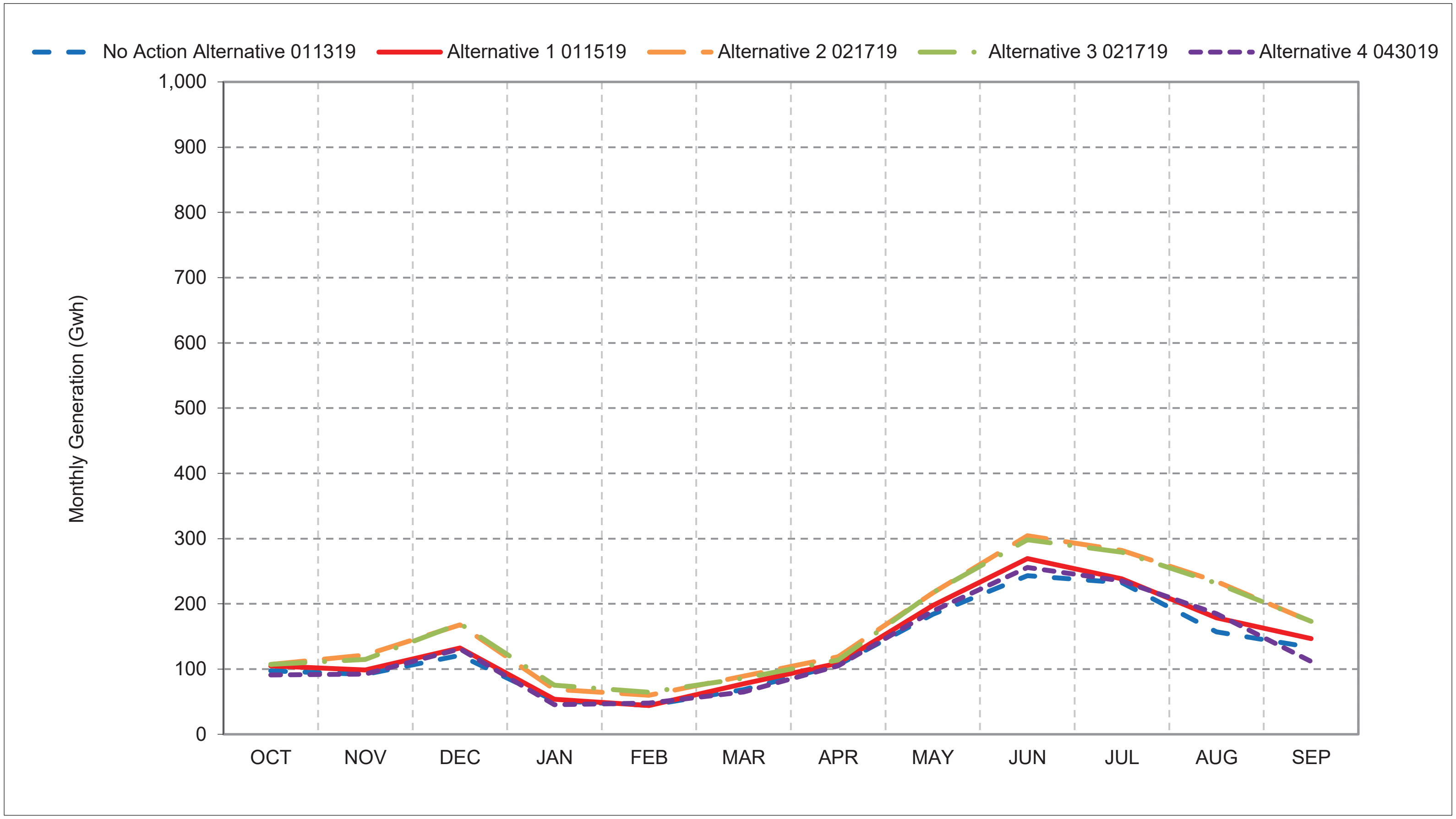
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 6-5. SWP Total Generation, Dry Year Average Generation



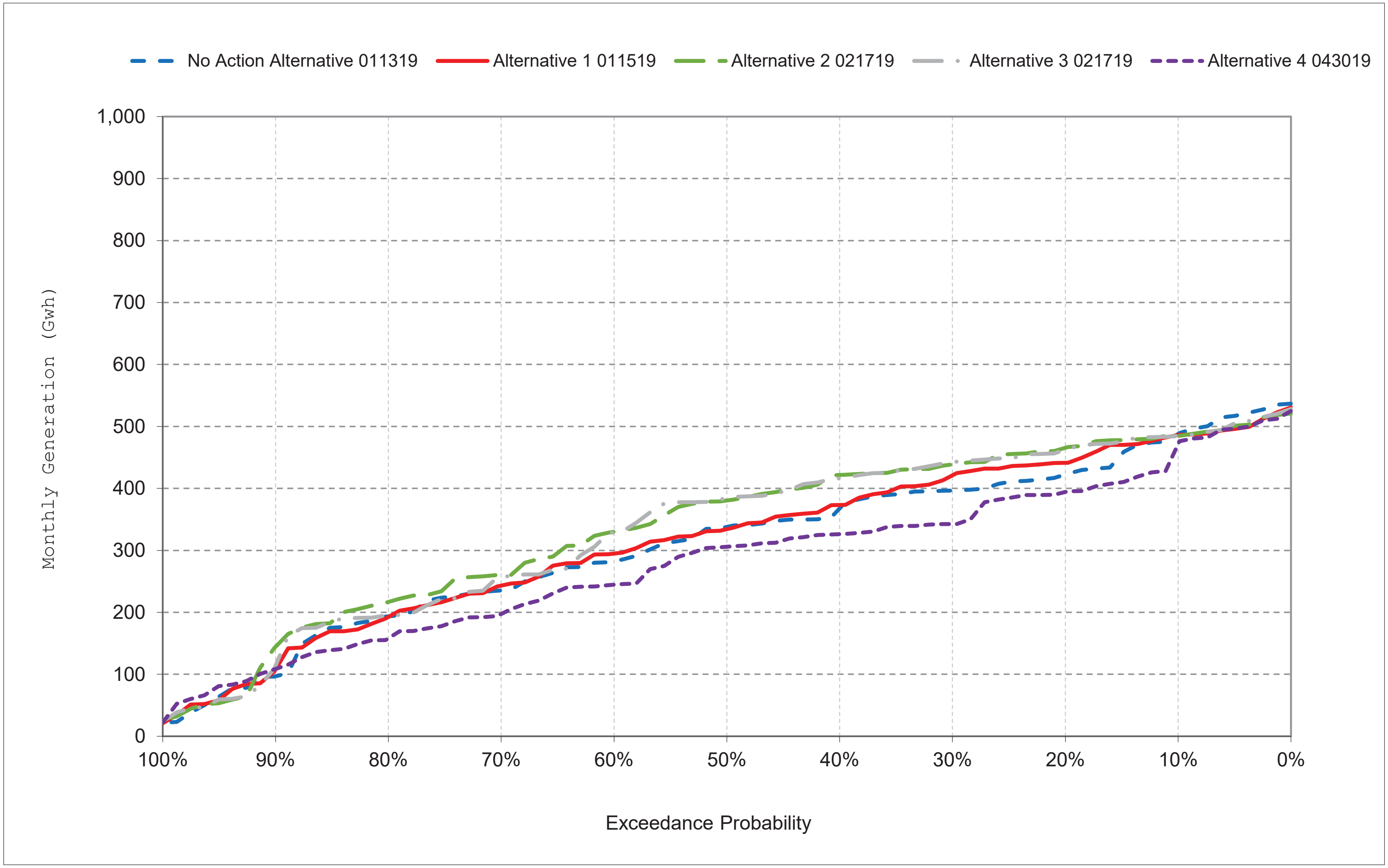
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 6-6. SWP Total Generation, Critical Year Average Generation



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

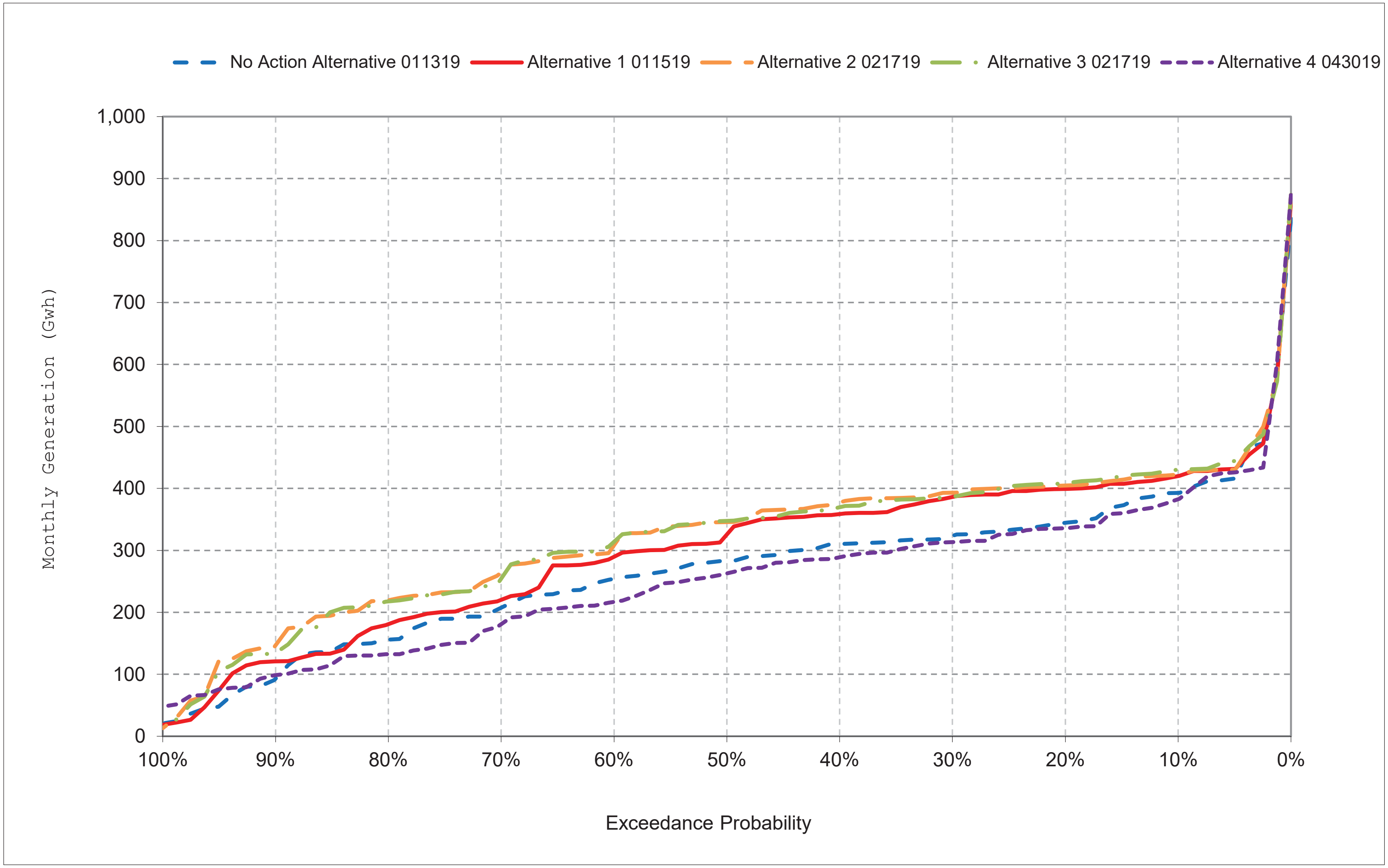
Figure 6-7. SWP Total Generation, October



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

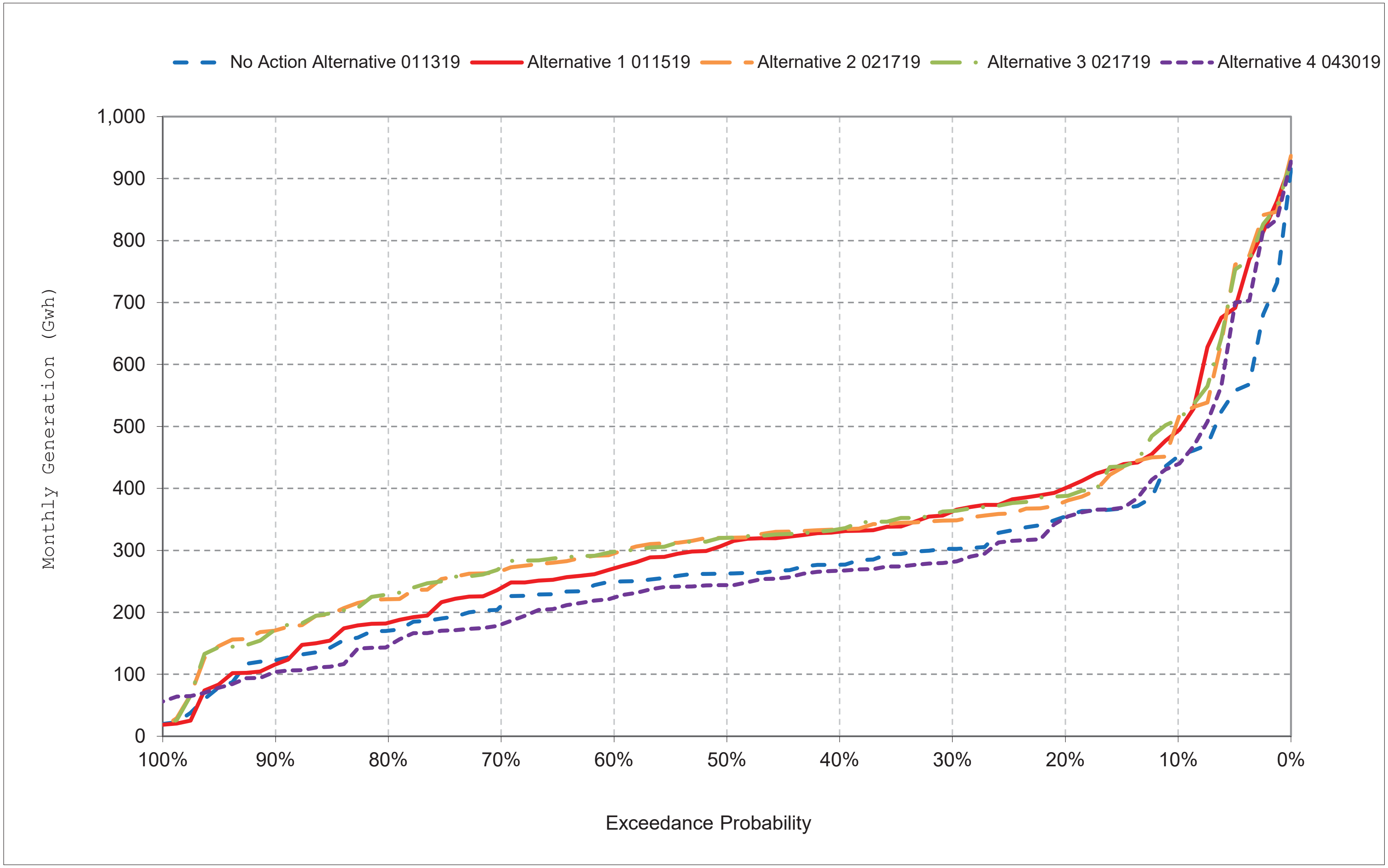
Figure 6-8. SWP Total Generation, November



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

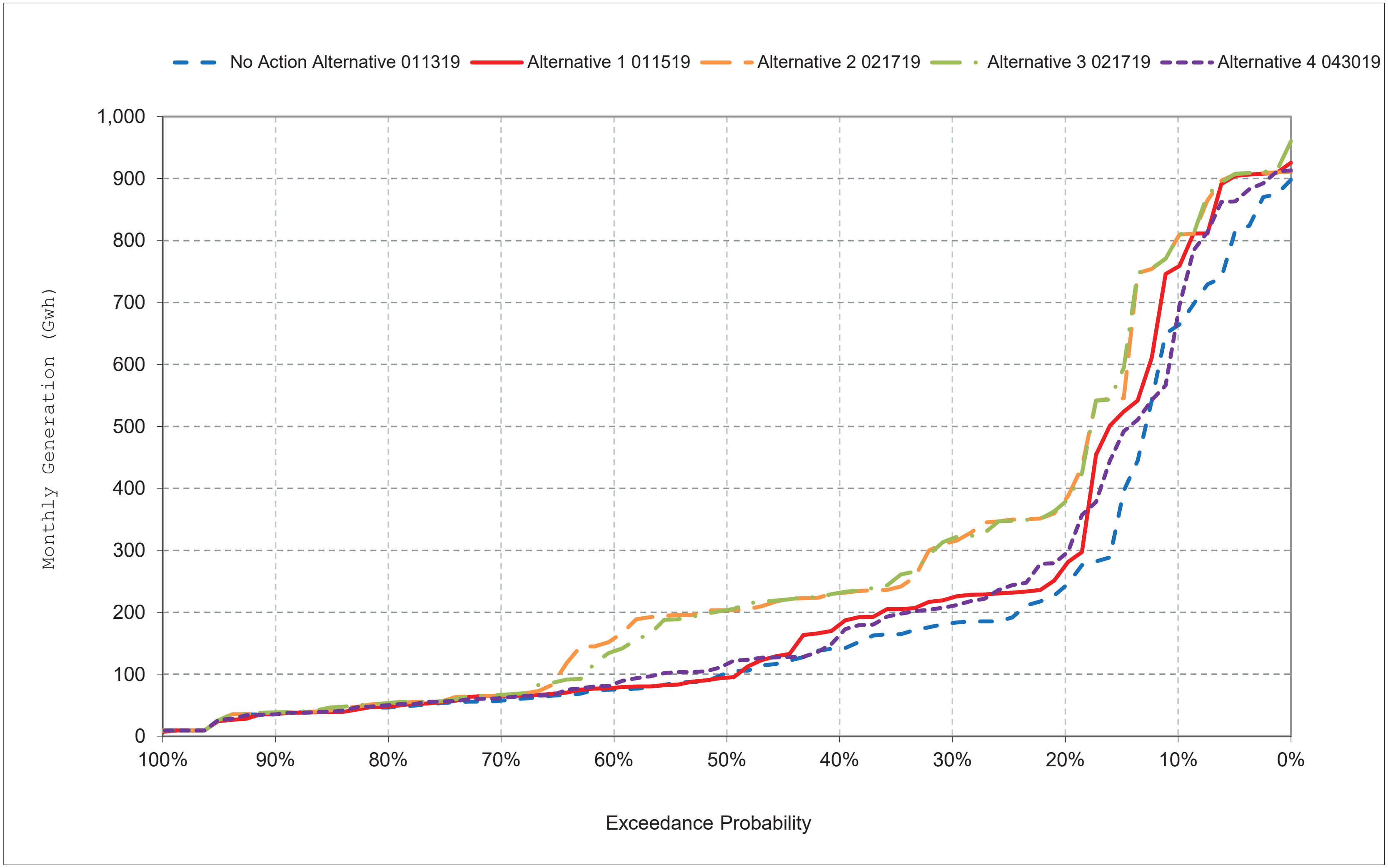
Figure 6-9. SWP Total Generation, December



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

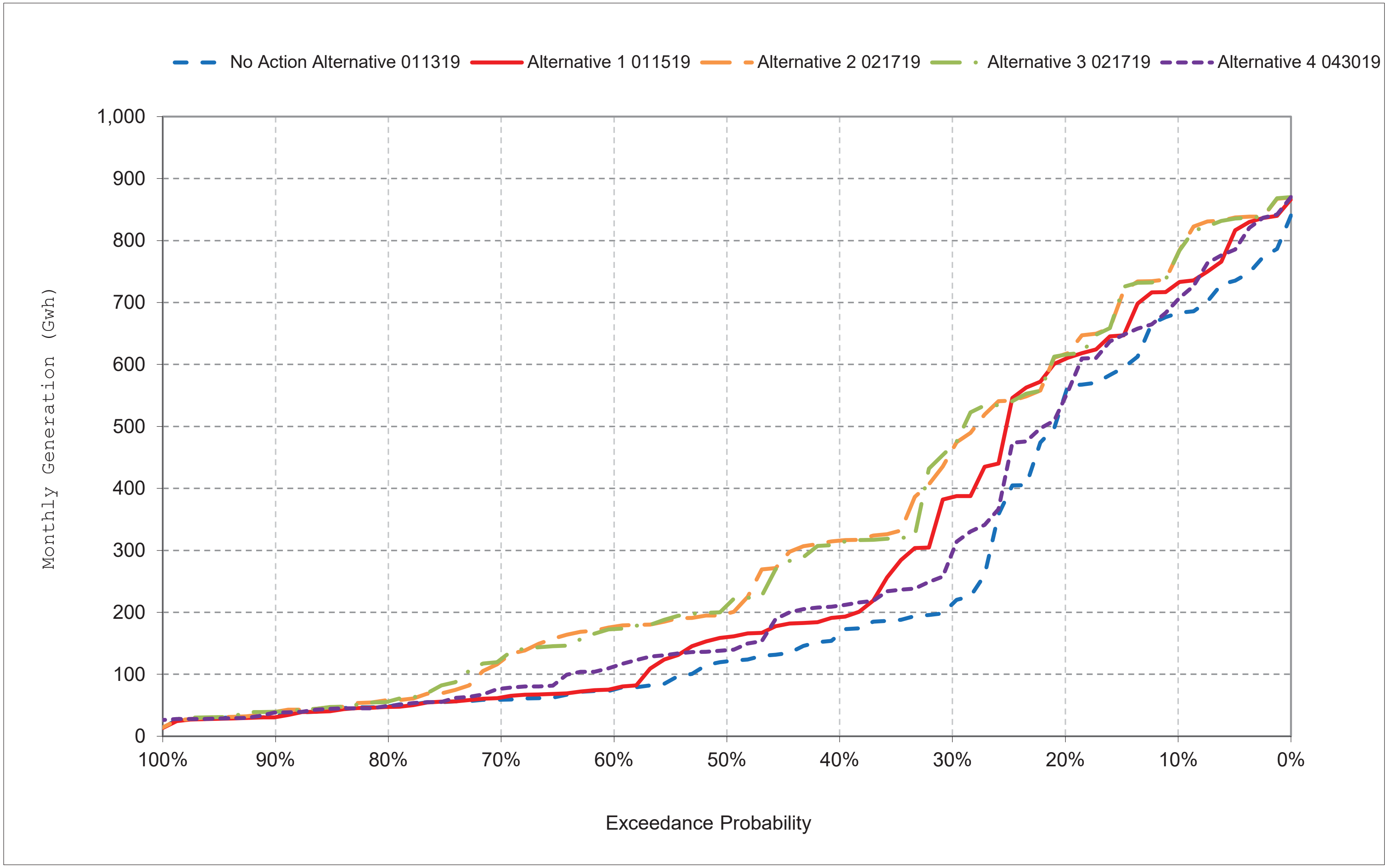
Figure 6-10. SWP Total Generation, January



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

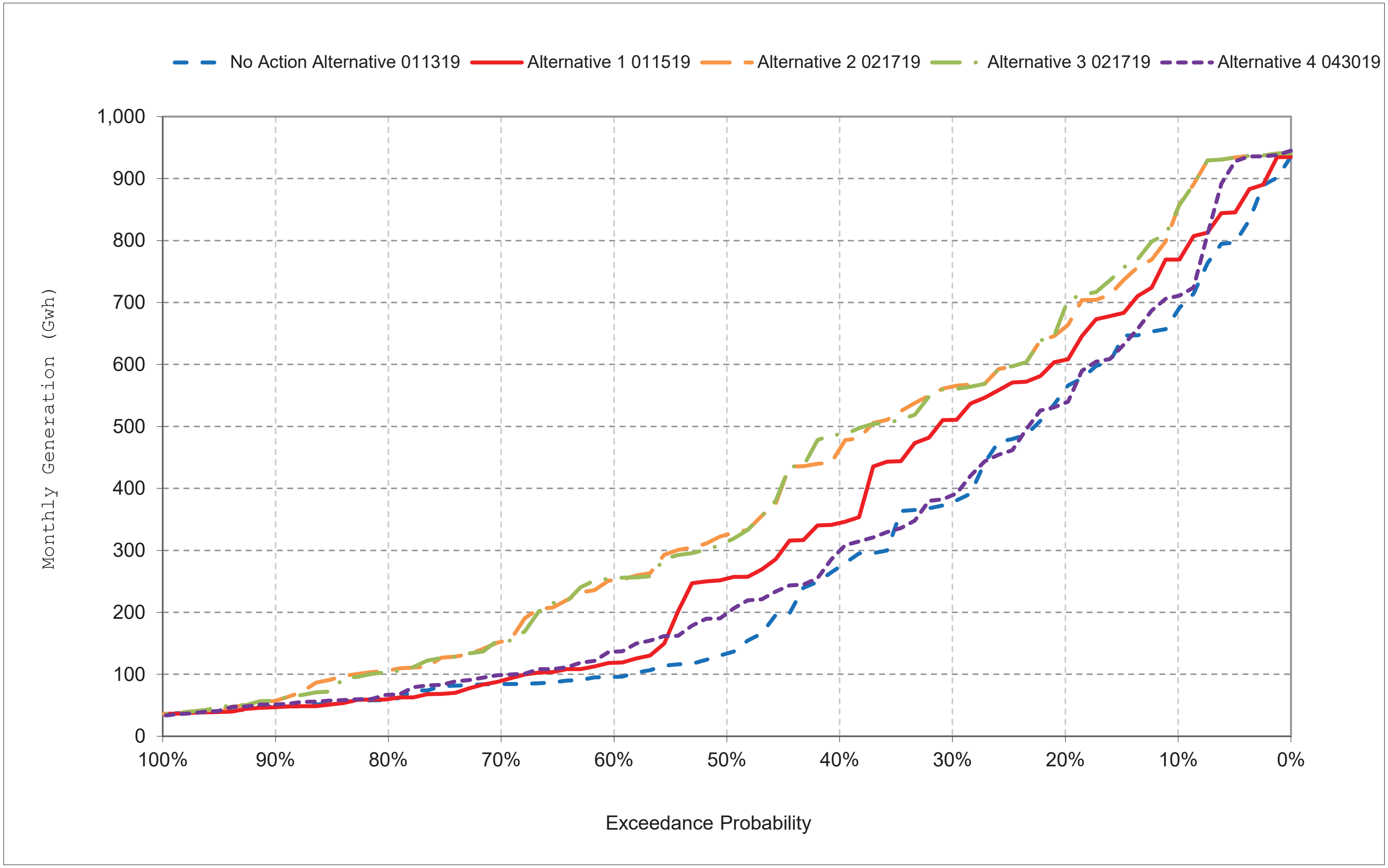
Figure 6-11. SWP Total Generation, February



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

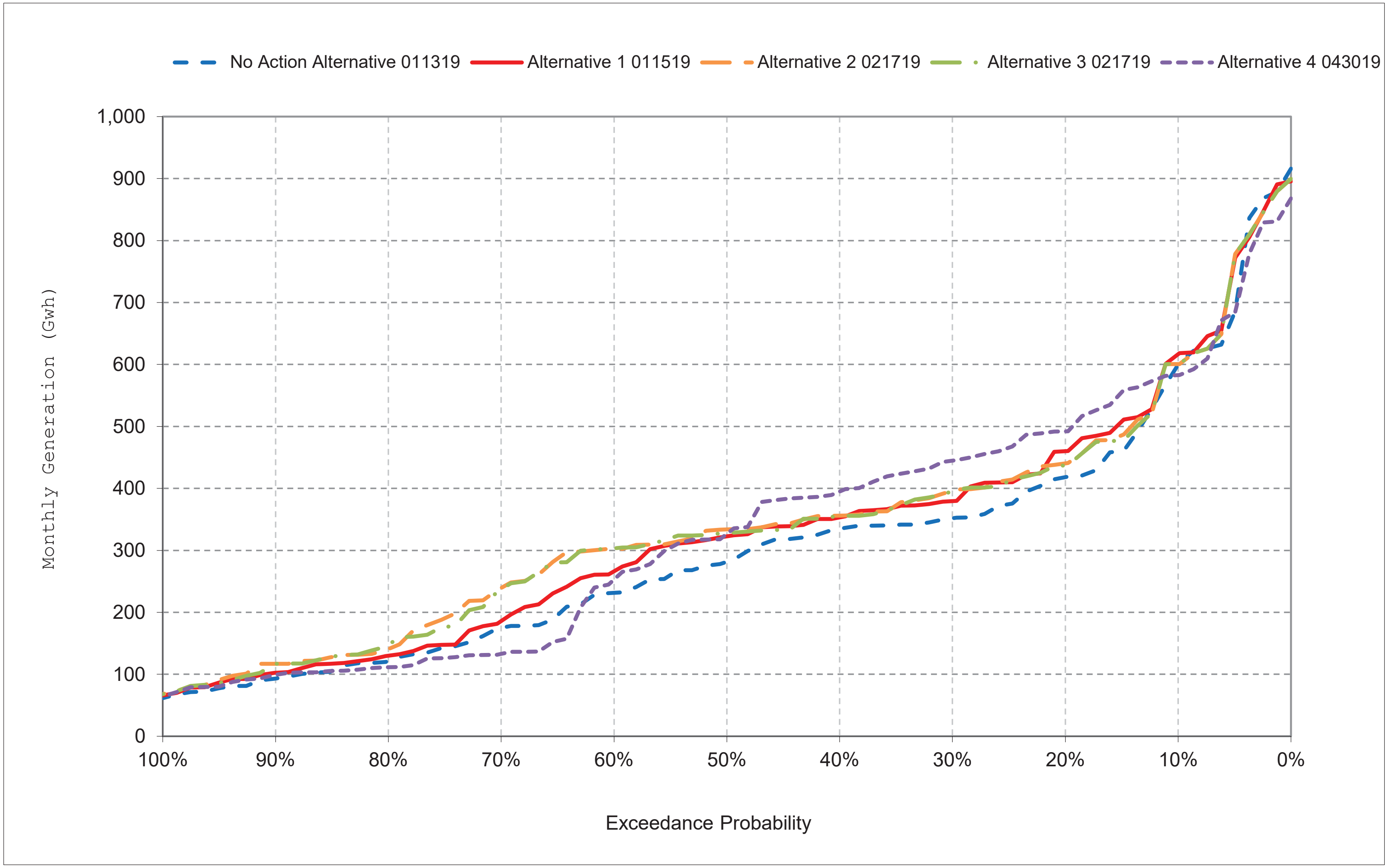
Figure 6-12. SWP Total Generation, March



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

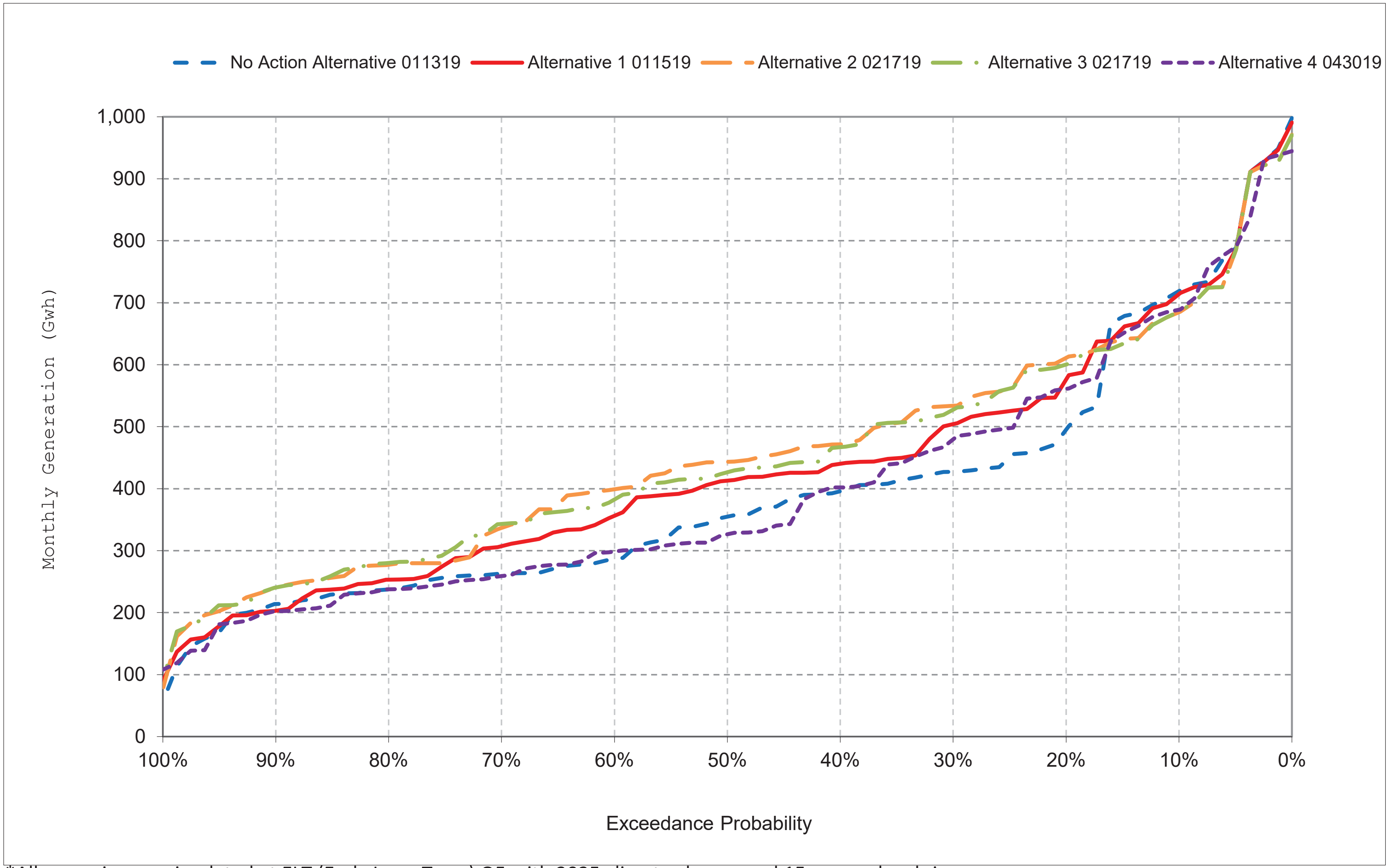
Figure 6-13. SWP Total Generation, April



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

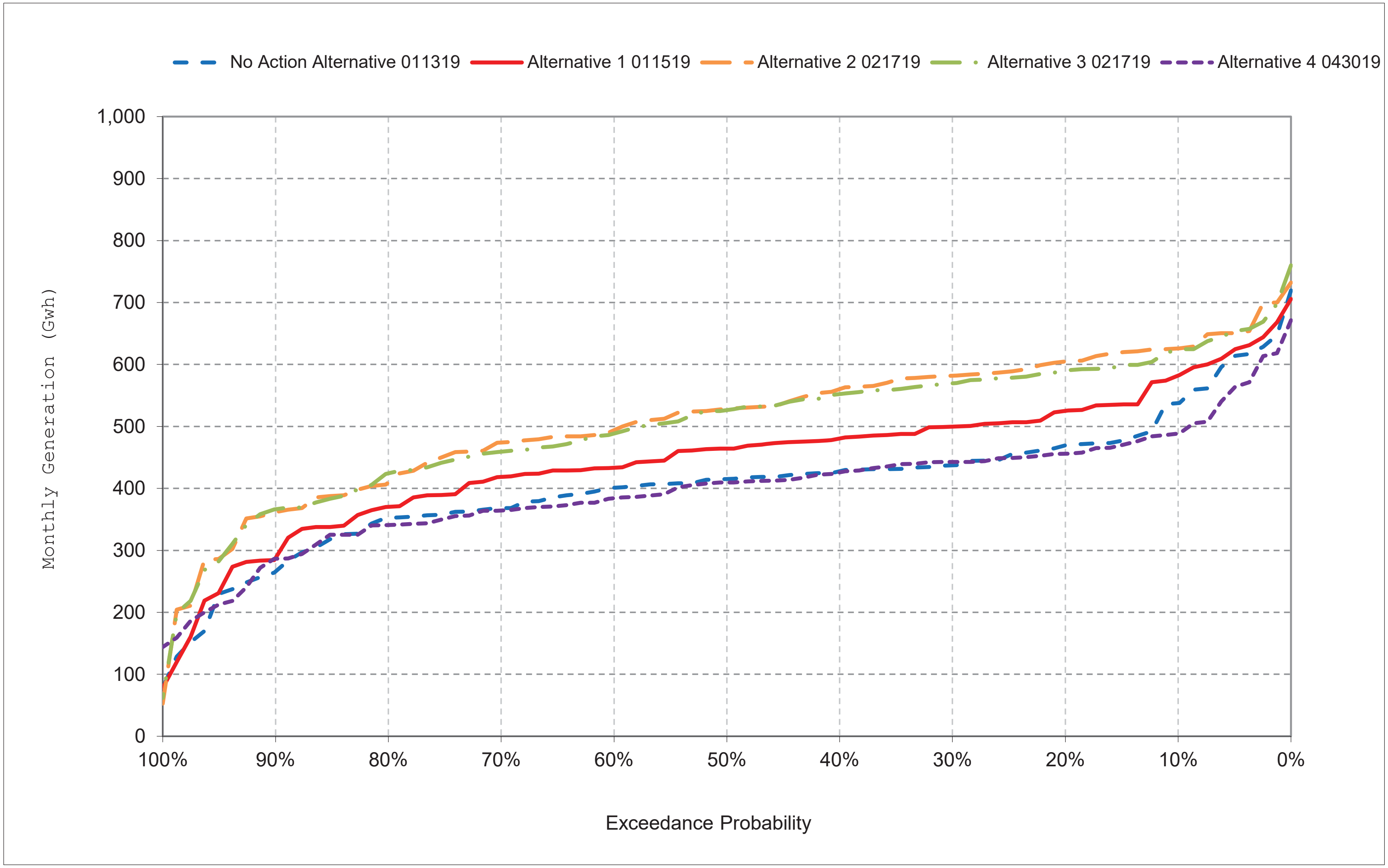
Figure 6-14. SWP Total Generation, May



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

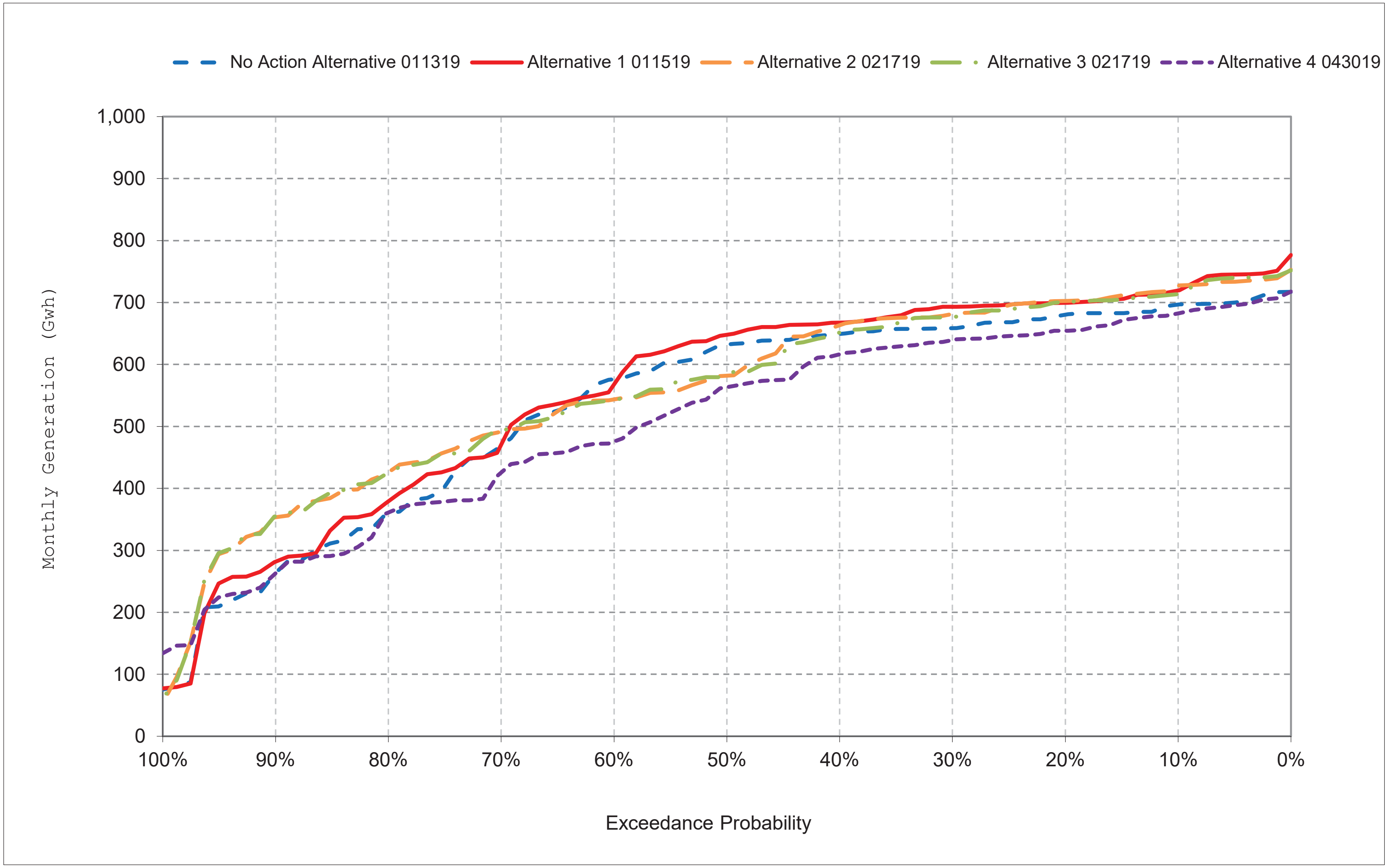
Figure 6-15. SWP Total Generation, June



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

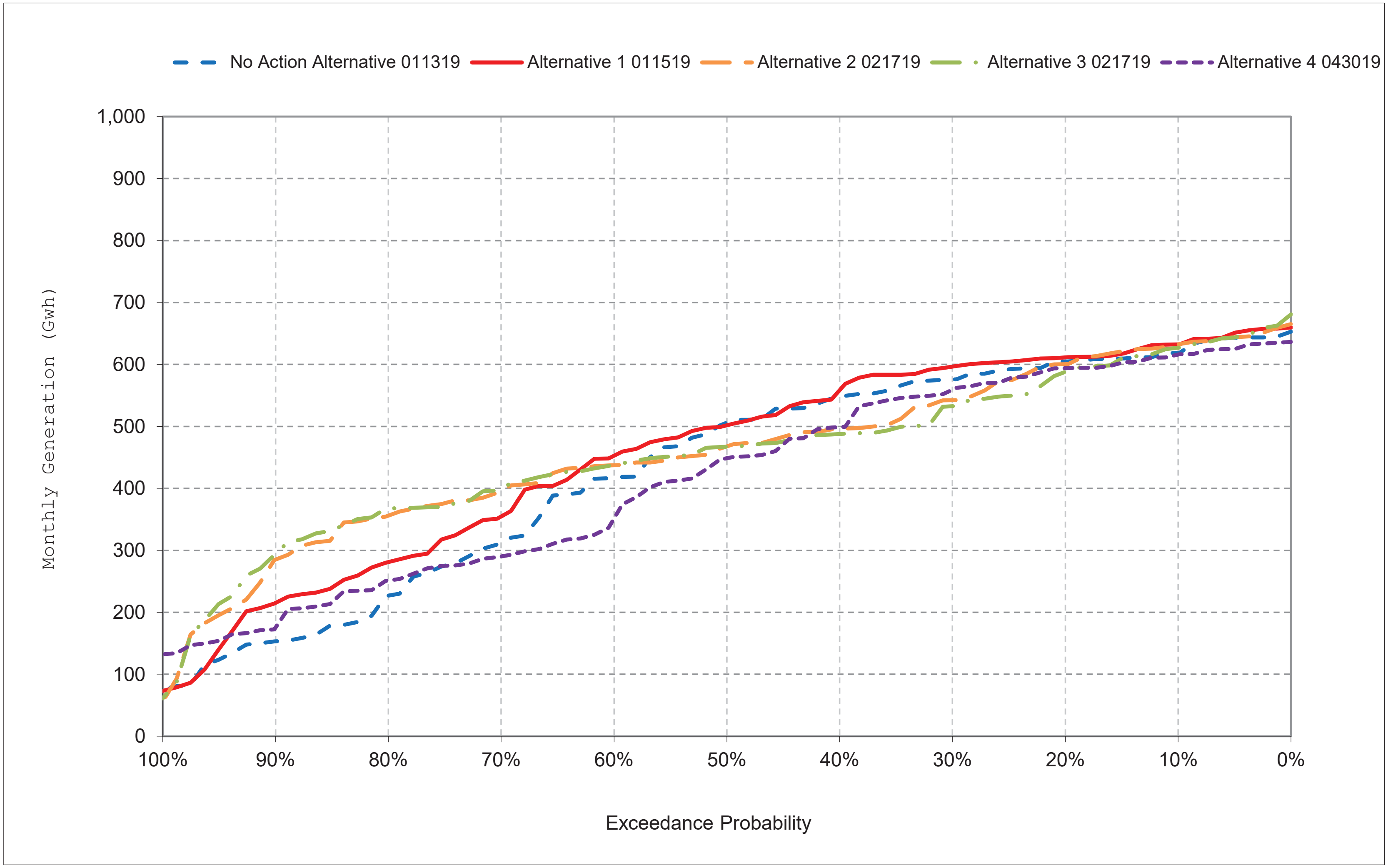
Figure 6-16. SWP Total Generation, July



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

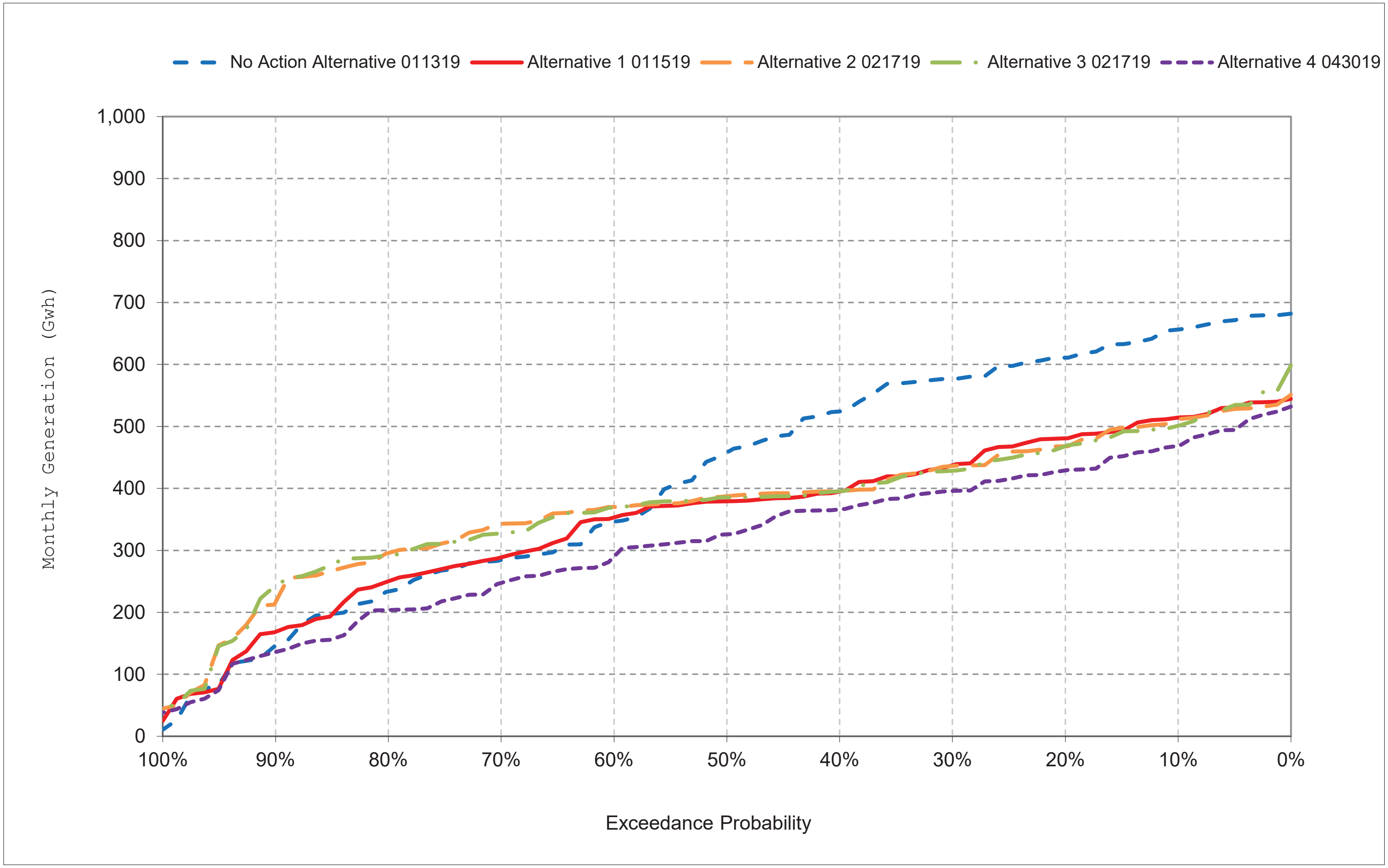
Figure 6-17. SWP Total Generation, August



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 6-18. SWP Total Generation, September



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Table 7-1. SWP Total Energy Use, Monthly Energy Use

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Energy Use (GWh)											
Probability of Exceedance												
10%	1,034	947	1,044	664	803	1,019	818	1,009	985	1,120	1,124	1,112
20%	917	867	911	465	530	767	714	860	814	1,047	1,103	1,091
30%	862	775	807	373	455	596	657	782	760	1,013	1,077	1,056
40%	830	734	761	278	339	375	545	696	733	992	1,052	999
50%	777	687	722	153	248	254	417	477	716	966	1,033	952
60%	710	596	670	119	165	196	385	430	643	911	945	883
70%	570	539	551	109	124	166	194	401	553	783	667	721
80%	406	380	433	101	93	130	121	380	483	611	471	569
90%	263	221	276	86	65	108	105	281	352	389	235	379
Long Term												
Full Simulation Period[a]	696	635	683	301	334	424	453	593	666	846	833	841
Water Year Types[b,c]												
Wet (32%)	912	759	905	516	591	790	722	856	858	1,030	1,082	1,046
Above Normal (16%)	865	788	768	272	341	484	553	660	738	988	1,066	1,035
Below Normal (13%)	750	709	668	242	270	256	399	512	643	946	902	925
Dry (24%)	544	548	522	174	167	185	273	446	577	736	614	694
Critical (15%)	248	277	393	131	109	116	106	270	342	385	343	356

Alternative 1 011519

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Energy Use (GWh)											
Probability of Exceedance												
10%	1,140	1,100	1,065	934	956	1,028	980	1,098	1,010	1,150	1,150	1,143
20%	1,099	1,067	1,008	556	754	961	924	1,062	954	1,135	1,127	1,133
30%	1,035	1,027	980	485	526	849	865	1,011	910	1,120	1,119	1,111
40%	959	961	932	389	452	711	837	962	827	1,105	1,105	1,092
50%	853	870	875	196	343	488	720	815	751	1,036	1,050	1,022
60%	733	763	706	131	222	290	547	588	689	958	1,013	896
70%	586	583	632	120	131	174	332	420	569	850	791	818
80%	400	451	447	111	118	157	162	395	548	619	599	634
90%	264	274	270	104	102	143	118	299	362	397	399	406
Long Term												
Full Simulation Period[a]	767	774	759	366	419	539	608	733	727	907	898	880
Water Year Types[b,c]												
Wet (32%)	990	1,022	985	617	722	892	893	996	895	1,091	1,107	1,088
Above Normal (16%)	1,027	983	898	367	452	784	848	913	815	1,098	1,116	1,120
Below Normal (13%)	834	832	795	326	370	414	637	789	783	1,029	1,058	929
Dry (24%)	570	580	549	198	200	214	357	505	623	766	697	726
Critical (15%)	267	281	436	136	134	166	124	299	389	423	398	380

Alternative 1 011519 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Energy Use (GWh)											
Probability of Exceedance												
10%	106	153	21	270	153	9	162	89	25	30	26	31
20%	181	200	97	91	224	194	210	203	140	88	25	42
30%	173	251	172	111	72	252	209	228	150	107	42	55
40%	130	227	172	111	113	336	292	266	94	113	53	93
50%	76	183	154	42	95	234	303	337	35	70	17	71
60%	23	167	37	12	58	93	162	158	46	47	69	13
70%	16	44	81	11	7	8	138	19	16	67	124	98
80%	-6	71	14	10	25	27	41	15	65	8	127	65
90%	2	53	-6	18	38	35	13	18	9	8	164	27
Long Term												
Full Simulation Period[a]	71	139	76	65	85	115	156	140	60	61	65	39
Water Year Types[b,c]												
Wet (32%)	78	263	80	101	132	103	171	140	36	61	25	42
Above Normal (16%)	162	195	130	96	111	299	295	252	77	110	50	85
Below Normal (13%)	84	123	126	85	100	157	237	277	139	84	156	5
Dry (24%)	26	32	28	25	33	28	84	60	46	30	83	32
Critical (15%)	19	4	42	6	25	50	18	29	46	37	55	25

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 7-2. SWP Total Energy Use, Monthly Energy Use

No Action Alternative 011319

Statistic	Monthly Energy Use (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,034	947	1,044	664	803	1,019	818	1,009	985	1,120	1,124	1,112
20%	917	867	911	465	530	767	714	860	814	1,047	1,103	1,091
30%	862	775	807	373	455	596	657	782	760	1,013	1,077	1,056
40%	830	734	761	278	339	375	545	696	733	992	1,052	999
50%	777	687	722	153	248	254	417	477	716	966	1,033	952
60%	710	596	670	119	165	196	385	430	643	911	945	883
70%	570	539	551	109	124	166	194	401	553	783	667	721
80%	406	380	433	101	93	130	121	380	483	611	471	569
90%	263	221	276	86	65	108	105	281	352	389	235	379
Long Term												
Full Simulation Period[a]	696	635	683	301	334	424	453	593	666	846	833	841
Water Year Types[b,c]												
Wet (32%)	912	759	905	516	591	790	722	856	858	1,030	1,082	1,046
Above Normal (16%)	865	788	768	272	341	484	553	660	738	988	1,066	1,035
Below Normal (13%)	750	709	668	242	270	256	399	512	643	946	902	925
Dry (24%)	544	548	522	174	167	185	273	446	577	736	614	694
Critical (15%)	248	277	393	131	109	116	106	270	342	385	343	356

Alternative 2 021719

Statistic	Monthly Energy Use (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,137	1,108	1,098	1,073	1,009	1,104	972	1,096	1,048	1,152	1,147	1,141
20%	1,106	1,078	1,041	1,025	974	1,102	950	1,073	1,028	1,143	1,138	1,125
30%	1,079	1,058	1,013	826	941	1,097	923	1,045	982	1,125	1,123	1,116
40%	1,049	1,028	976	675	869	1,024	861	988	959	1,105	1,077	1,083
50%	978	967	928	594	615	880	807	924	872	1,053	1,024	1,029
60%	855	877	890	410	510	759	689	813	808	965	985	998
70%	628	736	828	290	357	473	458	533	744	916	913	864
80%	496	516	722	262	277	293	265	412	576	757	792	788
90%	334	433	478	166	133	174	177	390	539	597	602	499
Long Term												
Full Simulation Period[a]	819	845	865	596	625	746	666	799	828	953	952	936
Water Year Types[b,c]												
Wet (32%)	1,071	1,036	1,001	865	912	1,070	906	1,012	963	1,090	1,094	1,091
Above Normal (16%)	1,071	1,042	999	678	826	1,040	916	1,042	990	1,124	1,118	1,113
Below Normal (13%)	893	928	938	681	569	733	756	915	925	1,050	983	998
Dry (24%)	613	709	729	365	403	465	443	578	714	868	882	871
Critical (15%)	274	369	583	232	211	203	162	340	459	527	556	460

Alternative 2 021719 minus No Action Alternative 011319

Statistic	Monthly Energy Use (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	103	161	54	409	206	85	154	87	63	32	22	29
20%	189	211	131	560	444	335	236	213	214	96	36	34
30%	217	283	205	453	487	500	267	262	222	112	47	60
40%	219	294	216	397	530	649	316	293	226	113	25	84
50%	201	280	206	440	367	626	389	446	156	87	-9	77
60%	146	281	220	291	345	563	305	383	165	54	40	114
70%	58	198	277	182	233	308	263	132	190	134	246	143
80%	89	136	289	161	183	163	144	33	93	146	321	218
90%	71	212	202	79	68	66	72	109	187	208	367	120
Long Term												
Full Simulation Period[a]	123	210	182	296	291	322	213	206	161	107	119	95
Water Year Types[b,c]												
Wet (32%)	159	277	96	349	321	281	183	156	104	60	11	45
Above Normal (16%)	205	255	231	407	485	556	363	381	252	136	52	78
Below Normal (13%)	144	220	269	440	300	477	357	403	282	104	81	74
Dry (24%)	69	161	208	191	236	280	169	132	137	132	268	177
Critical (15%)	25	92	190	101	102	87	56	70	116	142	213	104

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 7-3. SWP Total Energy Use, Monthly Energy Use

No Action Alternative 011319

Statistic	Monthly Energy Use (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,034	947	1,044	664	803	1,019	818	1,009	985	1,120	1,124	1,112
20%	917	867	911	465	530	767	714	860	814	1,047	1,103	1,091
30%	862	775	807	373	455	596	657	782	760	1,013	1,077	1,056
40%	830	734	761	278	339	375	545	696	733	992	1,052	999
50%	777	687	722	153	248	254	417	477	716	966	1,033	952
60%	710	596	670	119	165	196	385	430	643	911	945	883
70%	570	539	551	109	124	166	194	401	553	783	667	721
80%	406	380	433	101	93	130	121	380	483	611	471	569
90%	263	221	276	86	65	108	105	281	352	389	235	379
Long Term												
Full Simulation Period[a]	696	635	683	301	334	424	453	593	666	846	833	841
Water Year Types[b,c]												
Wet (32%)	912	759	905	516	591	790	722	856	858	1,030	1,082	1,046
Above Normal (16%)	865	788	768	272	341	484	553	660	738	988	1,066	1,035
Below Normal (13%)	750	709	668	242	270	256	399	512	643	946	902	925
Dry (24%)	544	548	522	174	167	185	273	446	577	736	614	694
Critical (15%)	248	277	393	131	109	116	106	270	342	385	343	356

Alternative 3 021719

Statistic	Monthly Energy Use (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,135	1,120	1,140	1,085	1,004	1,104	975	1,096	1,041	1,149	1,146	1,141
20%	1,116	1,075	1,061	1,019	974	1,102	946	1,068	1,020	1,143	1,139	1,125
30%	1,074	1,057	1,025	826	935	1,090	911	1,046	983	1,125	1,121	1,111
40%	1,009	1,025	984	685	781	1,029	844	964	939	1,087	1,046	1,052
50%	943	965	936	533	604	906	788	897	868	1,012	1,022	1,023
60%	854	883	877	375	487	714	682	823	806	958	983	986
70%	559	723	826	288	353	473	448	542	724	894	926	870
80%	400	520	694	262	281	269	250	424	582	757	794	773
90%	234	414	466	169	144	153	175	388	545	598	624	563
Long Term												
Full Simulation Period[a]	796	839	871	588	620	744	656	793	818	946	951	932
Water Year Types[b,c]												
Wet (32%)	1,064	1,032	1,018	854	917	1,072	890	1,002	952	1,079	1,078	1,079
Above Normal (16%)	1,071	1,042	998	674	786	1,044	913	1,040	981	1,119	1,118	1,108
Below Normal (13%)	862	915	924	669	563	749	743	908	908	1,040	1,027	987
Dry (24%)	553	714	739	351	396	451	440	569	708	865	882	875
Critical (15%)	265	342	590	240	226	195	152	341	454	514	543	463

Alternative 3 021719 minus No Action Alternative 011319

Statistic	Monthly Energy Use (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	101	174	96	422	201	85	157	87	56	29	22	29
20%	199	208	150	554	444	335	232	208	207	97	36	34
30%	212	281	218	453	480	494	254	264	223	112	44	55
40%	179	291	223	407	443	654	298	268	206	95	-6	53
50%	166	278	215	379	357	652	371	420	152	45	-11	71
60%	144	287	208	256	323	517	298	393	163	47	38	103
70%	-11	184	275	180	229	307	254	141	170	112	259	149
80%	-6	140	262	160	188	139	128	44	99	145	323	204
90%	-29	193	190	83	79	45	70	107	192	209	389	184
Long Term												
Full Simulation Period[a]	100	205	188	288	286	321	204	200	152	100	118	90
Water Year Types[b,c]												
Wet (32%)	151	274	113	338	327	283	168	146	94	50	-4	33
Above Normal (16%)	206	255	230	402	445	559	360	380	243	131	52	73
Below Normal (13%)	113	206	256	428	293	493	344	396	264	95	126	62
Dry (24%)	8	166	217	177	229	265	167	124	131	130	268	181
Critical (15%)	16	65	197	109	117	79	46	71	111	129	200	108

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 7-4. SWP Total Energy Use, Monthly Energy Use

No Action Alternative 011319

	Monthly Energy Use (GWh)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,034	947	1,044	664	803	1,019	818	1,009	985	1,120	1,124	1,112
20%	917	867	911	465	530	767	714	860	814	1,047	1,103	1,091
30%	862	775	807	373	455	596	657	782	760	1,013	1,077	1,056
40%	830	734	761	278	339	375	545	696	733	992	1,052	999
50%	777	687	722	153	248	254	417	477	716	966	1,033	952
60%	710	596	670	119	165	196	385	430	643	911	945	883
70%	570	539	551	109	124	166	194	401	553	783	667	721
80%	406	380	433	101	93	130	121	380	483	611	471	569
90%	263	221	276	86	65	108	105	281	352	389	235	379
Long Term												
Full Simulation Period[a]	696	635	683	301	334	424	453	593	666	846	833	841
Water Year Types[b,c]												
Wet (32%)	912	759	905	516	591	790	722	856	858	1,030	1,082	1,046
Above Normal (16%)	865	788	768	272	341	484	553	660	738	988	1,066	1,035
Below Normal (13%)	750	709	668	242	270	256	399	512	643	946	902	925
Dry (24%)	544	548	522	174	167	185	273	446	577	736	614	694
Critical (15%)	248	277	393	131	109	116	106	270	342	385	343	356

Alternative 4 043019

	Monthly Energy Use (GWh)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,104	972	968	899	942	994	781	958	930	1,067	1,124	1,113
20%	901	894	879	518	699	564	684	793	783	1,011	1,082	1,063
30%	857	800	733	412	505	445	590	715	726	973	1,056	1,016
40%	802	737	683	317	386	282	434	527	694	943	1,021	941
50%	753	659	629	224	322	192	405	434	646	909	958	886
60%	584	548	531	144	244	134	246	398	572	742	768	774
70%	442	427	451	115	183	95	120	391	551	631	601	615
80%	382	319	347	109	121	83	105	323	439	488	464	481
90%	244	281	281	100	103	79	95	258	356	392	369	338
Long Term												
Full Simulation Period[a]	673	625	615	348	401	349	399	546	634	791	811	781
Water Year Types[b,c]												
Wet (32%)	944	887	825	575	673	708	679	821	829	1,008	1,064	1,028
Above Normal (16%)	874	799	719	368	402	353	567	640	728	962	1,061	1,025
Below Normal (13%)	673	578	548	331	391	205	331	413	600	871	820	809
Dry (24%)	453	407	424	193	209	121	143	364	496	592	551	580
Critical (15%)	234	278	426	109	142	77	98	276	368	392	415	288

Alternative 4 043019 minus No Action Alternative 011319

	Monthly Energy Use (GWh)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	70	25	-76	235	139	-24	-37	-51	-55	-53	-1	1
20%	-16	28	-32	53	169	-203	-30	-67	-31	-36	-21	-28
30%	-5	25	-75	39	51	-152	-67	-67	-34	-41	-21	-40
40%	-28	3	-78	40	48	-93	-111	-169	-39	-49	-31	-58
50%	-24	-28	-93	71	75	-63	-13	-43	-70	-58	-75	-66
60%	-125	-48	-138	26	79	-63	-139	-32	-72	-169	-177	-109
70%	-128	-111	-100	6	58	-71	-75	-10	-3	-152	-66	-106
80%	-24	-61	-86	8	28	-47	-17	-57	-44	-123	-7	-88
90%	-18	59	5	13	39	-29	-10	-23	4	3	134	-41
Long Term												
Full Simulation Period[a]	-23	-9	-68	47	67	-75	-54	-47	-33	-55	-22	-60
Water Year Types[b,c]												
Wet (32%)	31	128	-80	59	82	-82	-44	-35	-30	-22	-19	-18
Above Normal (16%)	9	12	-48	96	61	-132	14	-21	-9	-26	-5	-11
Below Normal (13%)	-76	-131	-120	89	122	-52	-68	-99	-44	-75	-82	-116
Dry (24%)	-91	-140	-97	19	42	-64	-131	-82	-81	-144	-63	-113
Critical (15%)	-14	1	33	-22	33	-38	-9	7	26	7	72	-68

a Based on the 82-year simulation period.

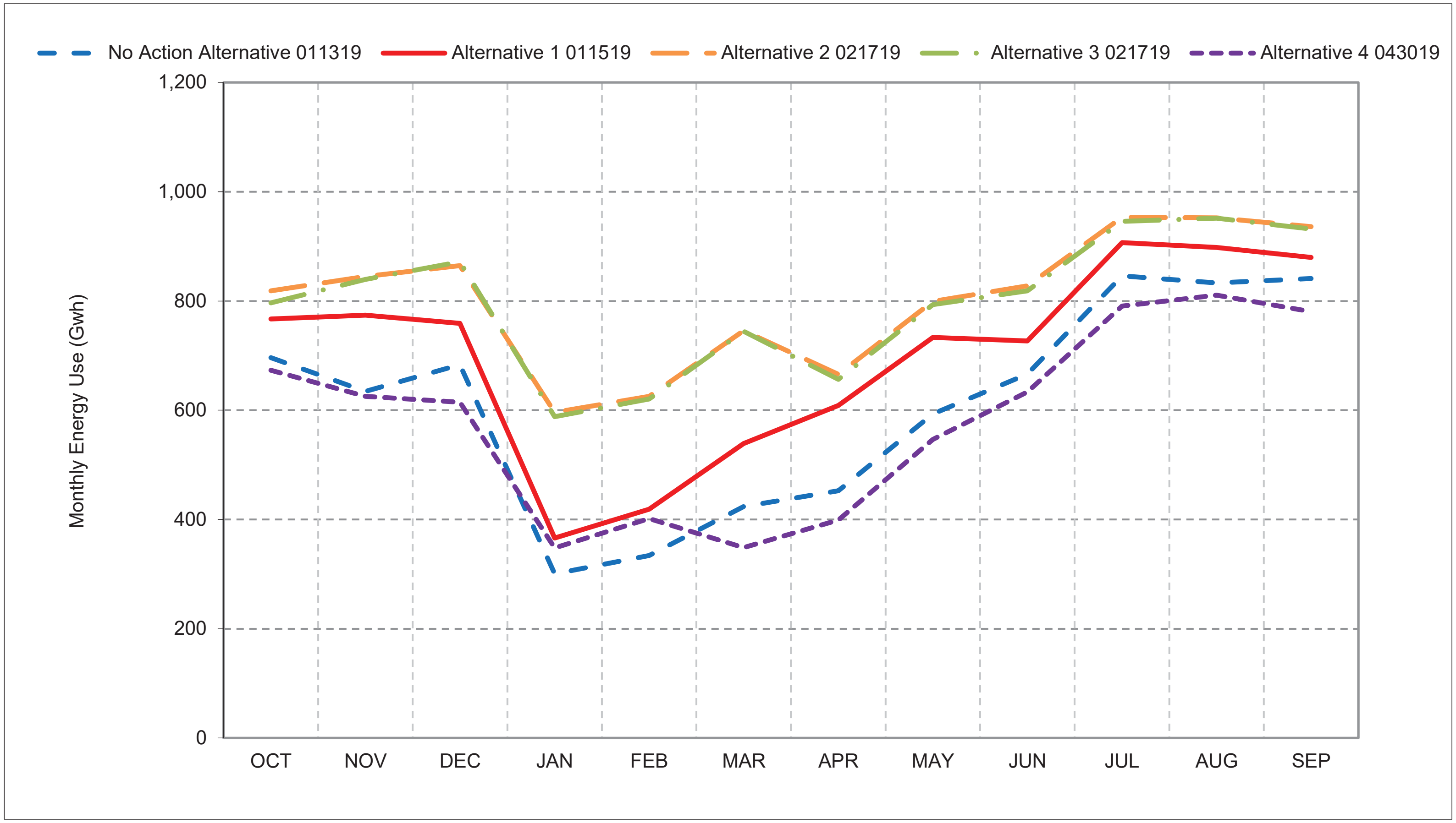
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Figure 7-1. SWP Total Energy Use, Long-Term Average Energy Use



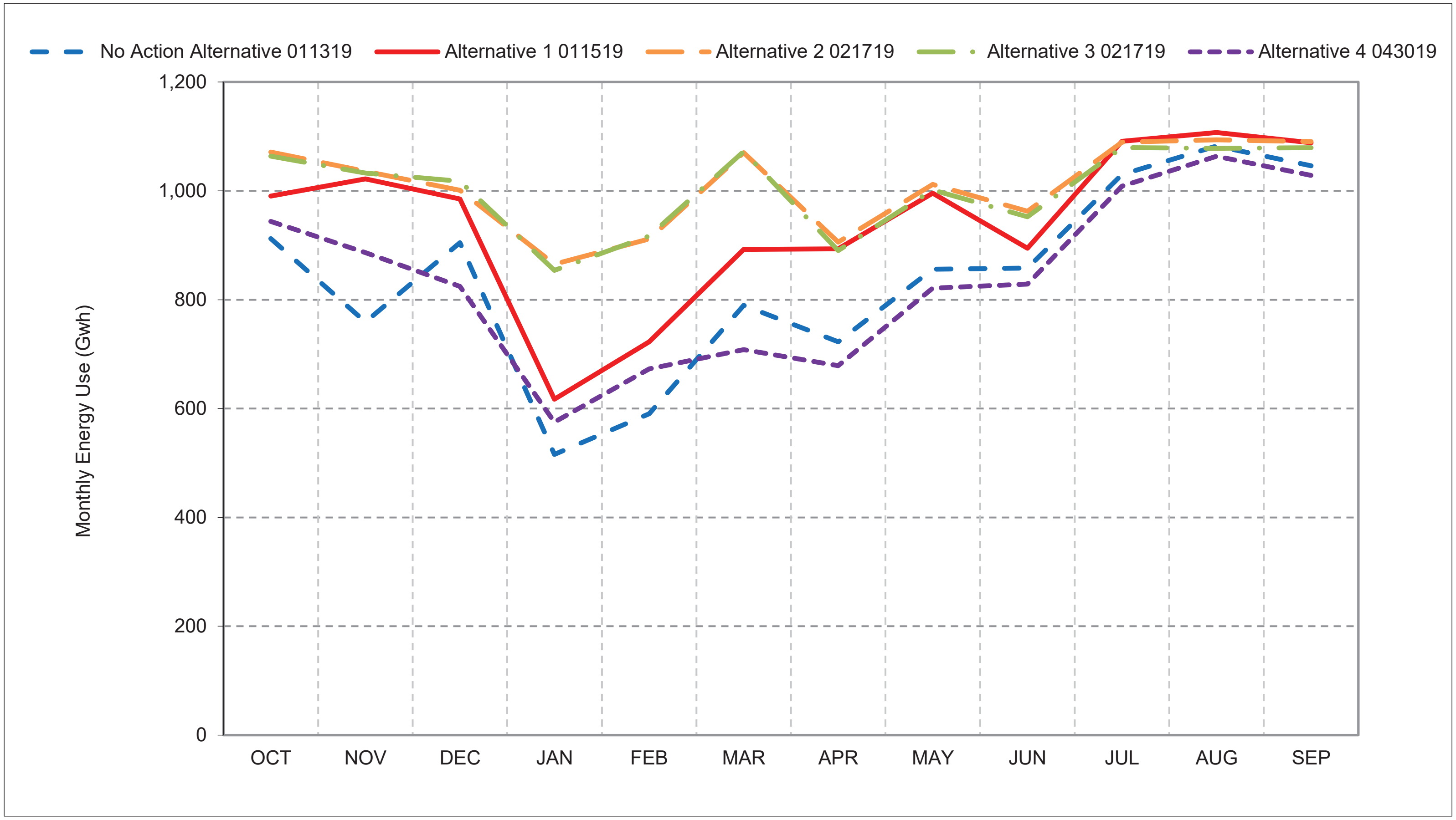
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

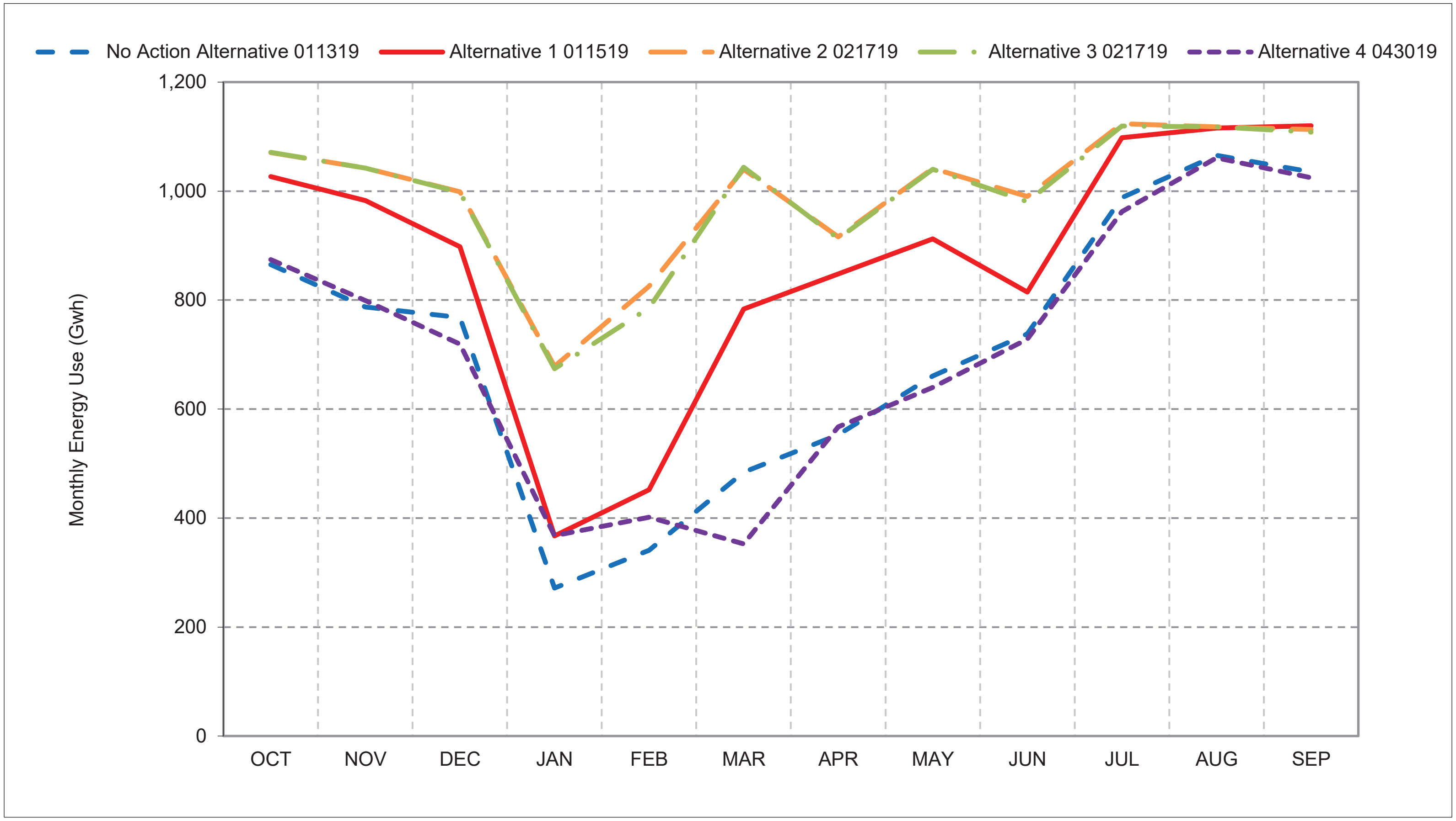
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 7-2. SWP Total Energy Use, Wet Year Average Energy Use



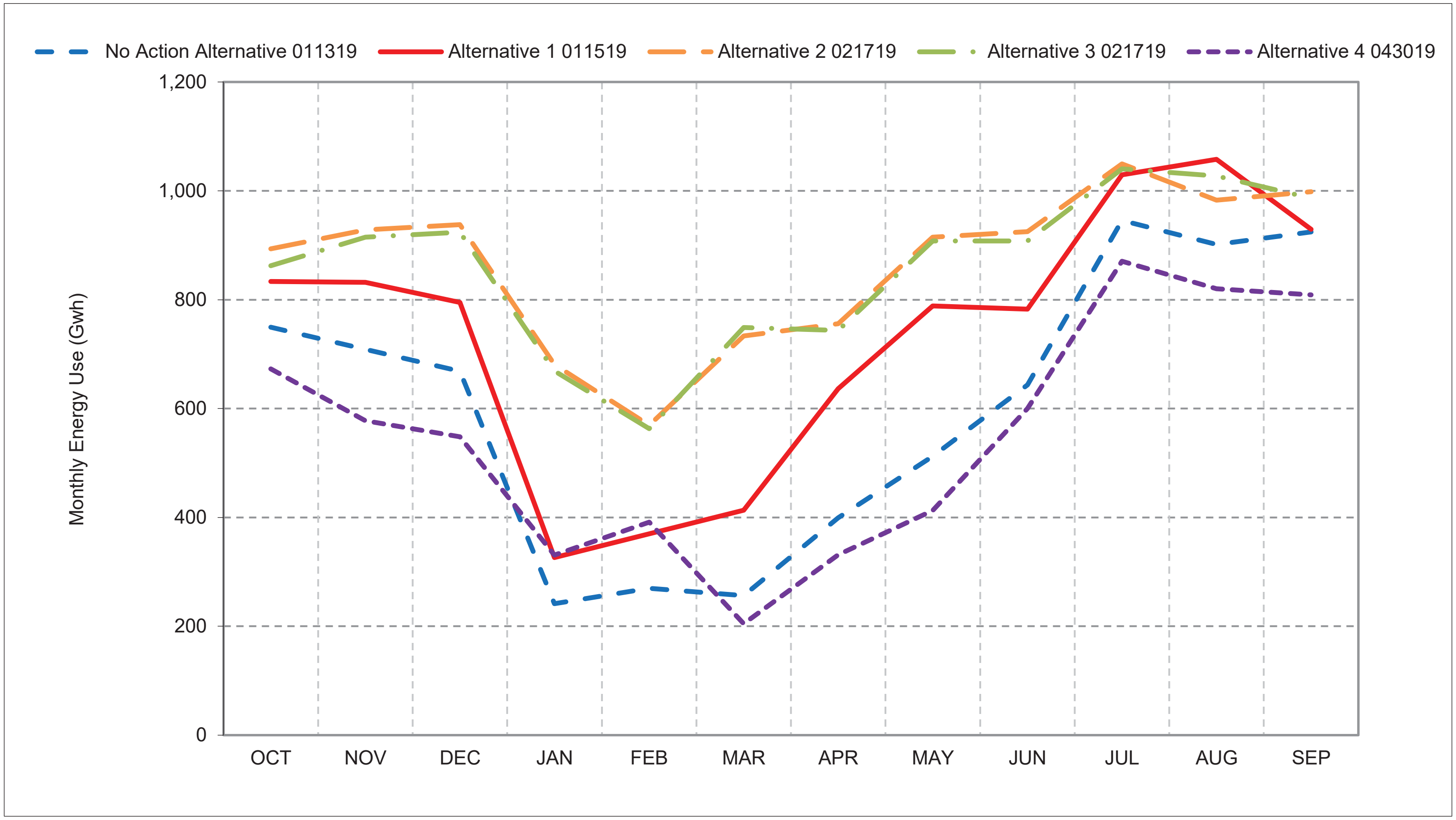
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 7-3. SWP Total Energy Use, Above Normal Year Average Energy Use



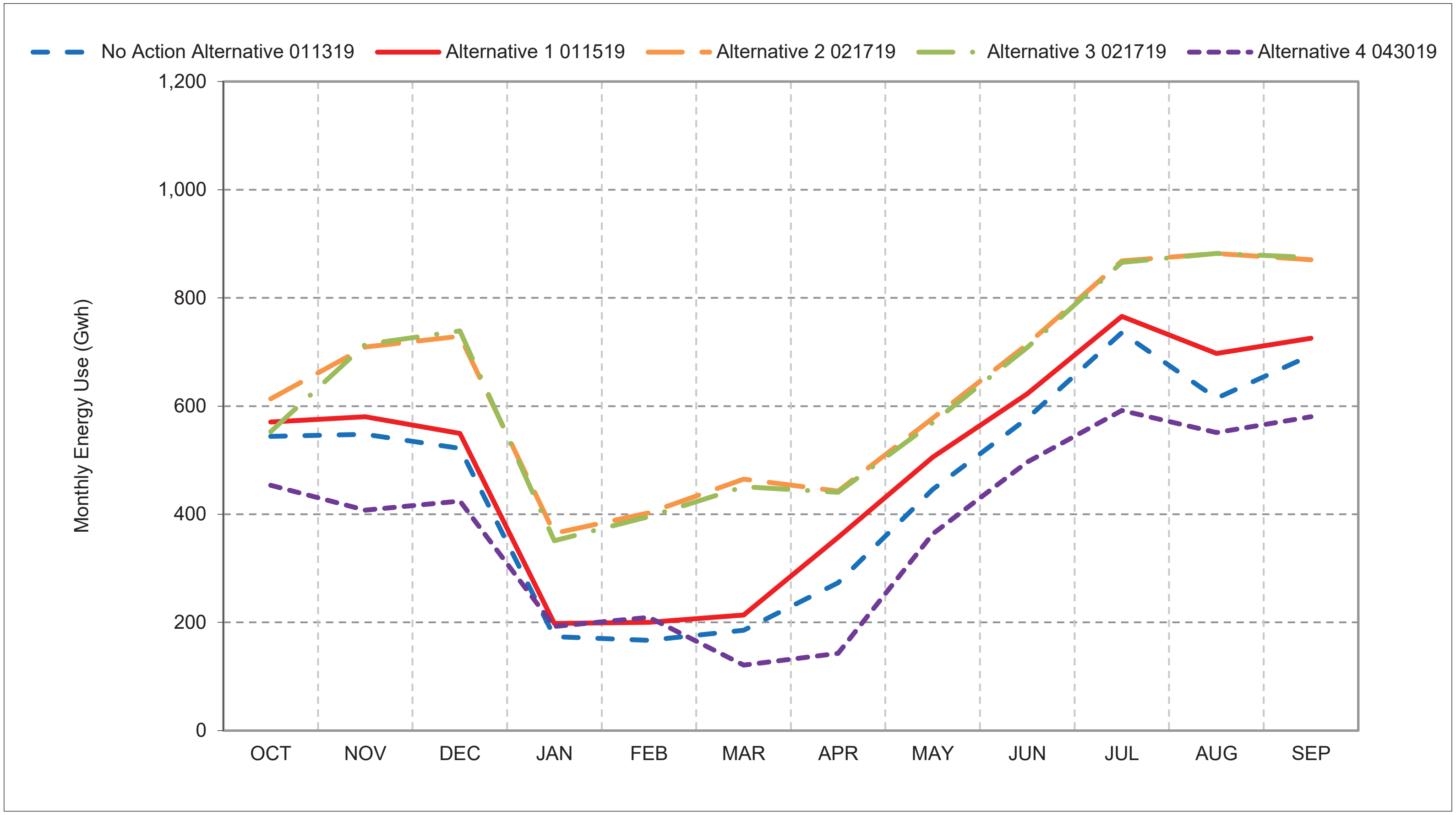
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 7-4. SWP Total Energy Use, Below Normal Year Average Energy Use



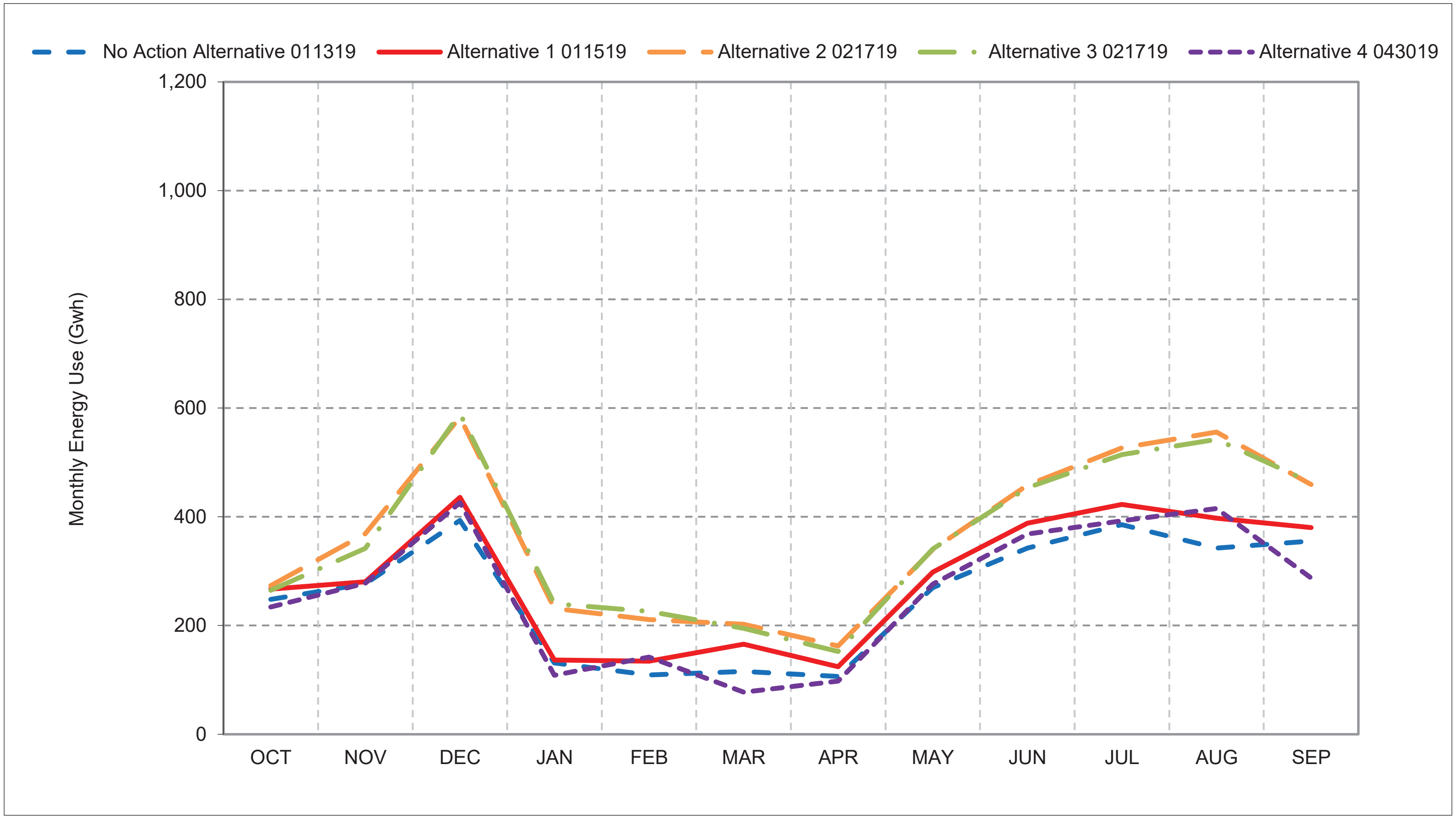
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 7-5. SWP Total Energy Use, Dry Year Average Energy Use



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 7-6. SWP Total Energy Use, Critical Year Average Energy Use



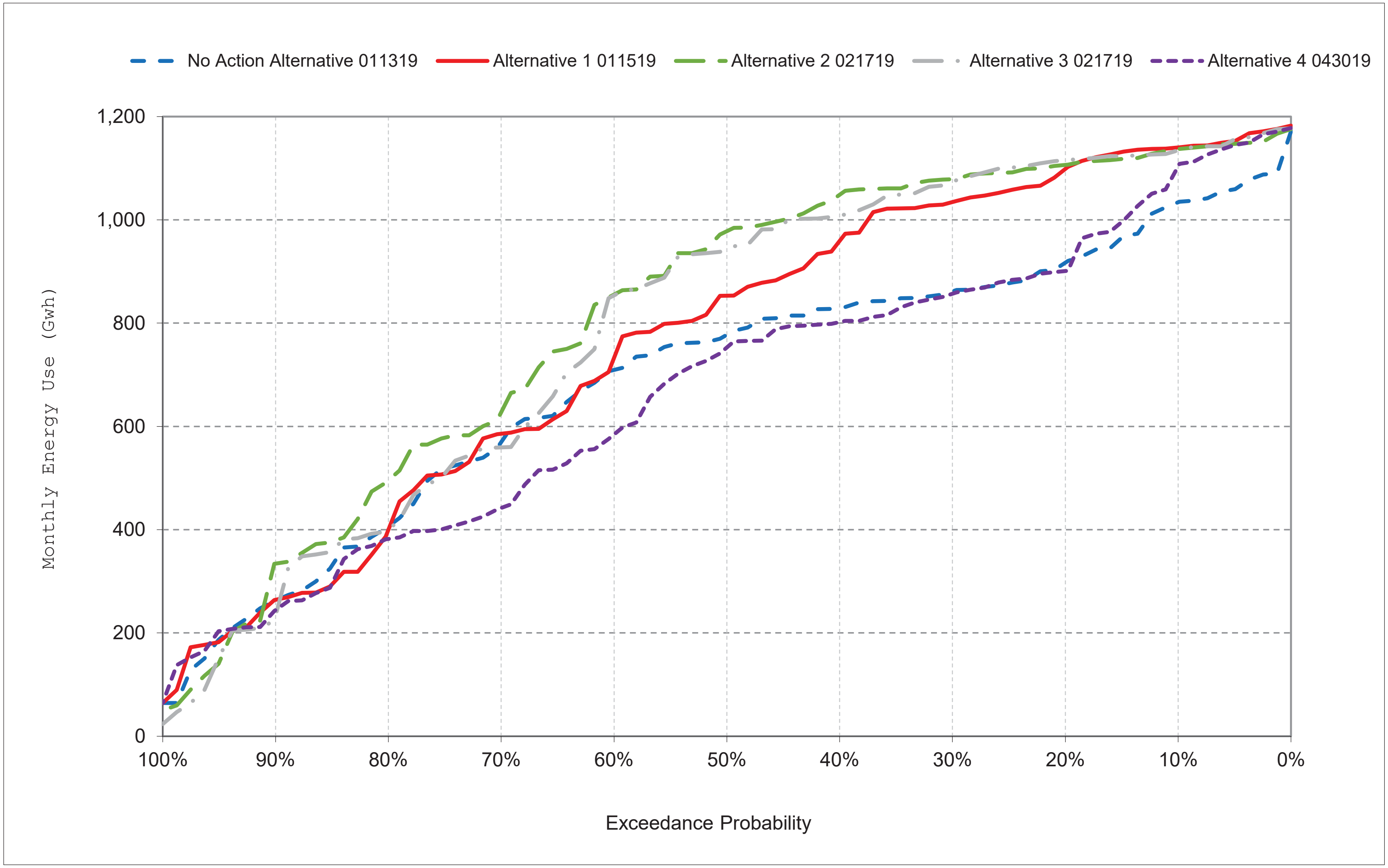
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

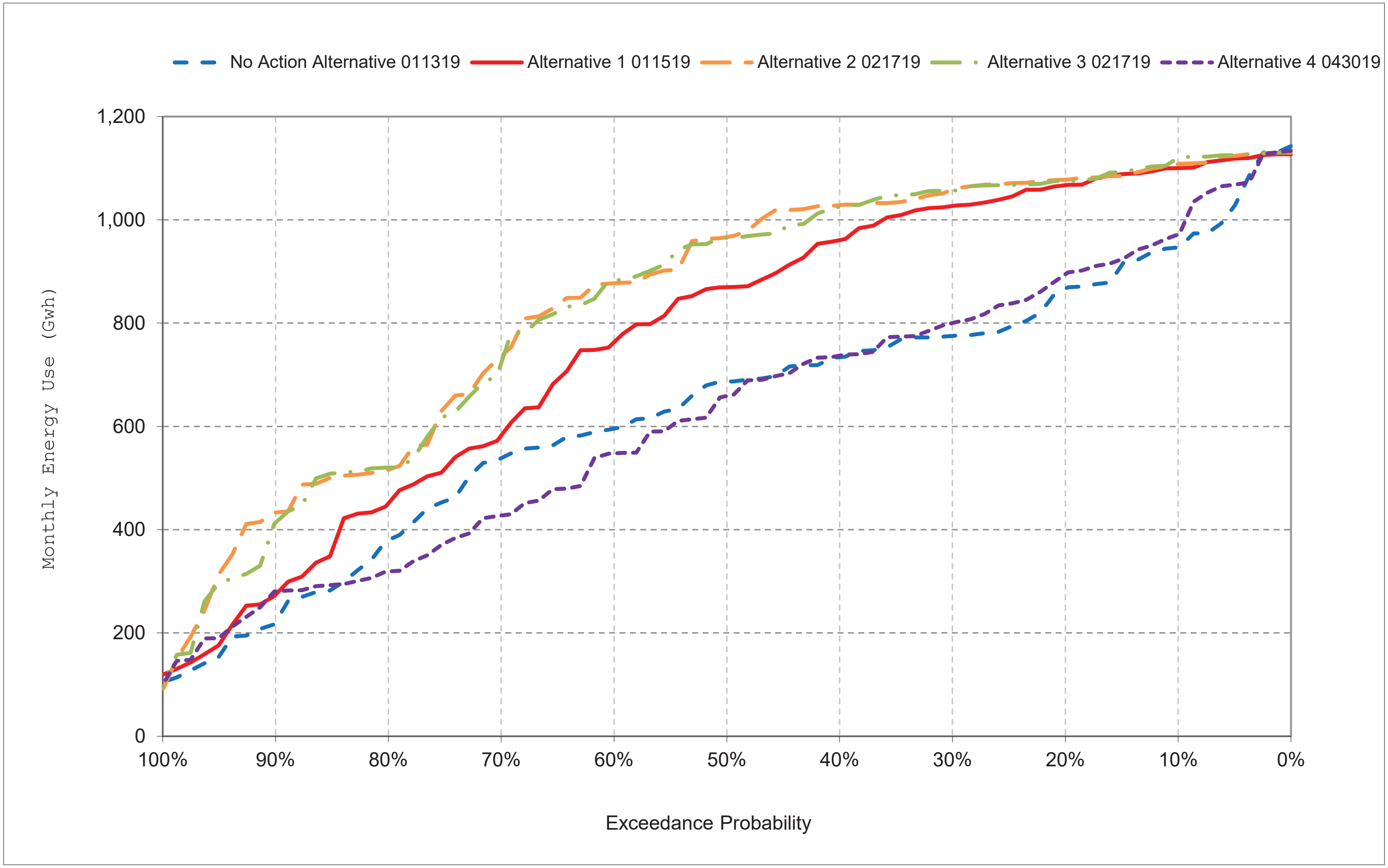
Figure 7-7. SWP Total Energy Use, October



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

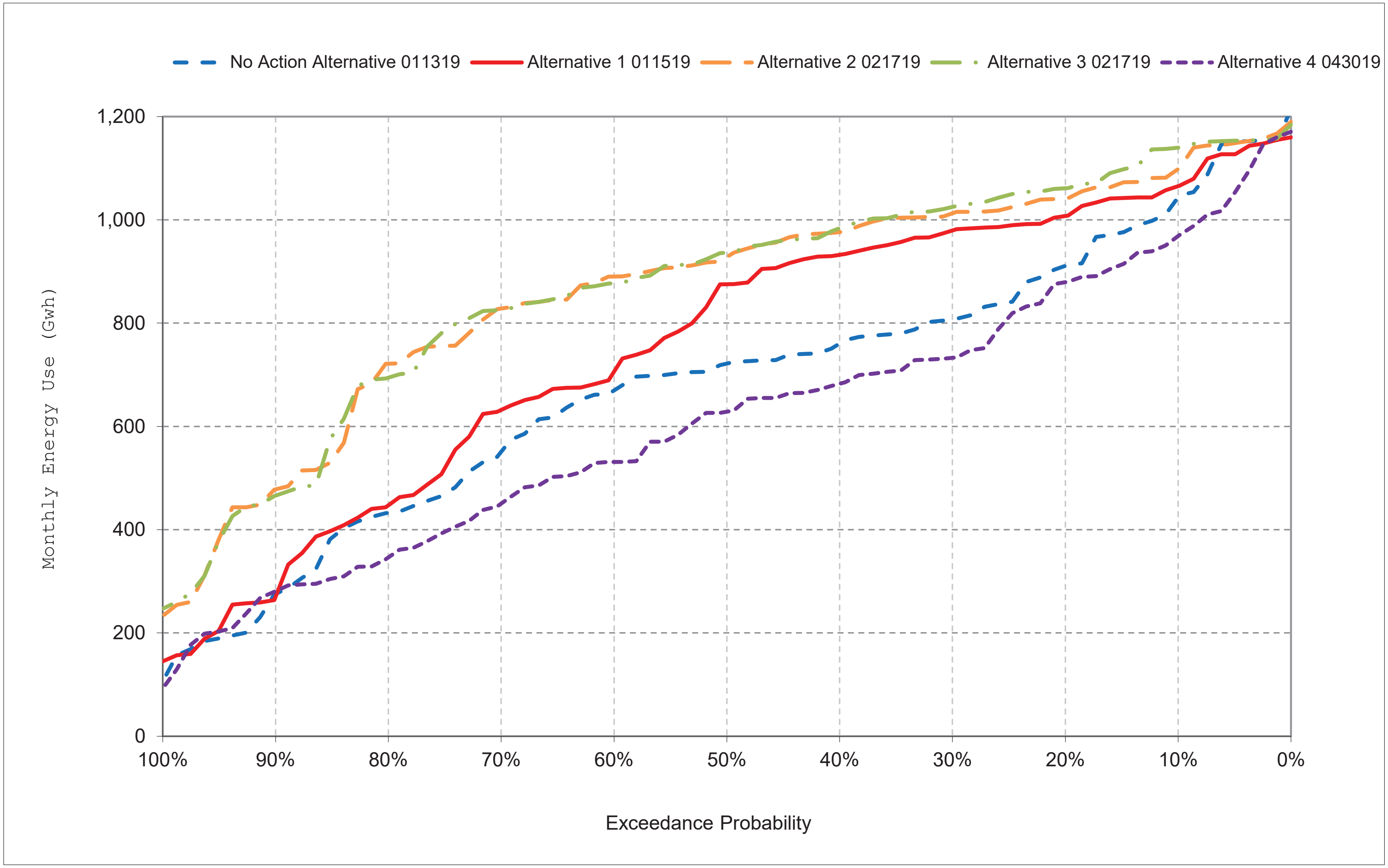
Figure 7-8. SWP Total Energy Use, November



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

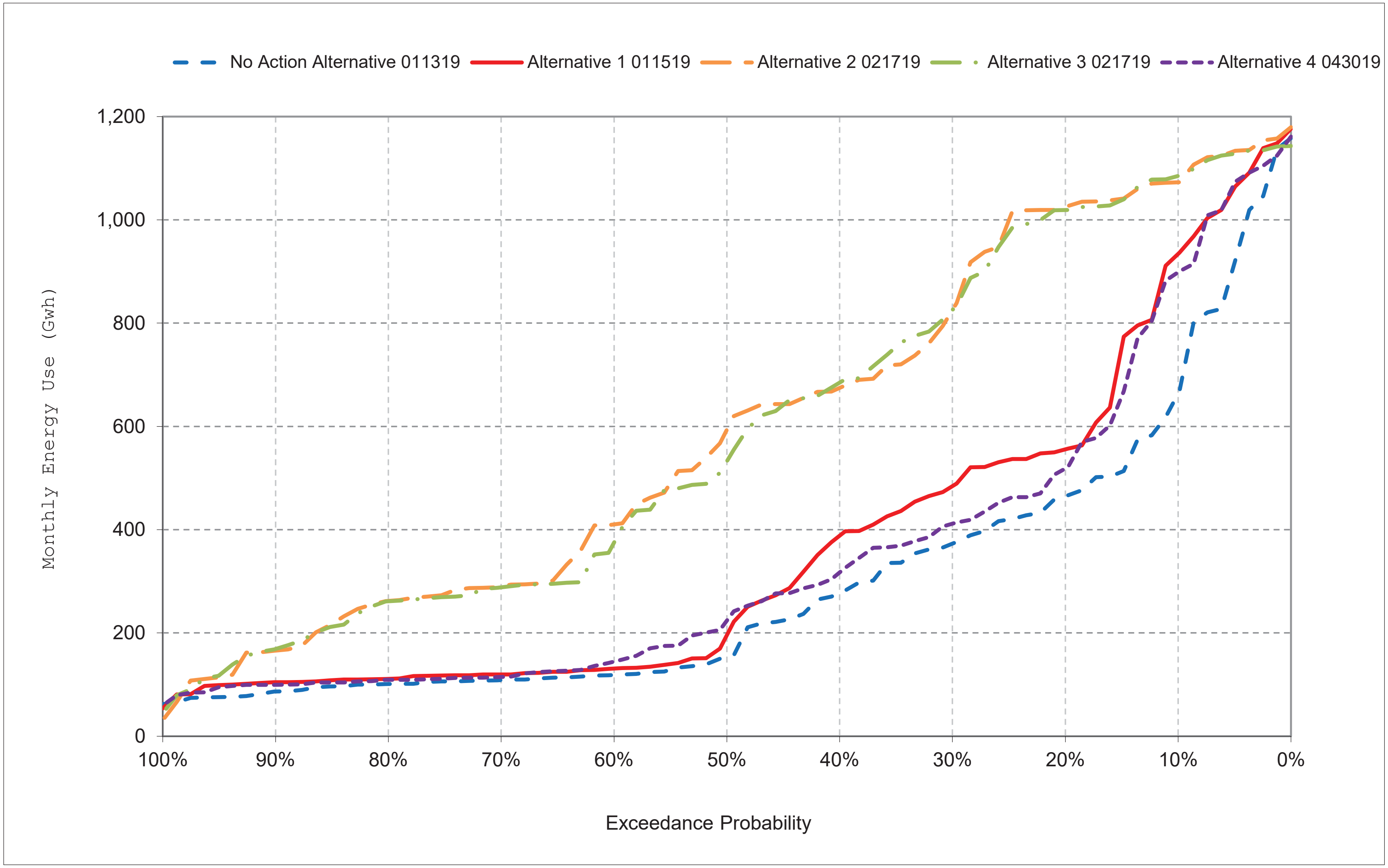
Figure 7-9. SWP Total Energy Use, December



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

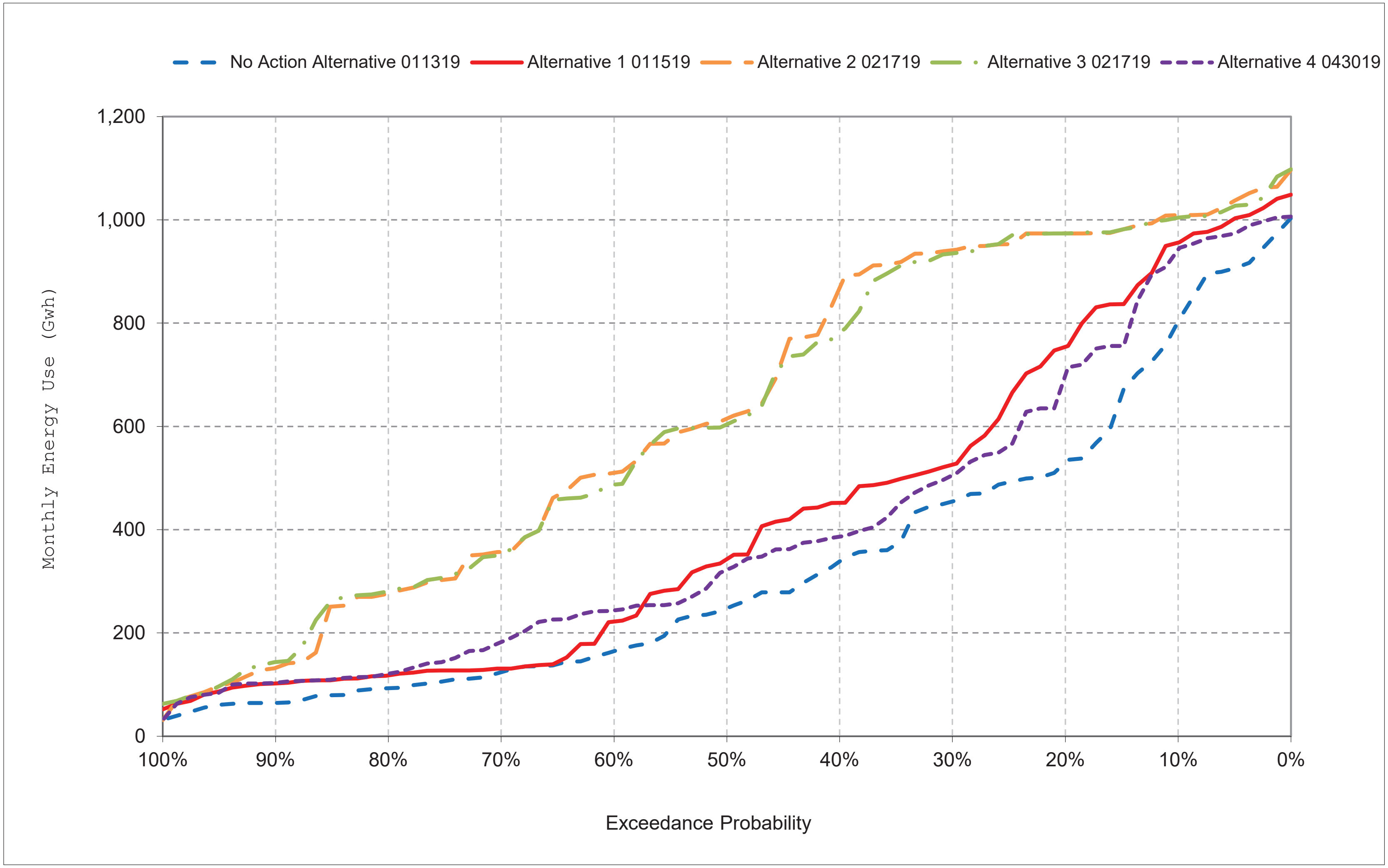
Figure 7-10. SWP Total Energy Use, January



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

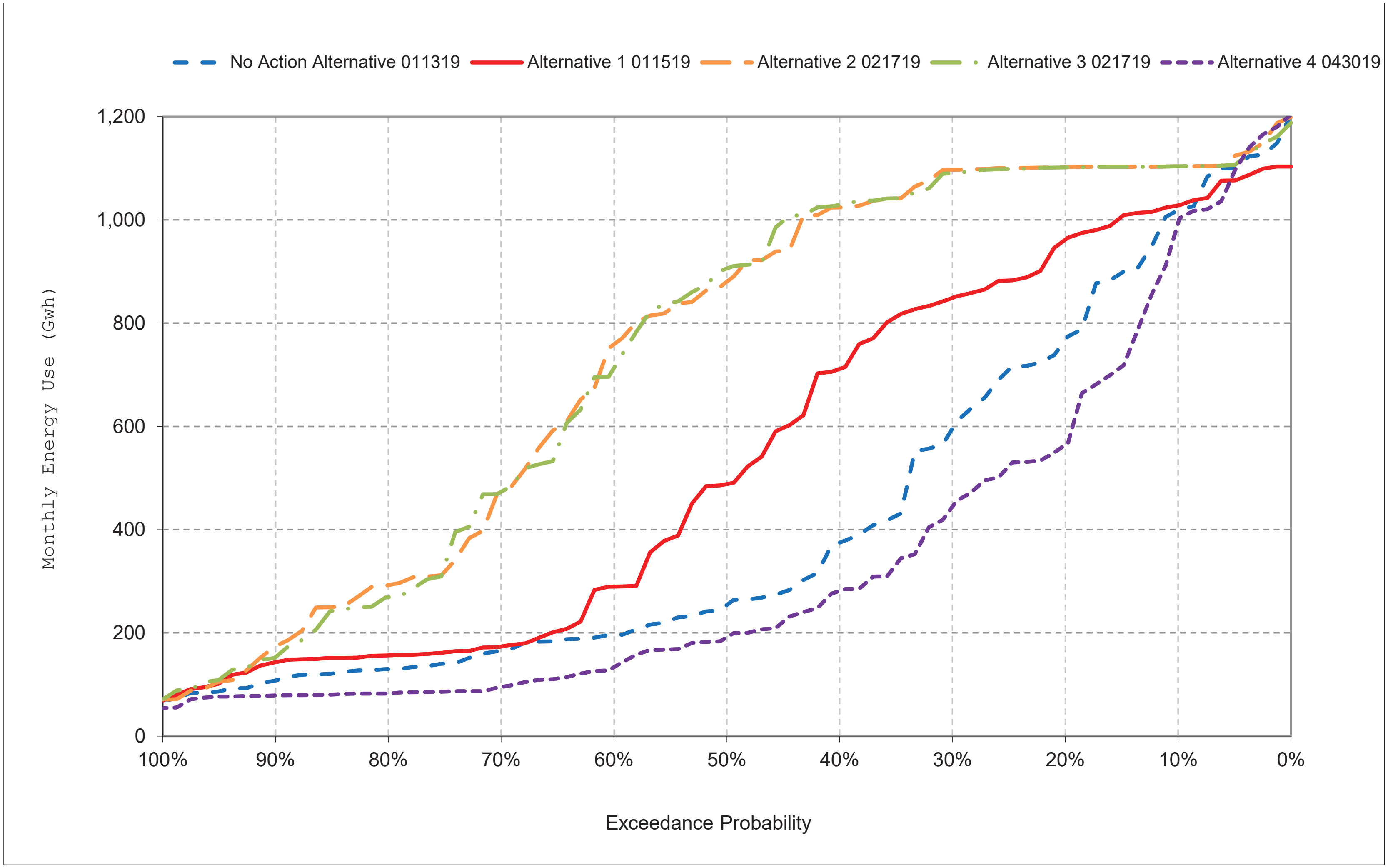
Figure 7-11. SWP Total Energy Use, February



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

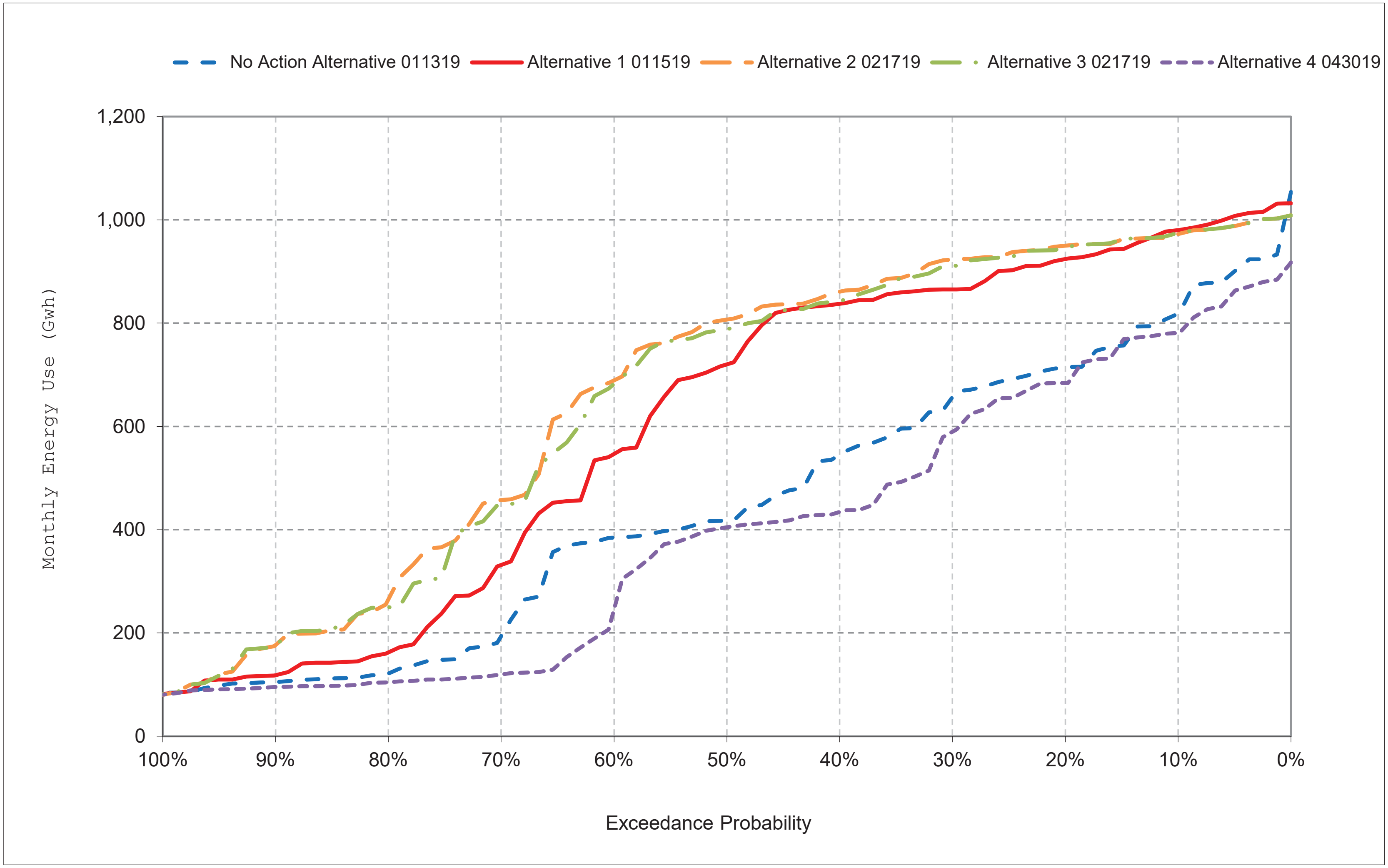
Figure 7-12. SWP Total Energy Use, March



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

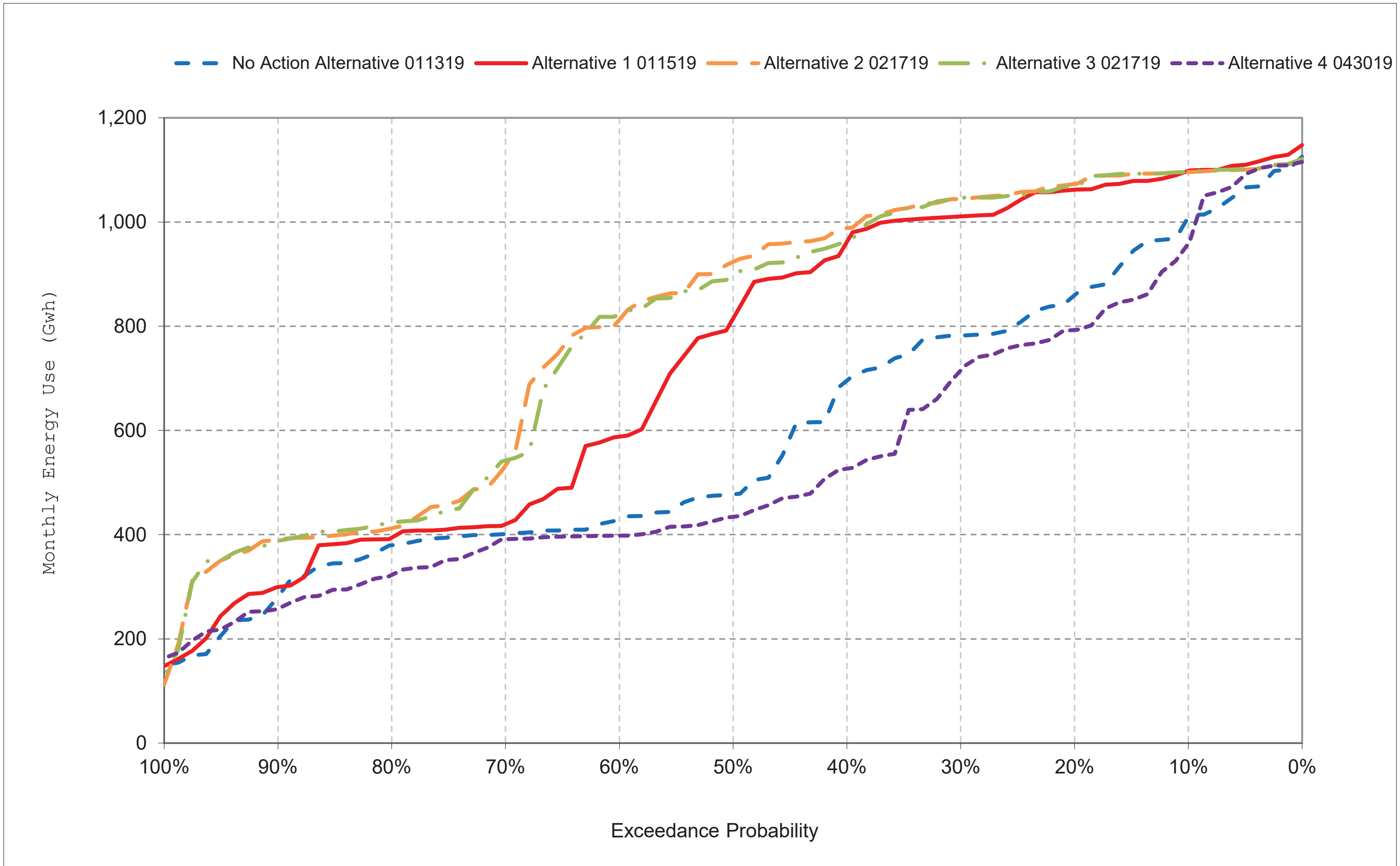
Figure 7-13. SWP Total Energy Use, April



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

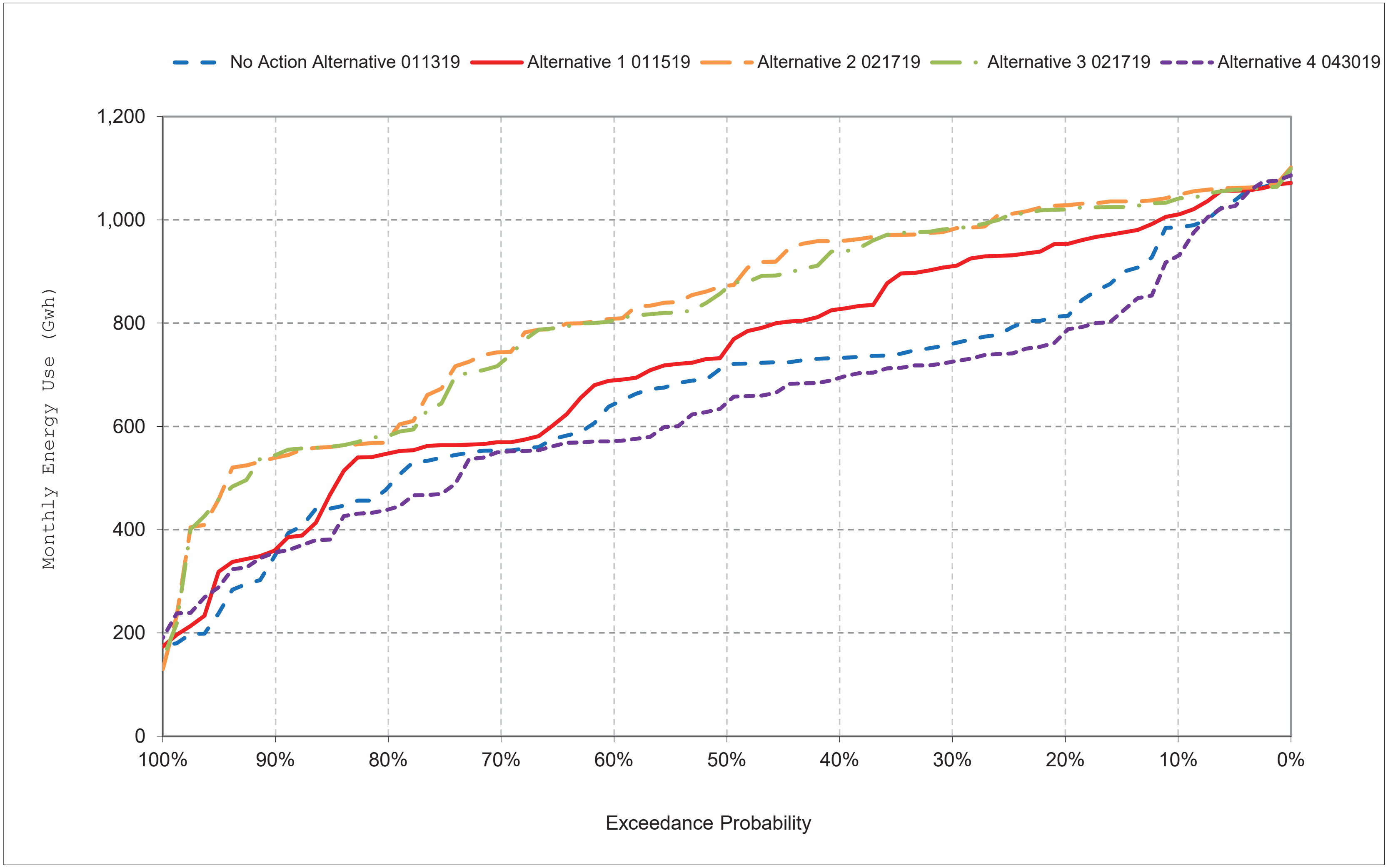
Figure 7-14. SWP Total Energy Use, May



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

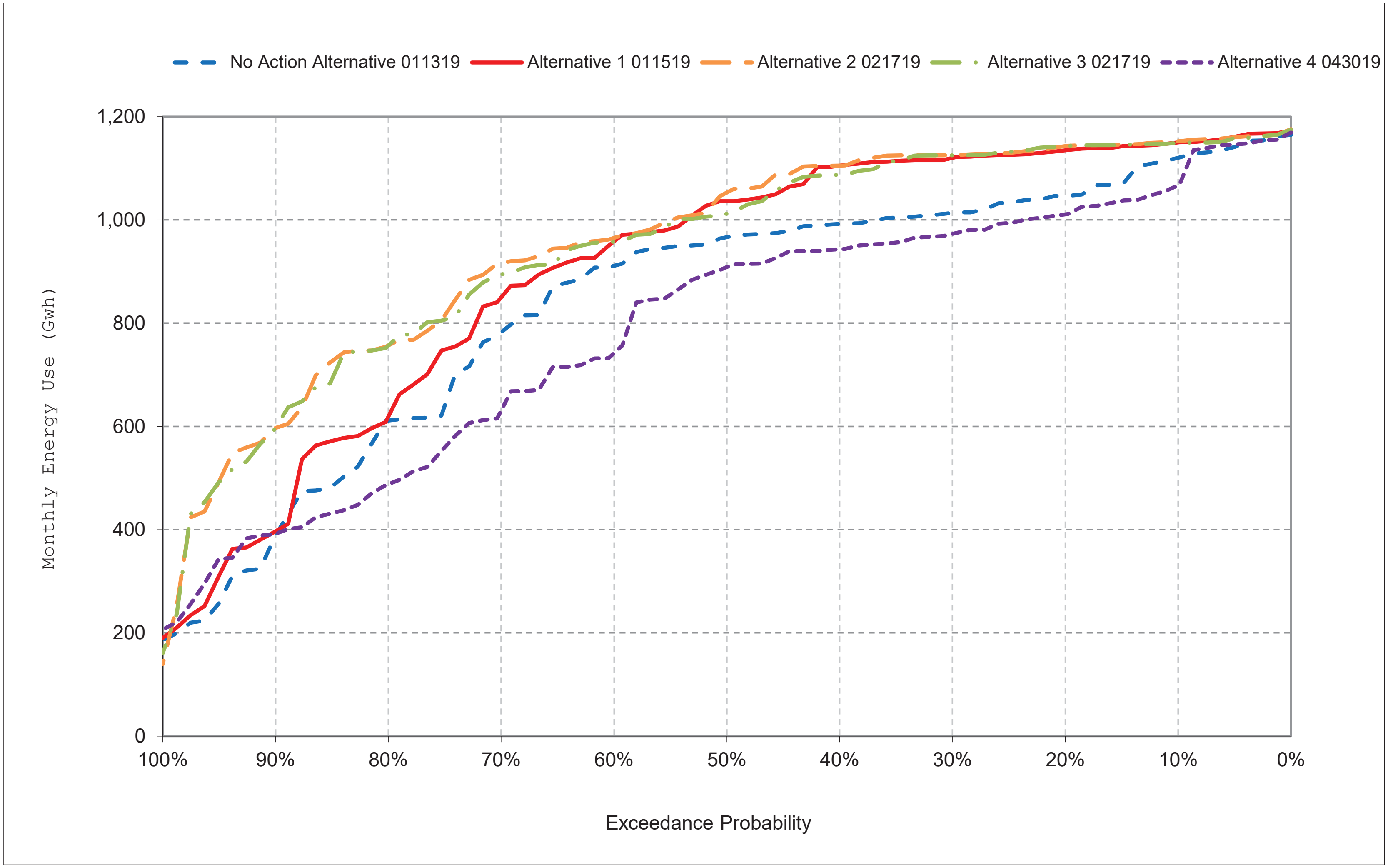
Figure 7-15. SWP Total Energy Use, June



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

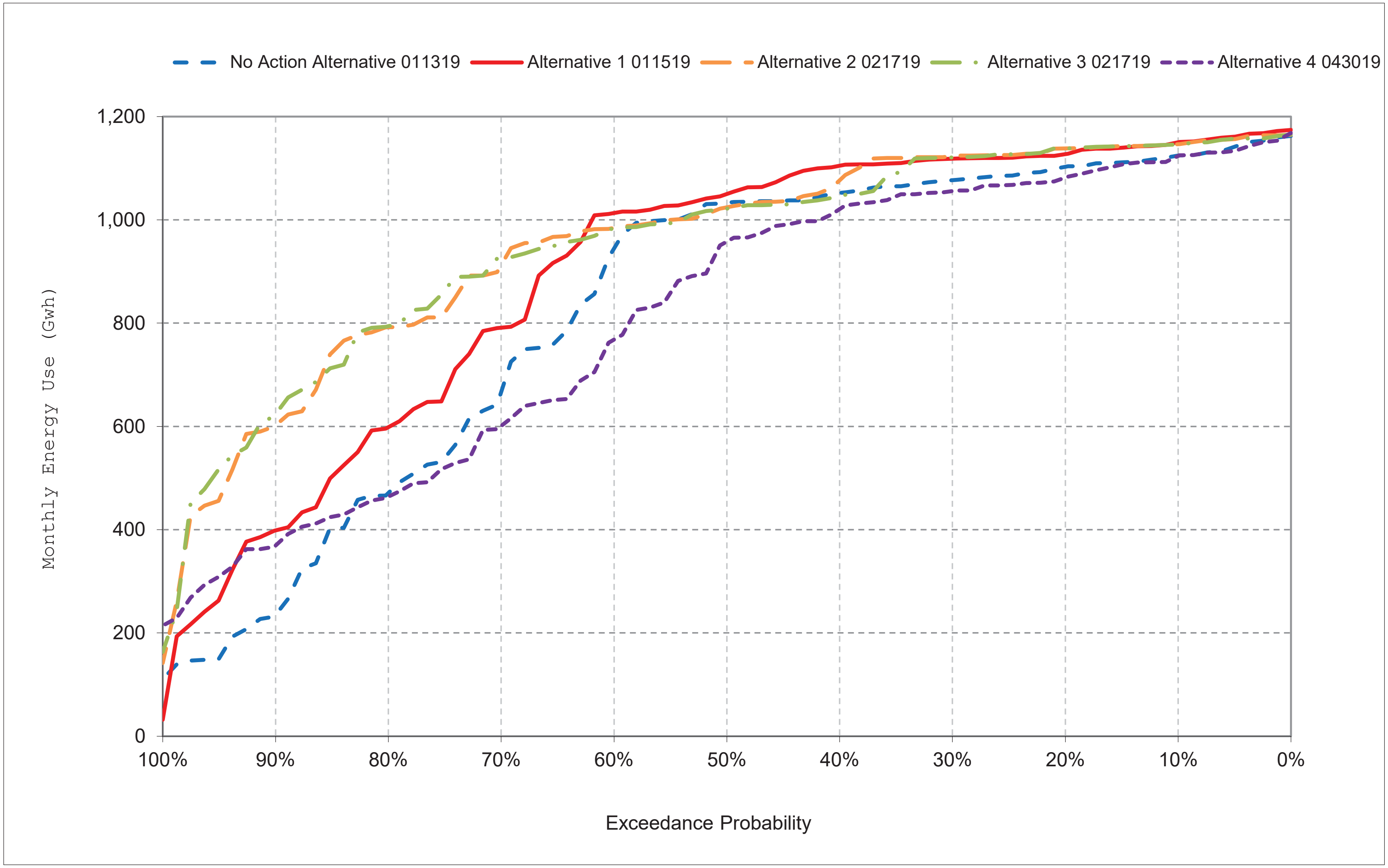
Figure 7-16. SWP Total Energy Use, July



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

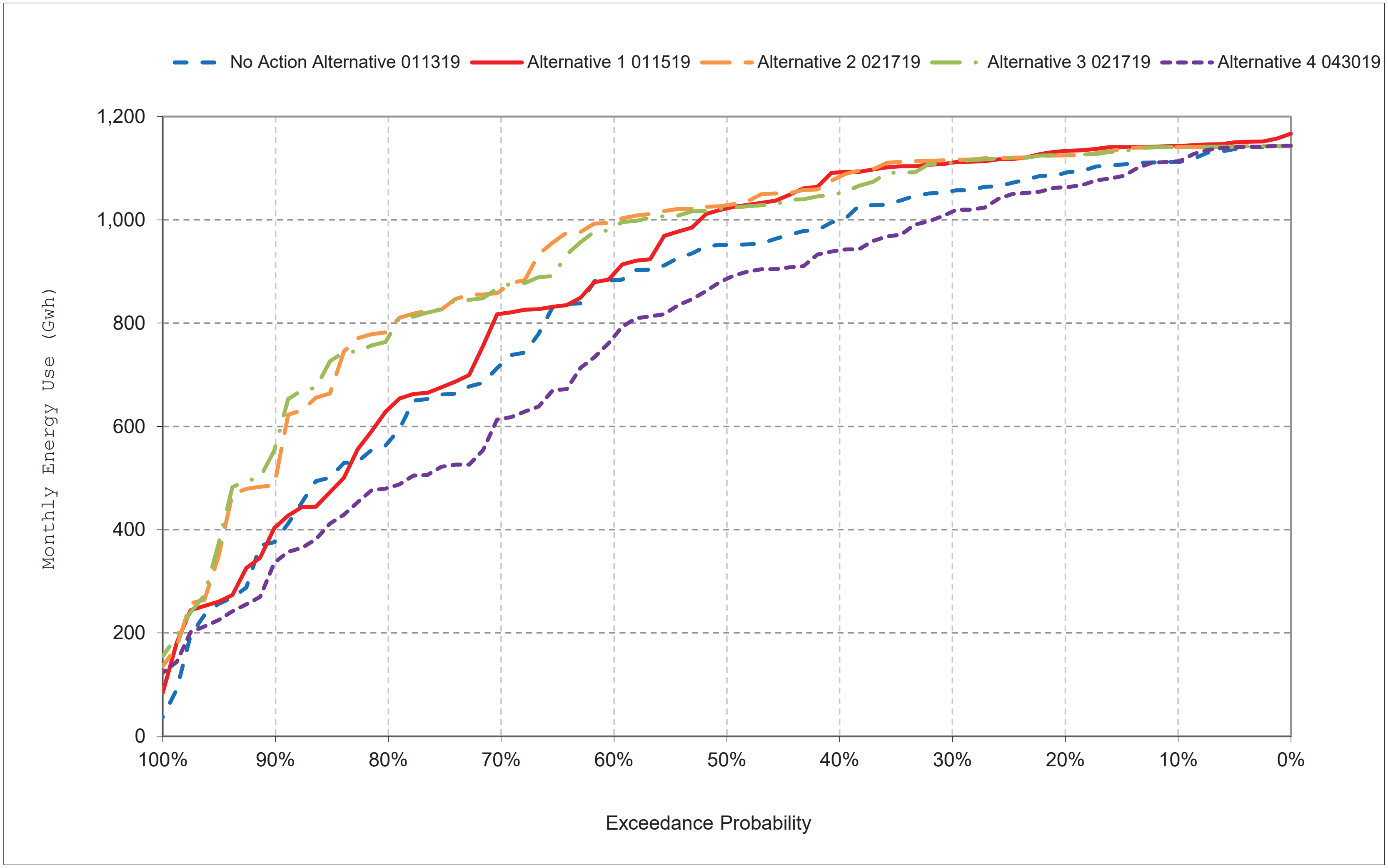
Figure 7-17. SWP Total Energy Use, August



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 7-18. SWP Total Energy Use, September



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Table 8-1. SWP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-160	-133	-155	-9	24	35	15	-16	-76	-137	-146	-223
20%	-224	-200	-229	-36	-17	-26	-21	-90	-138	-201	-261	-324
30%	-332	-288	-297	-43	-39	-48	-34	-117	-169	-247	-328	-383
40%	-372	-335	-401	-55	-52	-73	-60	-145	-211	-291	-432	-402
50%	-416	-376	-443	-70	-78	-95	-100	-157	-264	-310	-458	-427
60%	-445	-426	-465	-103	-107	-126	-169	-189	-309	-319	-474	-459
70%	-494	-458	-507	-162	-161	-155	-258	-257	-334	-361	-489	-485
80%	-520	-502	-559	-210	-210	-285	-292	-351	-376	-394	-523	-538
90%	-554	-579	-630	-264	-277	-421	-361	-398	-429	-464	-579	-592
Long Term												
Full Simulation Period[a]	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
Water Year Types[b,c]												
Wet (32%)	-471	-394	-519	-100	-80	-199	-202	-236	-372	-406	-531	-429
Above Normal (16%)	-473	-462	-471	-122	-132	-156	-225	-277	-325	-320	-458	-479
Below Normal (13%)	-452	-437	-424	-125	-157	-140	-158	-195	-253	-320	-422	-559
Dry (24%)	-314	-337	-285	-92	-91	-109	-104	-161	-172	-263	-310	-420
Critical (15%)	-151	-185	-272	-80	-65	-47	0	-86	-99	-153	-186	-222

Alternative 1 011519

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-143	-148	-153	-26	-2	-28	-14	-73	-67	-133	-191	-252
20%	-219	-277	-224	-43	-54	-73	-60	-108	-143	-226	-303	-370
30%	-323	-358	-327	-56	-60	-92	-112	-143	-183	-302	-408	-462
40%	-407	-467	-390	-67	-80	-112	-191	-201	-239	-327	-450	-522
50%	-517	-518	-427	-84	-106	-150	-276	-314	-275	-371	-494	-584
60%	-554	-591	-532	-123	-184	-174	-385	-376	-333	-400	-511	-611
70%	-611	-636	-598	-201	-224	-275	-456	-435	-384	-422	-526	-644
80%	-640	-657	-632	-251	-270	-369	-491	-497	-405	-444	-552	-659
90%	-675	-700	-669	-323	-319	-457	-539	-566	-477	-465	-586	-749
Long Term												
Full Simulation Period[a]	-449	-474	-439	-139	-144	-207	-279	-303	-280	-349	-441	-524
Water Year Types[b,c]												
Wet (32%)	-571	-606	-523	-145	-160	-245	-367	-363	-378	-449	-554	-668
Above Normal (16%)	-588	-612	-550	-190	-182	-315	-459	-463	-359	-386	-492	-610
Below Normal (13%)	-519	-524	-505	-183	-171	-243	-337	-371	-317	-364	-508	-563
Dry (24%)	-333	-359	-304	-108	-118	-138	-173	-203	-176	-285	-358	-434
Critical (15%)	-162	-182	-303	-83	-90	-88	-15	-101	-119	-185	-219	-234

Alternative 1 011519 minus No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	17	-14	2	-17	-26	-63	-29	-57	9	4	-45	-29
20%	5	-77	5	-7	-37	-47	-39	-18	-6	-26	-42	-46
30%	9	-70	-29	-13	-21	-44	-78	-26	-14	-55	-80	-79
40%	-35	-132	11	-12	-28	-39	-131	-56	-28	-36	-18	-121
50%	-101	-143	16	-15	-28	-55	-176	-157	-10	-61	-36	-157
60%	-108	-165	-67	-20	-77	-48	-216	-187	-23	-81	-37	-152
70%	-117	-178	-91	-39	-63	-120	-198	-177	-50	-61	-37	-159
80%	-120	-155	-73	-41	-61	-84	-199	-147	-29	-50	-29	-121
90%	-121	-122	-39	-58	-42	-37	-178	-168	-48	-1	-8	-156
Long Term												
Full Simulation Period[a]	-65	-108	-34	-37	-45	-66	-133	-106	-20	-40	-41	-103
Water Year Types[b,c]												
Wet (32%)	-100	-212	-4	-45	-80	-46	-166	-128	-7	-43	-23	-240
Above Normal (16%)	-115	-150	-79	-68	-49	-159	-233	-185	-35	-66	-34	-131
Below Normal (13%)	-68	-86	-81	-58	-13	-103	-179	-176	-64	-44	-85	-4
Dry (24%)	-19	-22	-19	-16	-27	-28	-69	-41	-4	-22	-48	-15
Critical (15%)	-11	3	-31	-3	-26	-41	-15	-15	-20	-32	-33	-11

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 8-2. SWP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Monthly Generation (GWh) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-160	-133	-155	-9	24	35	15	-16	-76	-137	-146	-223
20%	-224	-200	-229	-36	-17	-26	-21	-90	-138	-201	-261	-324
30%	-332	-288	-297	-43	-39	-48	-34	-117	-169	-247	-328	-383
40%	-372	-335	-401	-55	-52	-73	-60	-145	-211	-291	-432	-402
50%	-416	-376	-443	-70	-78	-95	-100	-157	-264	-310	-458	-427
60%	-445	-426	-465	-103	-107	-126	-169	-189	-309	-319	-474	-459
70%	-494	-458	-507	-162	-161	-155	-258	-257	-334	-361	-489	-485
80%	-520	-502	-559	-210	-210	-285	-292	-351	-376	-394	-523	-538
90%	-554	-579	-630	-264	-277	-421	-361	-398	-429	-464	-579	-592
Long Term												
Full Simulation Period[a]	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
Water Year Types[b,c]												
Wet (32%)	-471	-394	-519	-100	-80	-199	-202	-236	-372	-406	-531	-429
Above Normal (16%)	-473	-462	-471	-122	-132	-156	-225	-277	-325	-320	-458	-479
Below Normal (13%)	-452	-437	-424	-125	-157	-140	-158	-195	-253	-320	-422	-559
Dry (24%)	-314	-337	-285	-92	-91	-109	-104	-161	-172	-263	-310	-420
Critical (15%)	-151	-185	-272	-80	-65	-47	0	-86	-99	-153	-186	-222

Alternative 2 021719

Statistic	Monthly Generation (GWh) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-160	-251	-265	-110	-58	-104	-66	-112	-156	-263	-336	-334
20%	-277	-305	-361	-153	-108	-145	-114	-140	-187	-328	-430	-488
30%	-385	-472	-483	-208	-188	-203	-169	-194	-220	-355	-476	-526
40%	-479	-545	-539	-228	-248	-301	-259	-289	-266	-386	-499	-591
50%	-557	-586	-575	-264	-295	-351	-350	-369	-323	-404	-513	-610
60%	-603	-630	-607	-292	-328	-400	-422	-420	-367	-420	-529	-624
70%	-632	-647	-629	-408	-395	-504	-484	-462	-407	-431	-547	-643
80%	-642	-673	-671	-469	-459	-542	-515	-521	-447	-451	-564	-677
90%	-674	-711	-707	-646	-597	-612	-564	-576	-496	-489	-606	-740
Long Term												
Full Simulation Period[a]	-479	-524	-531	-320	-304	-351	-325	-344	-320	-394	-494	-564
Water Year Types[b,c]												
Wet (32%)	-617	-615	-550	-336	-305	-364	-383	-383	-419	-457	-569	-666
Above Normal (16%)	-626	-655	-644	-443	-458	-507	-527	-549	-429	-418	-518	-617
Below Normal (13%)	-546	-588	-622	-452	-330	-463	-423	-432	-321	-430	-509	-620
Dry (24%)	-355	-451	-451	-243	-279	-314	-234	-245	-218	-366	-476	-534
Critical (15%)	-166	-247	-415	-163	-151	-113	-44	-123	-154	-245	-322	-287

Alternative 2 021719 minus No Action Alternative 011319

Statistic	Monthly Generation (GWh) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0	-118	-111	-101	-83	-139	-81	-96	-80	-126	-190	-111
20%	-54	-104	-132	-118	-90	-119	-93	-50	-49	-127	-169	-164
30%	-53	-184	-185	-165	-148	-155	-135	-77	-51	-108	-147	-143
40%	-107	-210	-138	-174	-197	-228	-199	-145	-55	-95	-67	-189
50%	-141	-210	-133	-194	-217	-256	-250	-212	-59	-94	-56	-183
60%	-157	-205	-142	-189	-220	-274	-253	-231	-58	-101	-54	-165
70%	-138	-189	-122	-246	-234	-349	-226	-205	-73	-70	-58	-158
80%	-122	-171	-112	-259	-250	-257	-223	-170	-71	-57	-41	-140
90%	-120	-132	-78	-382	-320	-191	-203	-178	-67	-25	-27	-148
Long Term												
Full Simulation Period[a]	-95	-158	-125	-218	-205	-211	-179	-147	-60	-85	-94	-143
Water Year Types[b,c]												
Wet (32%)	-146	-221	-31	-235	-225	-165	-181	-147	-48	-51	-39	-237
Above Normal (16%)	-153	-193	-173	-320	-325	-351	-302	-272	-105	-98	-60	-138
Below Normal (13%)	-95	-151	-199	-328	-173	-323	-266	-237	-67	-110	-86	-61
Dry (24%)	-42	-113	-166	-150	-189	-205	-131	-83	-46	-103	-166	-114
Critical (15%)	-15	-63	-143	-83	-86	-66	-44	-37	-55	-92	-136	-65

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 8-3. SWP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	-160	-133	-155	-9	24	35	15	-16	-76	-137	-146	-223
20%	-224	-200	-229	-36	-17	-26	-21	-90	-138	-201	-261	-324
30%	-332	-288	-297	-43	-39	-48	-34	-117	-169	-247	-328	-383
40%	-372	-335	-401	-55	-52	-73	-60	-145	-211	-291	-432	-402
50%	-416	-376	-443	-70	-78	-95	-100	-157	-264	-310	-458	-427
60%	-445	-426	-465	-103	-107	-126	-169	-189	-309	-319	-474	-459
70%	-494	-458	-507	-162	-161	-155	-258	-257	-334	-361	-489	-485
80%	-520	-502	-559	-210	-210	-285	-292	-351	-376	-394	-523	-538
90%	-554	-579	-630	-264	-277	-421	-361	-398	-429	-464	-579	-592
Long Term												
Full Simulation Period[a]	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
Water Year Types[b,c]												
Wet (32%)	-471	-394	-519	-100	-80	-199	-202	-236	-372	-406	-531	-429
Above Normal (16%)	-473	-462	-471	-122	-132	-156	-225	-277	-325	-320	-458	-479
Below Normal (13%)	-452	-437	-424	-125	-157	-140	-158	-195	-253	-320	-422	-559
Dry (24%)	-314	-337	-285	-92	-91	-109	-104	-161	-172	-263	-310	-420
Critical (15%)	-151	-185	-272	-80	-65	-47	0	-86	-99	-153	-186	-222

Alternative 3 021719

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	-157	-251	-272	-108	-61	-101	-72	-106	-155	-276	-335	-344
20%	-224	-313	-387	-142	-116	-139	-118	-139	-181	-315	-437	-474
30%	-318	-456	-479	-190	-211	-178	-151	-195	-220	-344	-478	-534
40%	-453	-531	-522	-222	-243	-285	-251	-284	-252	-378	-497	-560
50%	-549	-593	-583	-250	-274	-334	-329	-375	-309	-398	-514	-592
60%	-596	-633	-613	-284	-324	-411	-403	-418	-361	-412	-531	-609
70%	-621	-653	-633	-391	-394	-482	-478	-465	-407	-430	-543	-642
80%	-635	-677	-679	-476	-464	-542	-512	-512	-440	-449	-562	-674
90%	-677	-702	-705	-642	-596	-603	-566	-580	-494	-483	-610	-742
Long Term												
Full Simulation Period[a]	-461	-520	-534	-313	-299	-348	-318	-343	-317	-388	-495	-560
Water Year Types[b,c]												
Wet (32%)	-611	-613	-558	-321	-310	-358	-369	-385	-412	-452	-571	-653
Above Normal (16%)	-624	-655	-636	-444	-426	-510	-525	-551	-432	-411	-515	-612
Below Normal (13%)	-525	-579	-618	-444	-318	-474	-416	-430	-319	-419	-537	-617
Dry (24%)	-307	-454	-458	-235	-275	-305	-234	-237	-215	-367	-472	-537
Critical (15%)	-157	-227	-420	-165	-162	-109	-38	-124	-155	-235	-311	-290

Alternative 3 021719 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	3	-117	-118	-99	-86	-136	-87	-90	-79	-140	-188	-121
20%	-1	-113	-158	-106	-99	-113	-97	-50	-43	-114	-177	-150
30%	14	-168	-181	-147	-172	-131	-117	-78	-51	-97	-150	-151
40%	-81	-196	-122	-168	-191	-212	-191	-139	-41	-87	-65	-158
50%	-133	-217	-140	-181	-197	-238	-229	-218	-44	-88	-56	-165
60%	-150	-207	-148	-181	-216	-285	-235	-230	-52	-93	-57	-150
70%	-128	-195	-126	-229	-233	-327	-220	-207	-73	-69	-54	-157
80%	-115	-176	-120	-266	-254	-257	-220	-161	-63	-55	-39	-136
90%	-122	-123	-76	-378	-319	-183	-205	-182	-65	-19	-32	-150
Long Term												
Full Simulation Period[a]	-77	-154	-128	-211	-200	-208	-172	-146	-57	-80	-95	-139
Water Year Types[b,c]												
Wet (32%)	-140	-219	-39	-221	-230	-159	-167	-150	-41	-46	-40	-224
Above Normal (16%)	-151	-193	-165	-321	-294	-354	-300	-274	-107	-92	-57	-133
Below Normal (13%)	-73	-141	-194	-319	-160	-333	-258	-235	-66	-99	-114	-59
Dry (24%)	6	-116	-173	-142	-185	-196	-130	-75	-43	-104	-162	-118
Critical (15%)	-6	-42	-148	-85	-97	-62	-38	-38	-56	-82	-125	-68

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 8-4. SWP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-160	-133	-155	-9	24	35	15	-16	-76	-137	-146	-223
20%	-224	-200	-229	-36	-17	-26	-21	-90	-138	-201	-261	-324
30%	-332	-288	-297	-43	-39	-48	-34	-117	-169	-247	-328	-383
40%	-372	-335	-401	-55	-52	-73	-60	-145	-211	-291	-432	-402
50%	-416	-376	-443	-70	-78	-95	-100	-157	-264	-310	-458	-427
60%	-445	-426	-465	-103	-107	-126	-169	-189	-309	-319	-474	-459
70%	-494	-458	-507	-162	-161	-155	-258	-257	-334	-361	-489	-485
80%	-520	-502	-559	-210	-210	-285	-292	-351	-376	-394	-523	-538
90%	-554	-579	-630	-264	-277	-421	-361	-398	-429	-464	-579	-592
Long Term												
Full Simulation Period[a]	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
Water Year Types[b,c]												
Wet (32%)	-471	-394	-519	-100	-80	-199	-202	-236	-372	-406	-531	-429
Above Normal (16%)	-473	-462	-471	-122	-132	-156	-225	-277	-325	-320	-458	-479
Below Normal (13%)	-452	-437	-424	-125	-157	-140	-158	-195	-253	-320	-422	-559
Dry (24%)	-314	-337	-285	-92	-91	-109	-104	-161	-172	-263	-310	-420
Critical (15%)	-151	-185	-272	-80	-65	-47	0	-86	-99	-153	-186	-222

Alternative 4 043019

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-130	-131	-116	-20	-14	110	54	-25	-74	-109	-189	-177
20%	-207	-190	-187	-38	-52	35	24	-46	-104	-150	-237	-279
30%	-270	-267	-233	-53	-64	-10	7	-87	-161	-234	-319	-358
40%	-339	-321	-311	-66	-81	-22	-7	-114	-201	-277	-379	-456
50%	-423	-386	-341	-83	-128	-32	-39	-136	-243	-290	-435	-506
60%	-472	-439	-385	-127	-164	-41	-56	-158	-266	-320	-470	-546
70%	-499	-476	-449	-159	-186	-76	-104	-188	-299	-333	-489	-588
80%	-554	-546	-476	-219	-218	-140	-189	-240	-339	-350	-504	-625
90%	-616	-581	-560	-266	-313	-222	-238	-289	-408	-459	-555	-683
Long Term												
Full Simulation Period[a]	-389	-371	-343	-127	-137	-44	-66	-147	-235	-283	-392	-466
Water Year Types[b,c]												
Wet (32%)	-547	-513	-415	-125	-140	-99	-131	-195	-359	-395	-519	-627
Above Normal (16%)	-516	-492	-437	-197	-166	-11	-131	-214	-308	-320	-470	-564
Below Normal (13%)	-381	-344	-326	-160	-195	-11	-27	-108	-204	-287	-414	-503
Dry (24%)	-253	-232	-225	-106	-106	-33	-7	-98	-118	-188	-263	-348
Critical (15%)	-143	-185	-295	-63	-94	-13	7	-88	-113	-157	-230	-176

Alternative 4 043019 minus No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	30	3	39	**-11**	**-38**	75	39	**-9**	2	27	**-43**	46
20%	17	11	42	**-3**	**-35**	61	45	44	33	51	24	45
30%	62	21	64	**-10**	**-25**	37	41	30	9	13	10	25
40%	34	14	90	**-12**	**-29**	50	53	31	10	14	53	**-54**
50%	**-7**	**-11**	102	**-13**	**-51**	63	61	21	21	20	23	**-79**
60%	**-26**	**-14**	80	**-24**	**-57**	85	113	31	43	**-1**	5	**-87**
70%	**-6**	**-18**	58	3	**-25**	78	154	69	35	28	0	**-103**
80%	**-34**	**-44**	83	**-9**	**-9**	145	103	110	38	44	19	**-87**
90%	**-62**	**-3**	70	**-1**	**-36**	199	122	109	21	5	23	**-91**
Long Term												
Full Simulation Period[a]	**-5**	**-5**	63	**-25**	**-38**	96	80	50	25	26	8	**-45**
Water Year Types[b,c]												
Wet (32%)	**-75**	**-119**	104	**-25**	**-60**	100	71	40	13	11	12	**-198**
Above Normal (16%)	**-43**	**-31**	33	**-74**	**-34**	145	94	63	17	**-1**	**-11**	**-85**
Below Normal (13%)	71	93	97	**-36**	**-38**	130	131	87	49	33	9	55
Dry (24%)	60	105	61	**-14**	**-15**	76	97	64	54	75	47	72
Critical (15%)	8	**-1**	**-23**	16	**-30**	35	7	**-2**	**-13**	**-4**	**-44**	46

a Based on the 82-year simulation period.

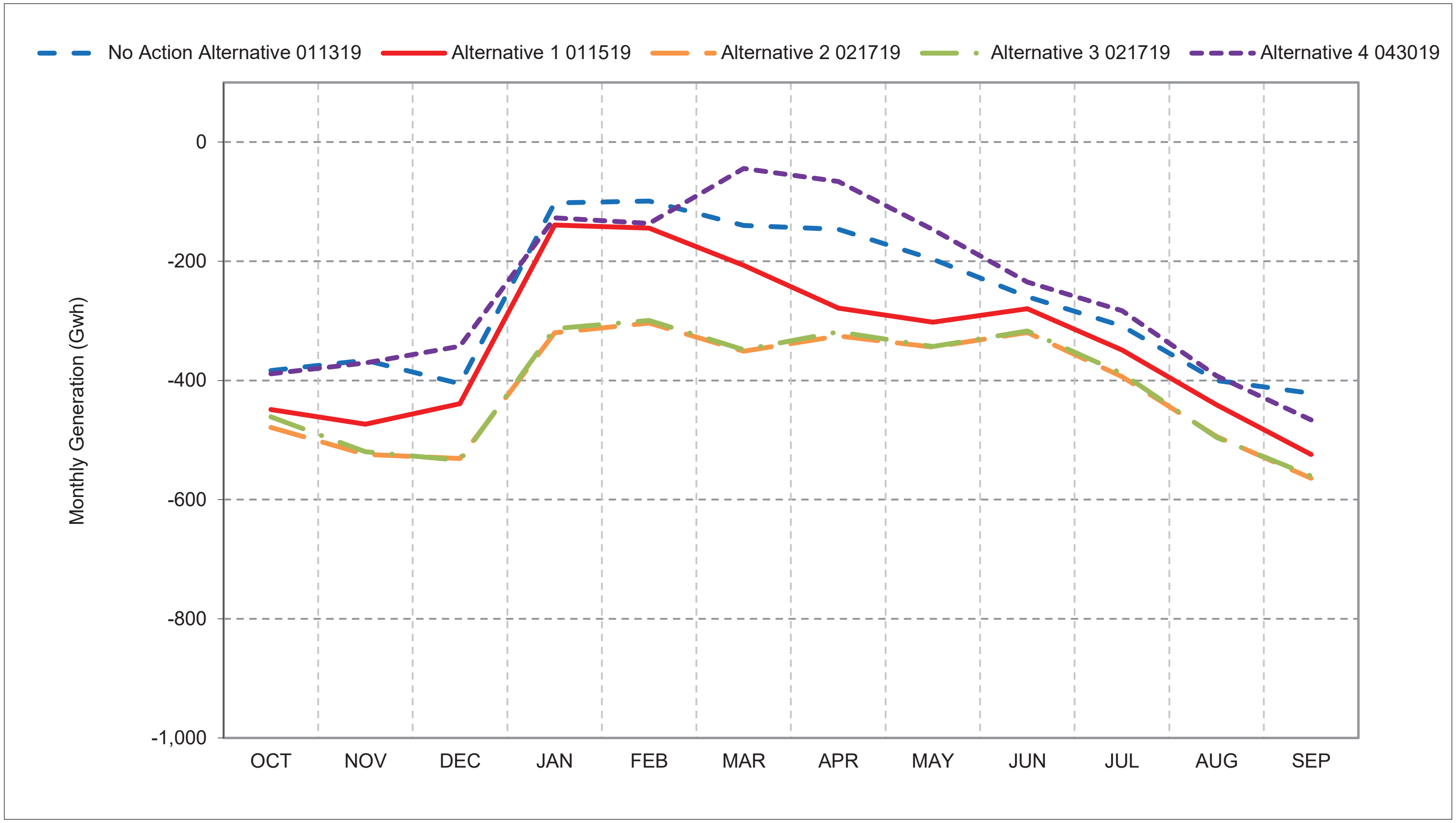
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Figure 8-1. SWP Net Generation, Long-Term Average Generation



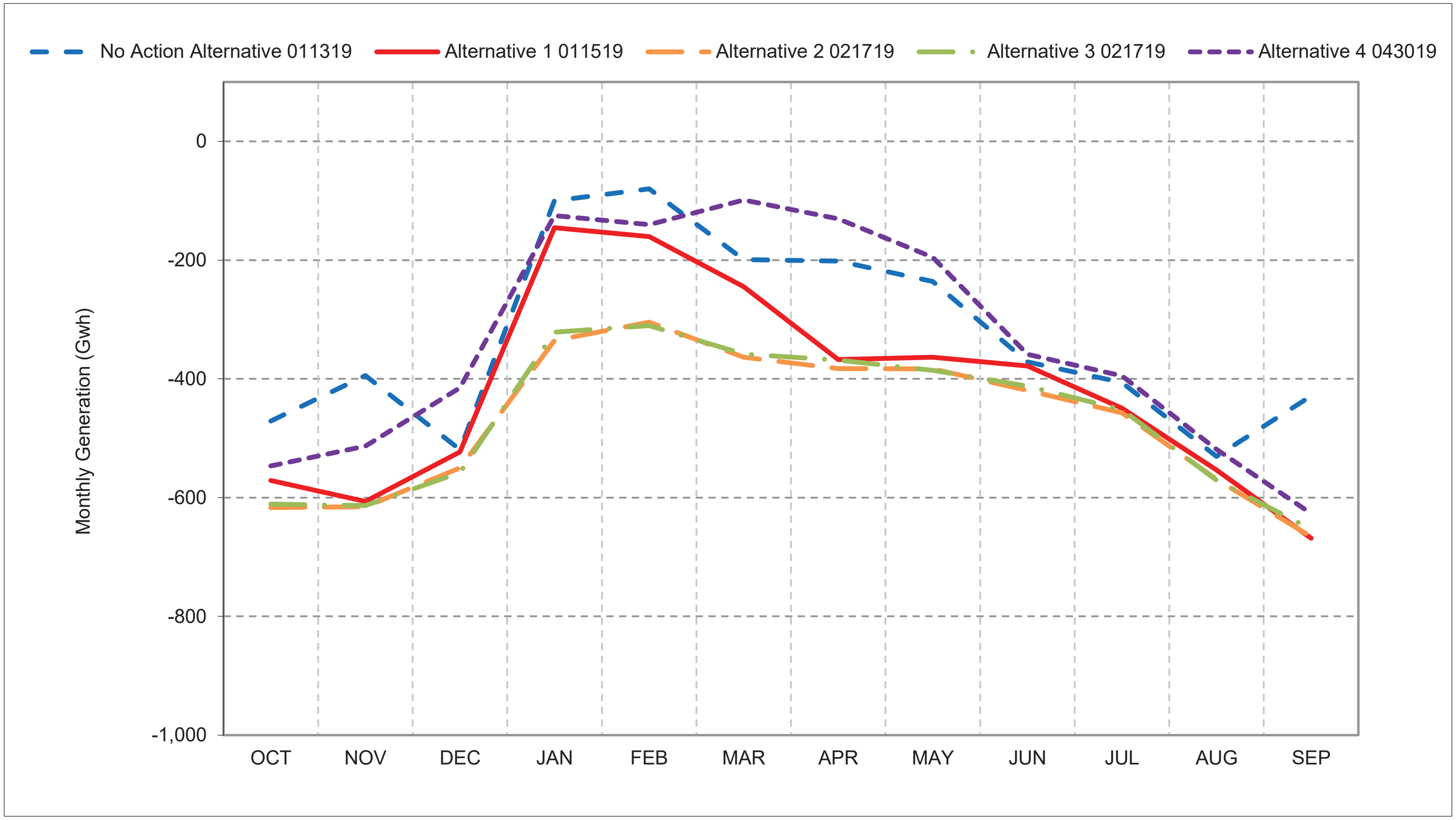
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

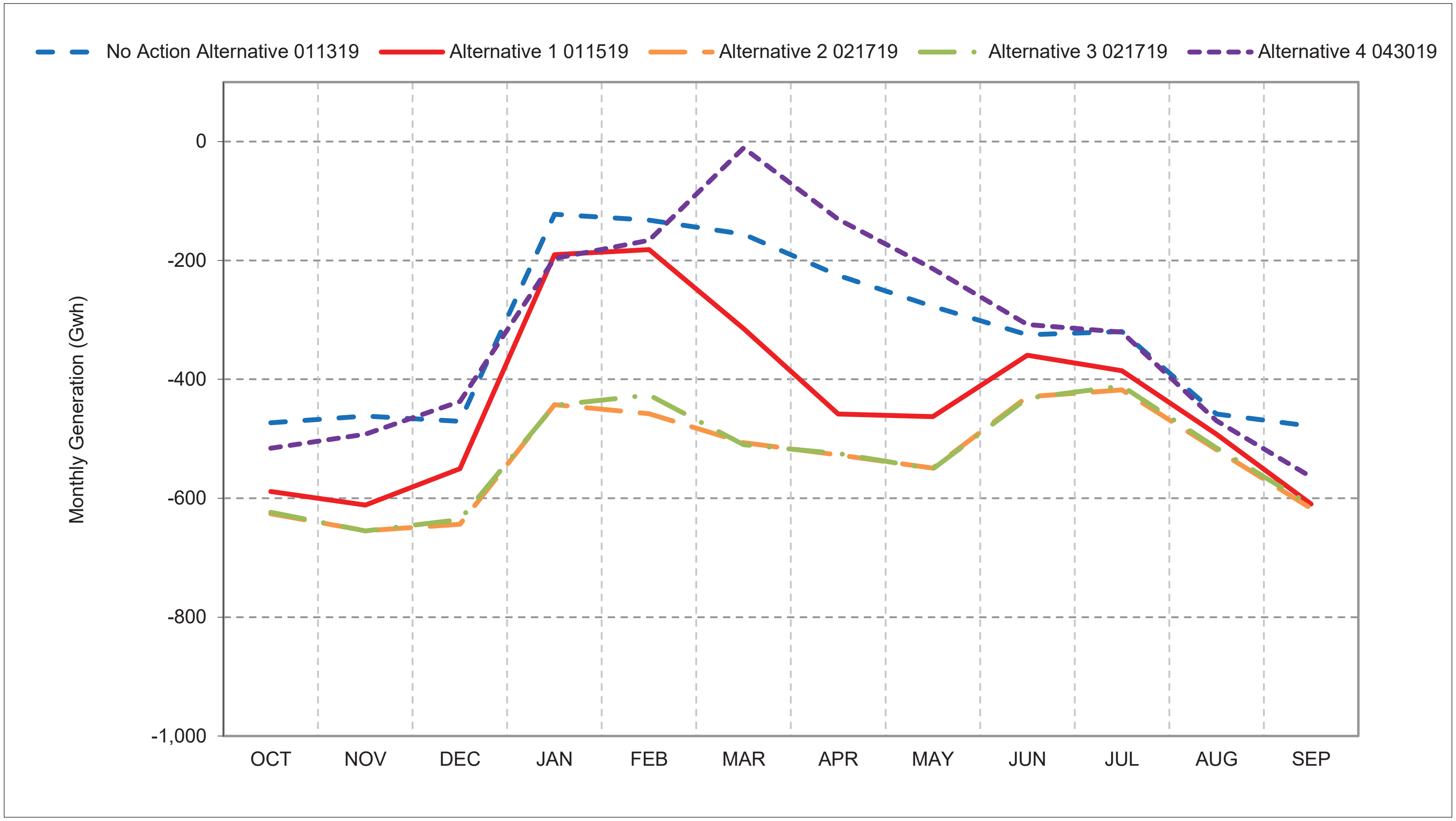
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 8-2. SWP Net Generation, Wet Year Average Generation



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 8-3. SWP Net Generation, Above Normal Year Average Generation



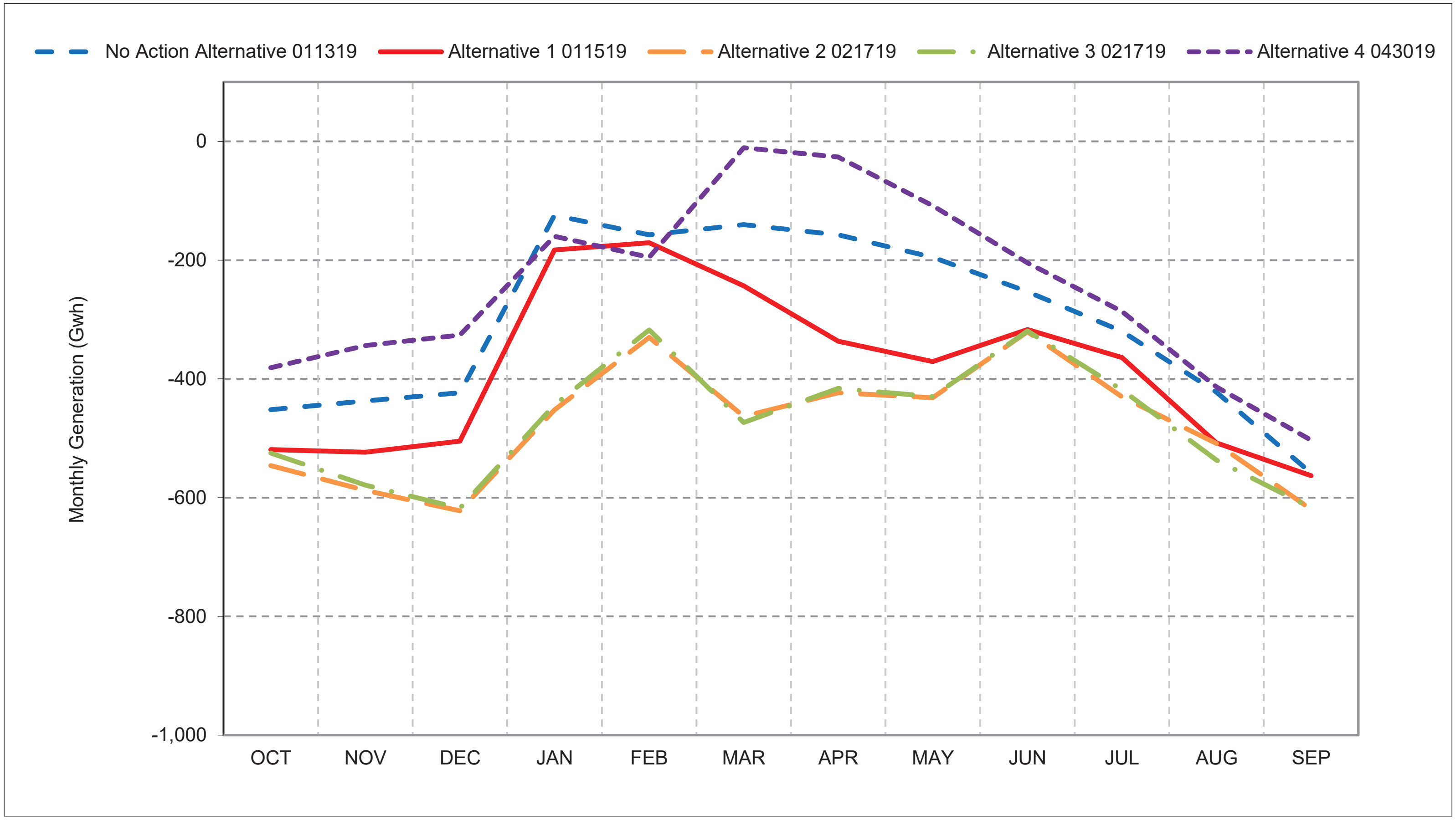
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 8-4. SWP Net Generation, Below Normal Year Average Generation



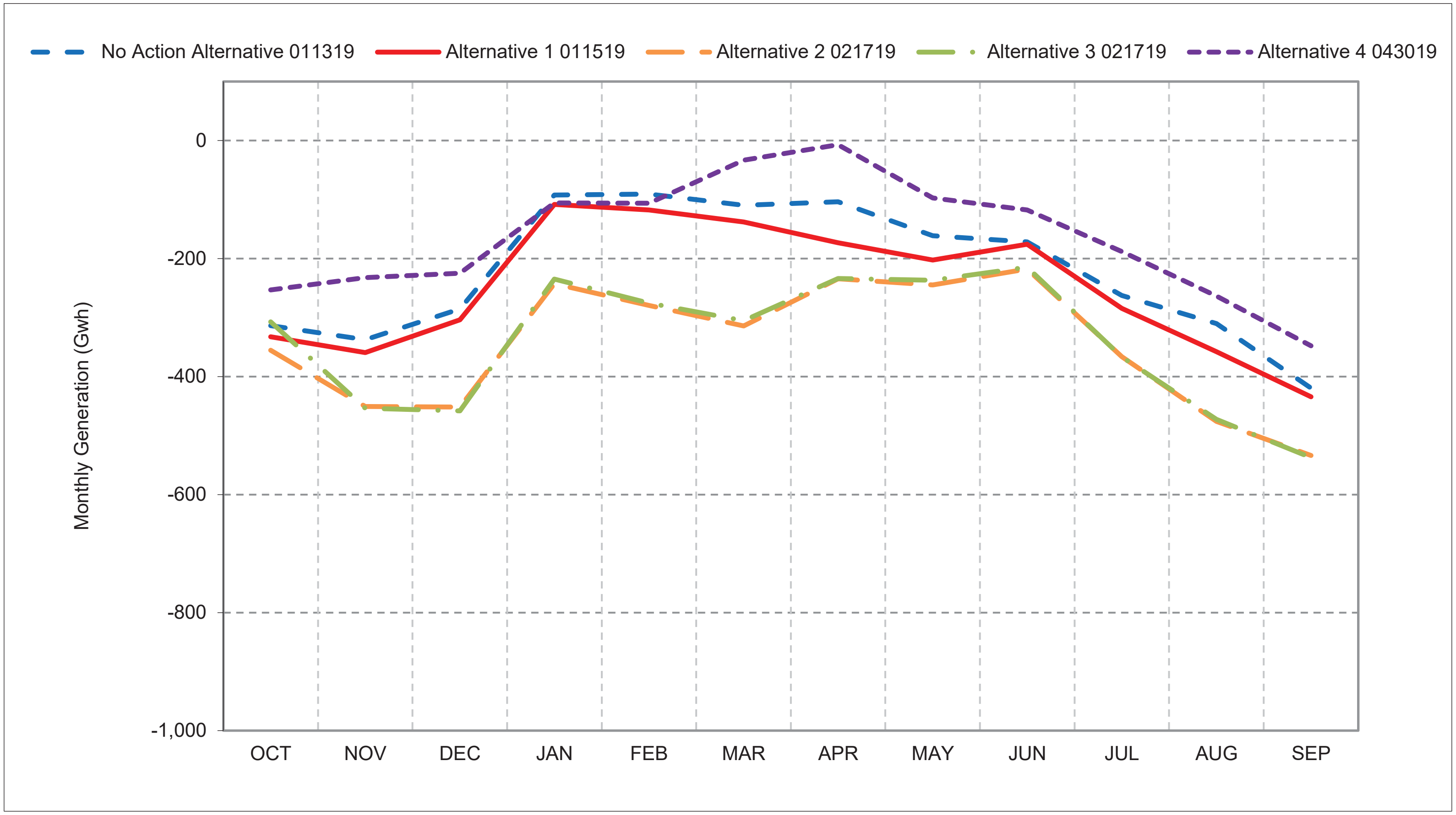
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

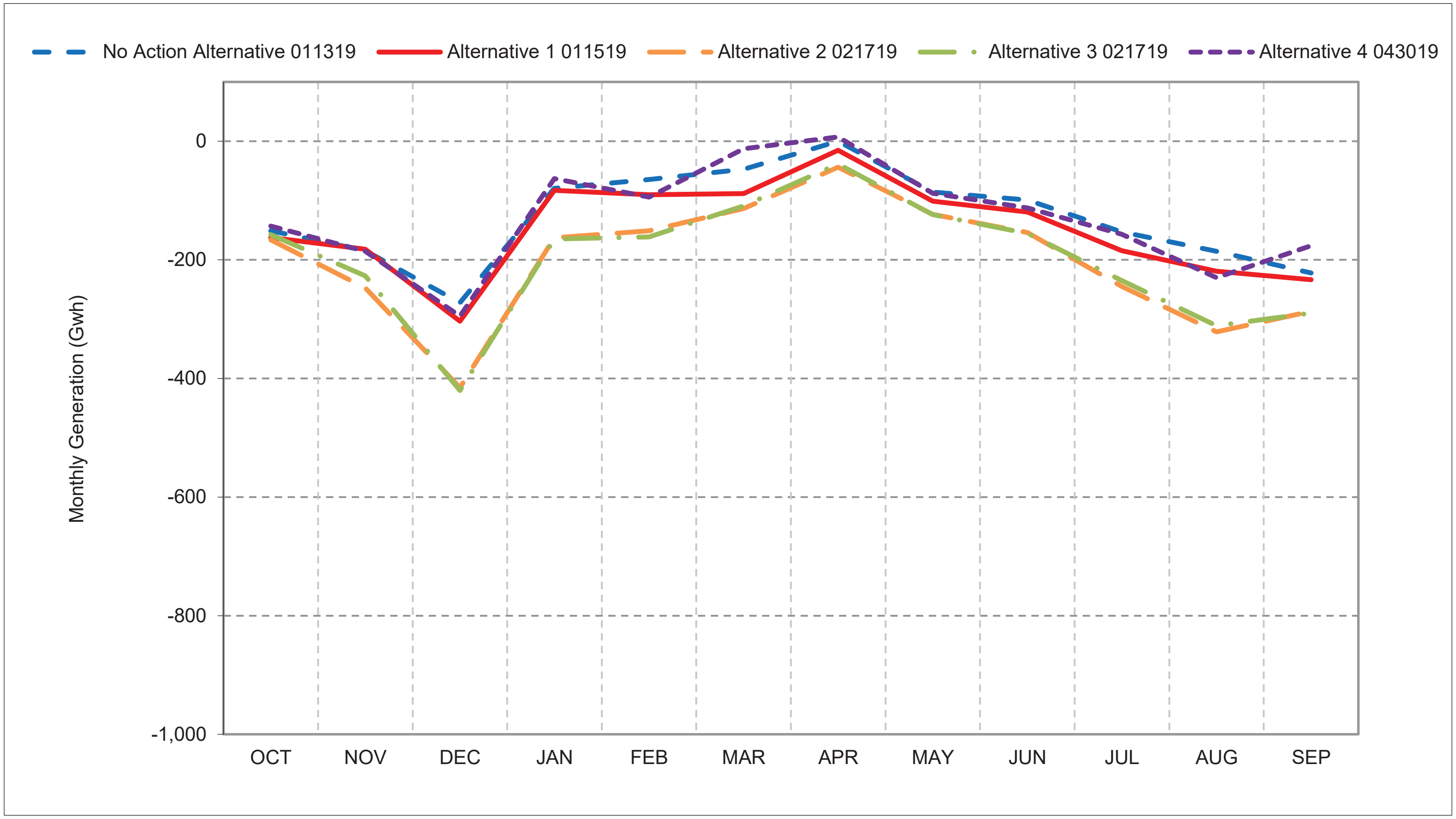
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 8-5. SWP Net Generation, Dry Year Average Generation



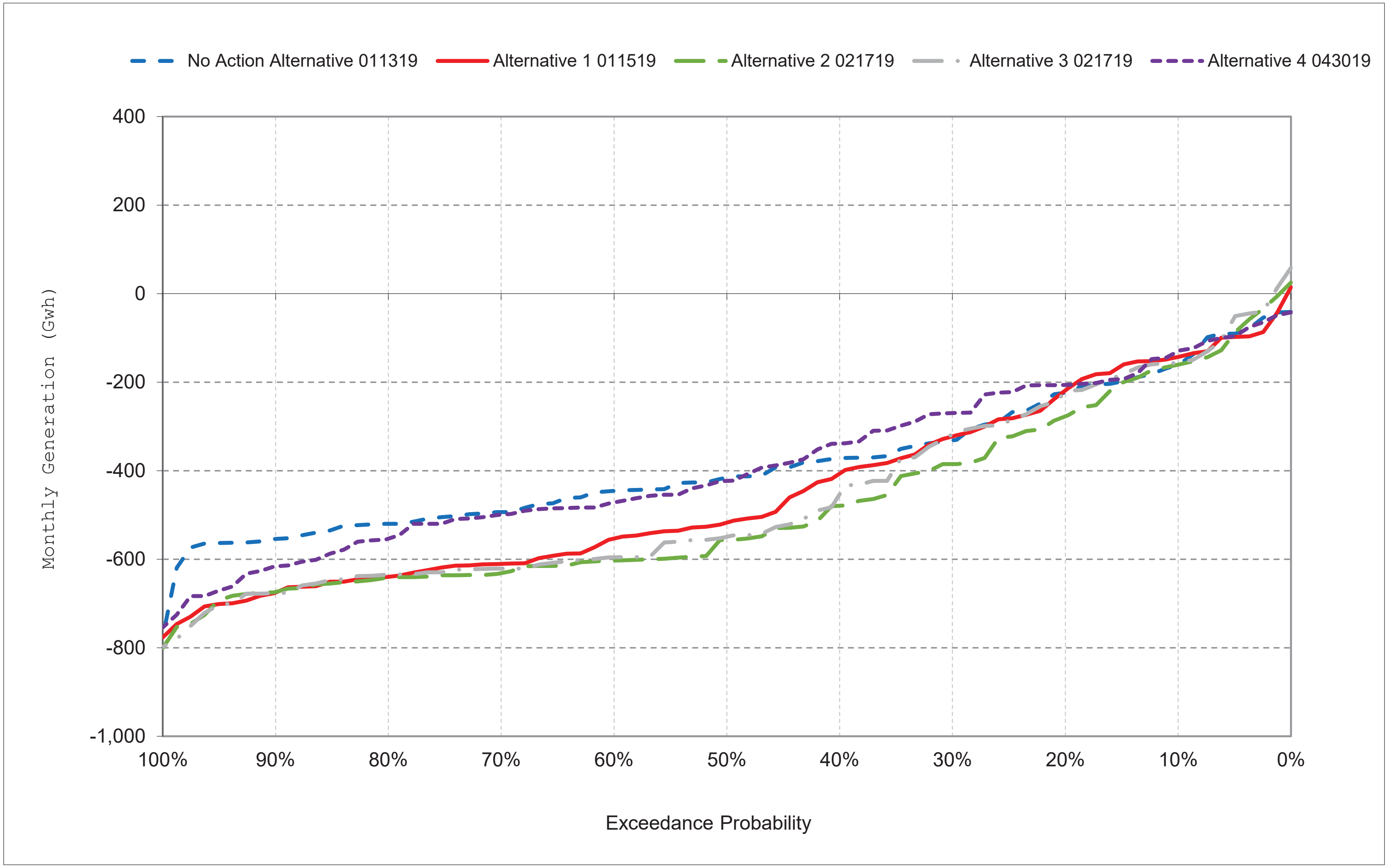
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 8-6. SWP Net Generation, Critical Year Average Generation



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

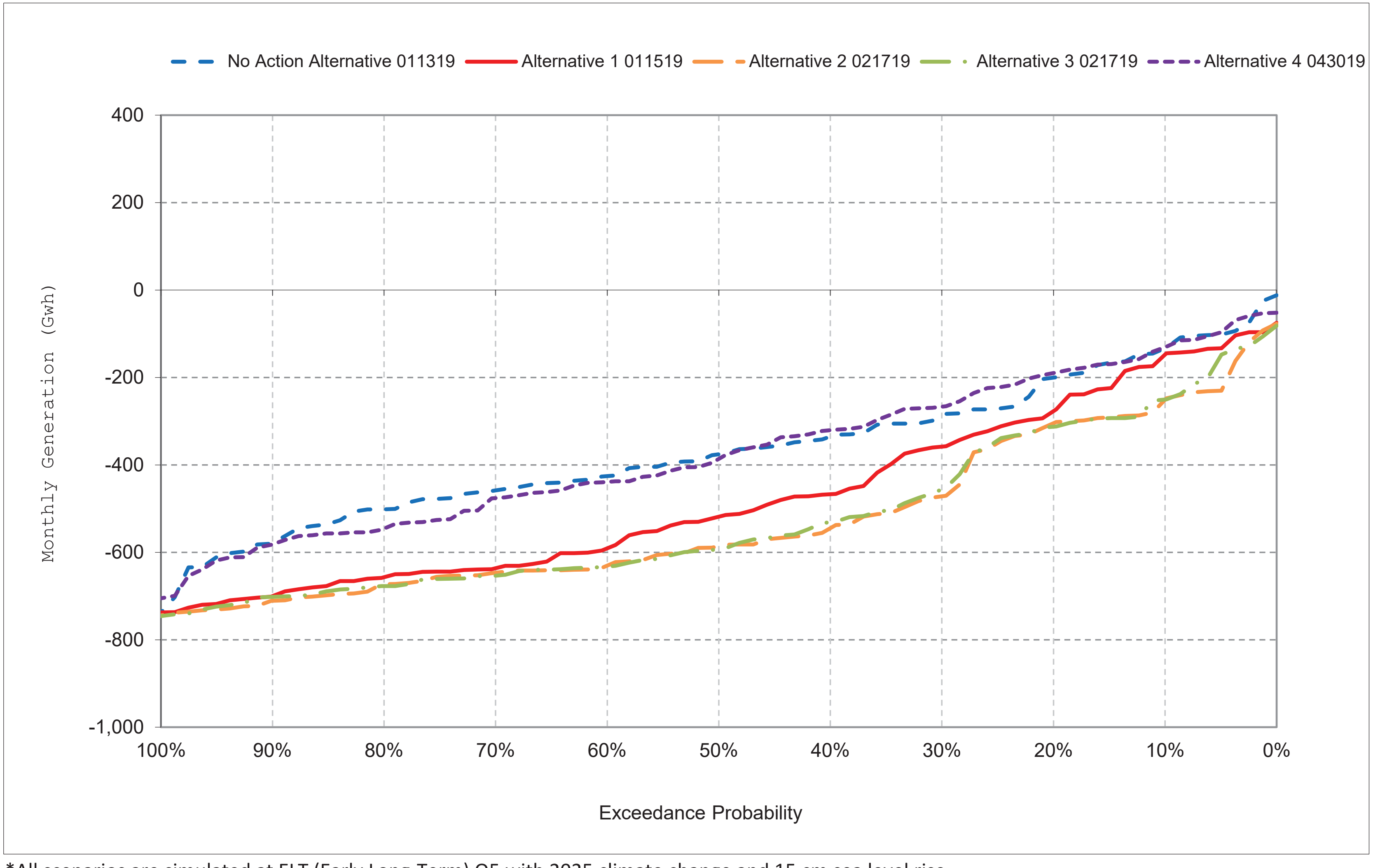
Figure 8-7. SWP Net Generation, October



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

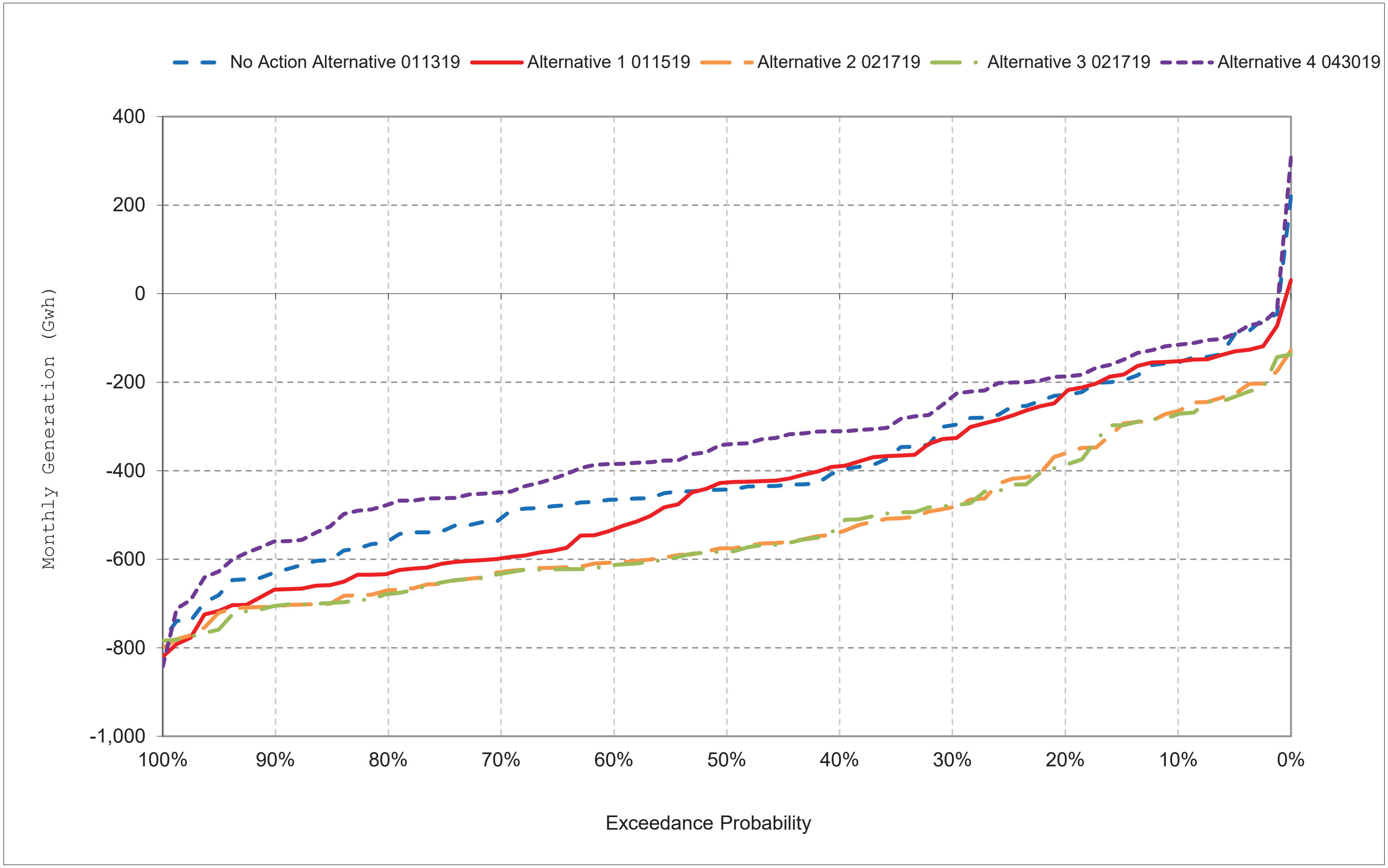
Figure 8-8. SWP Net Generation, November



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

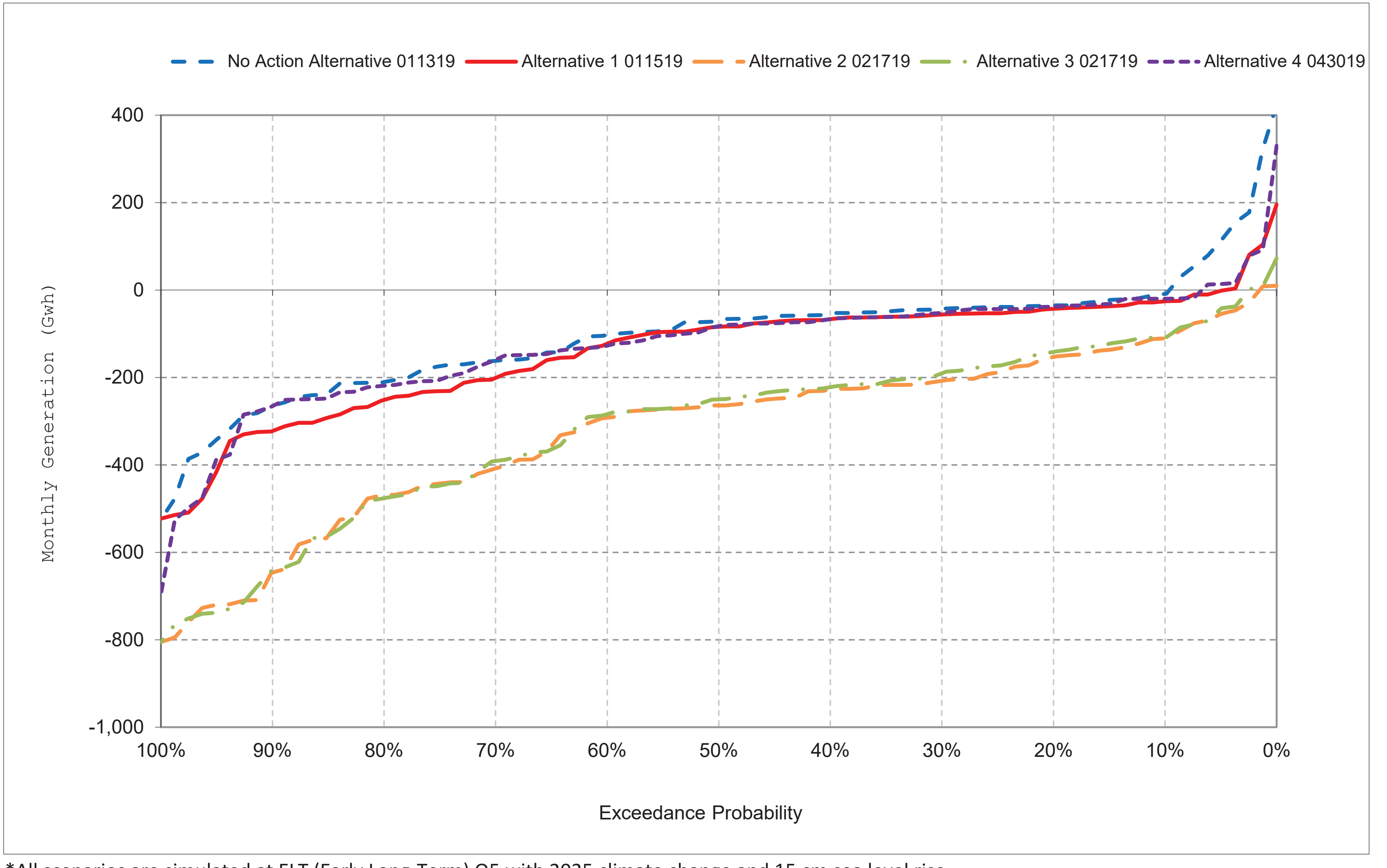
Figure 8-9. SWP Net Generation, December



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 8-10. SWP Net Generation, January



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

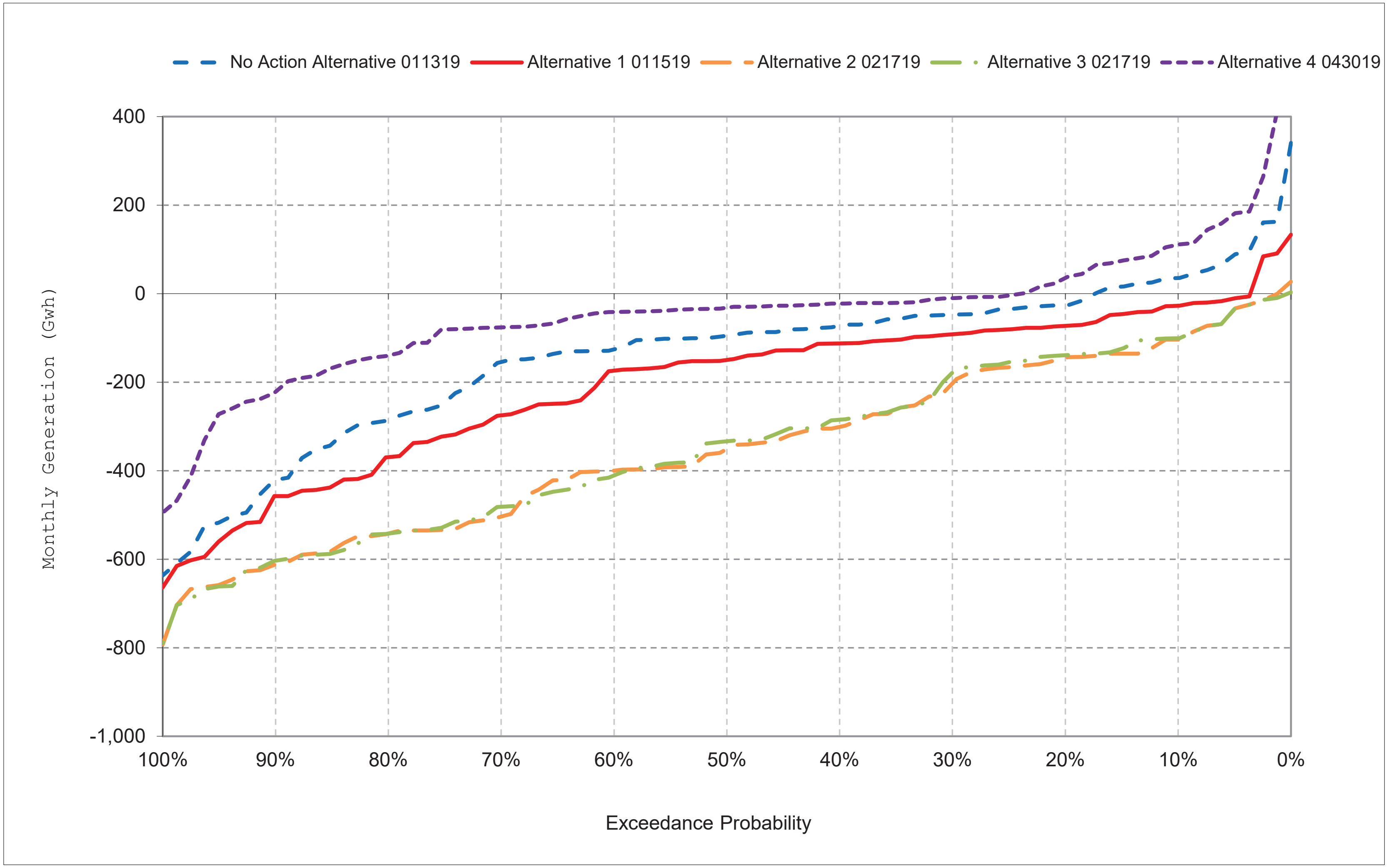
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 8-11. SWP Net Generation, February

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

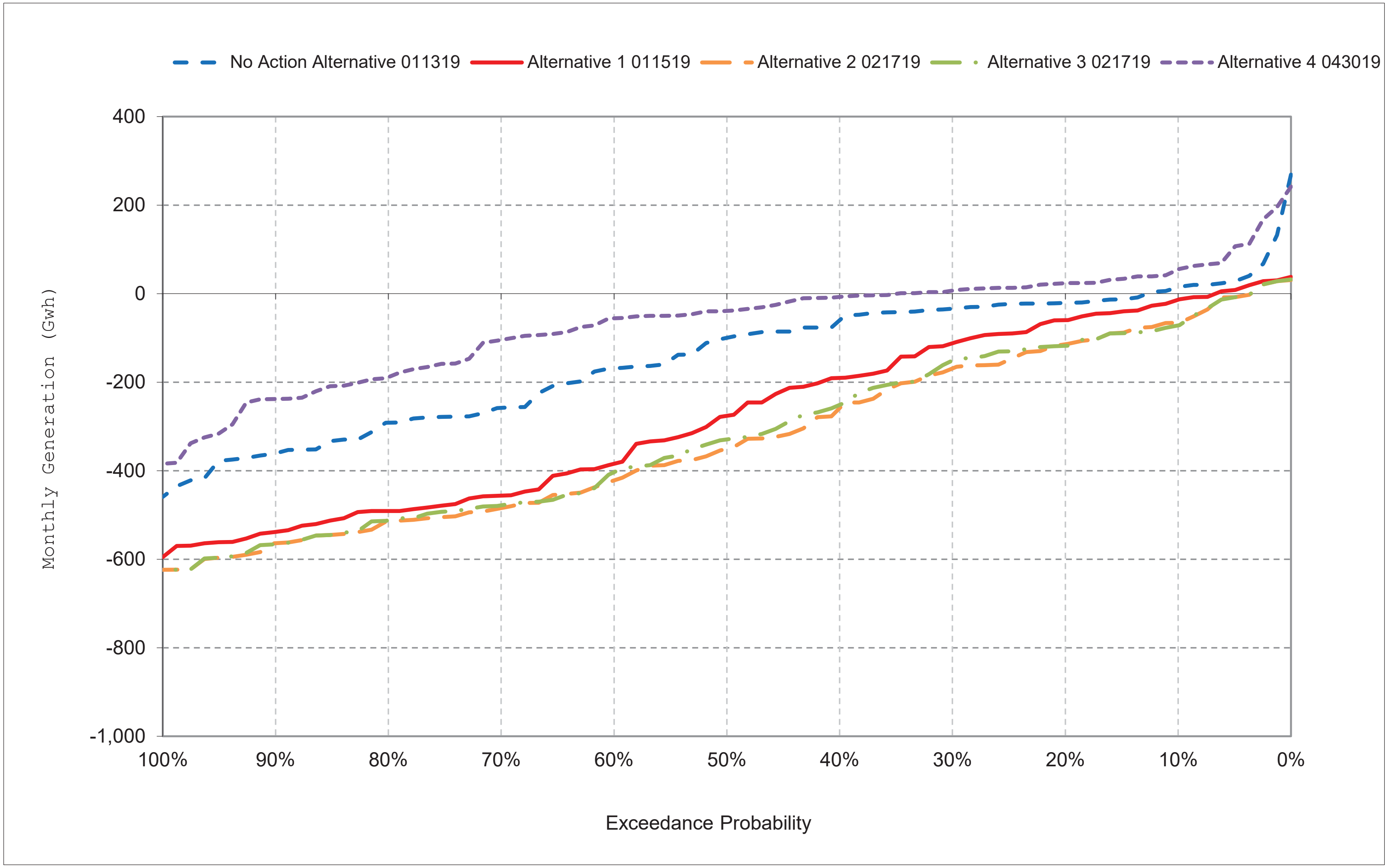
Figure 8-12. SWP Net Generation, March



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

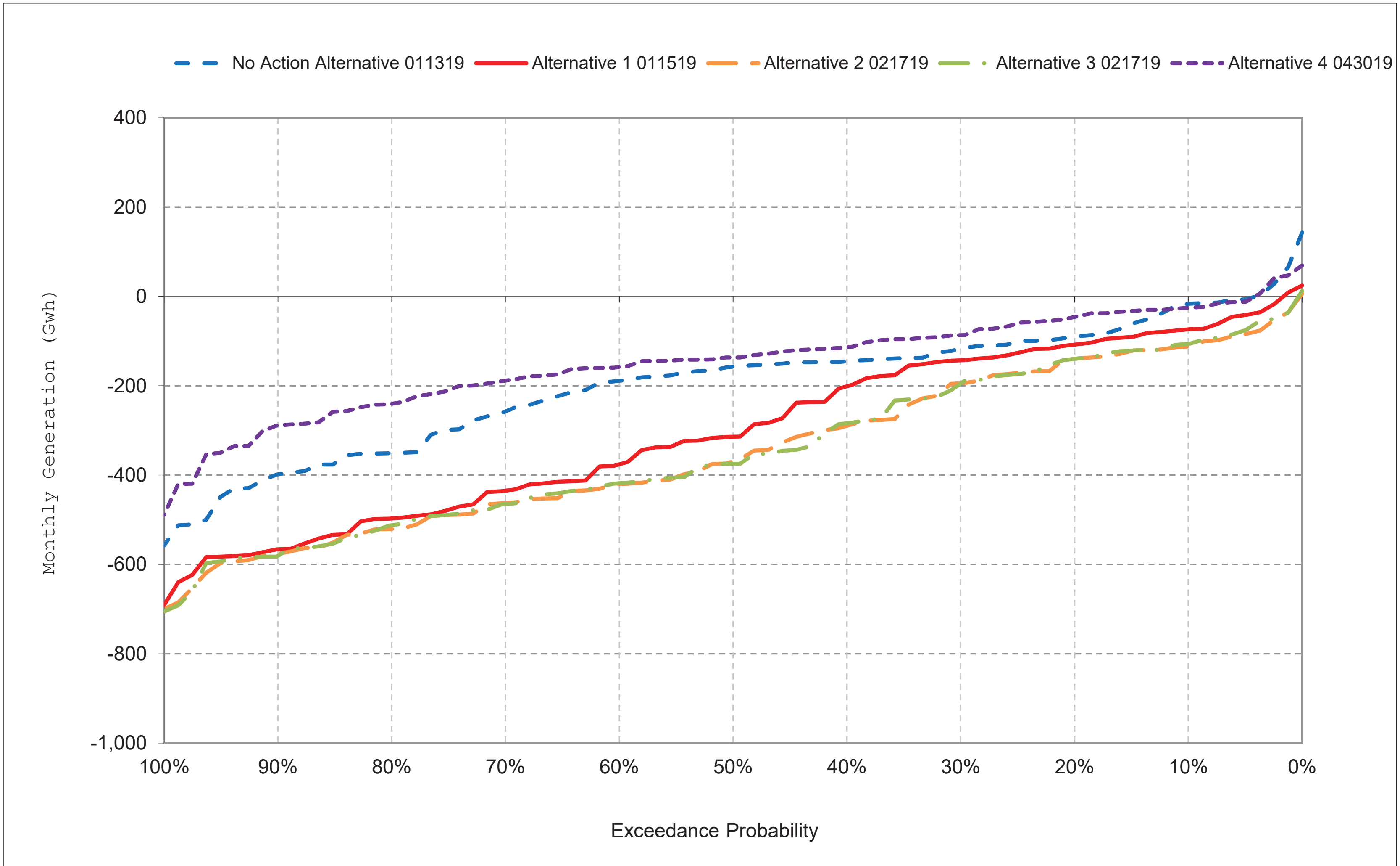
Figure 8-13. SWP Net Generation, April



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

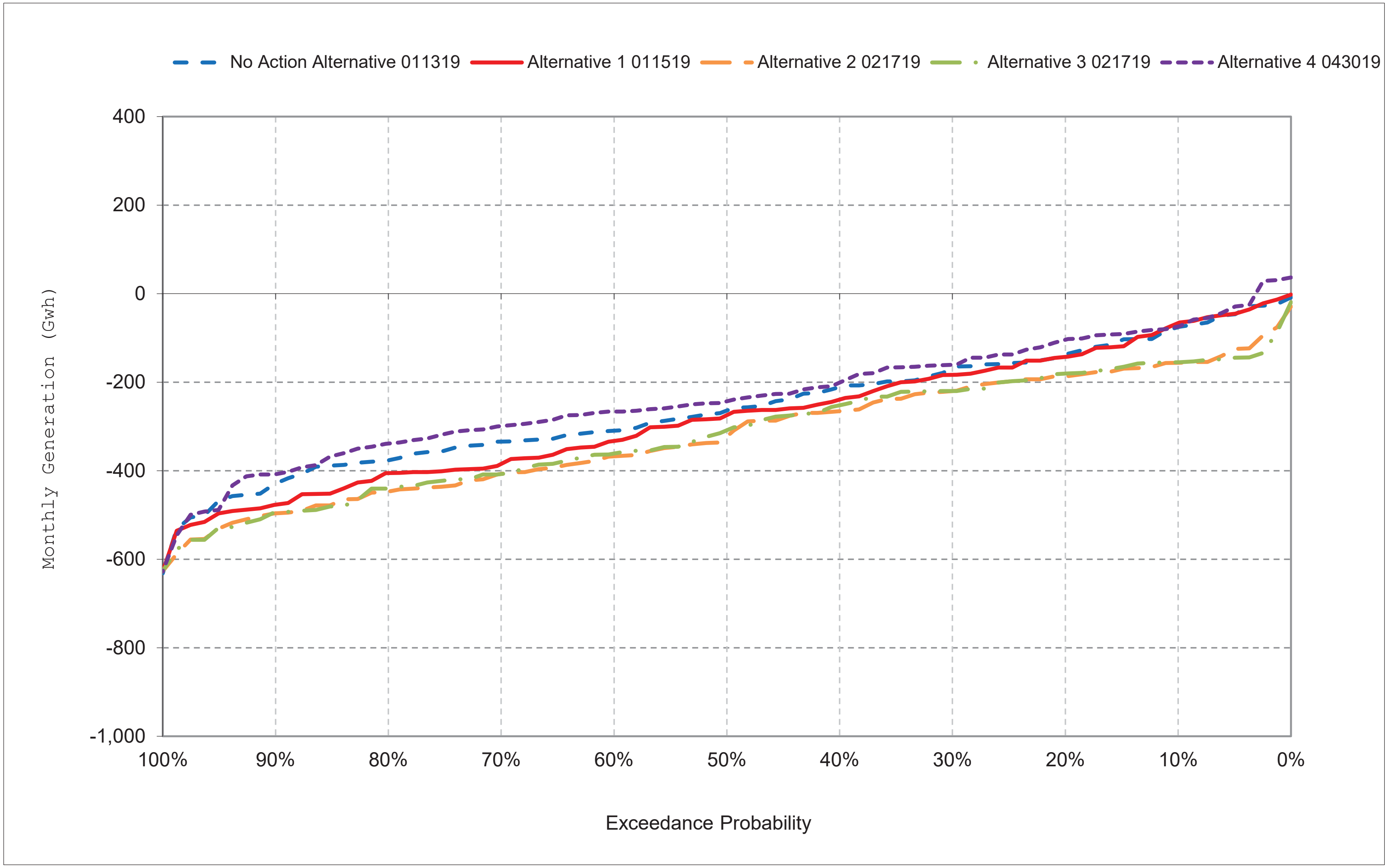
Figure 8-14. SWP Net Generation, May



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

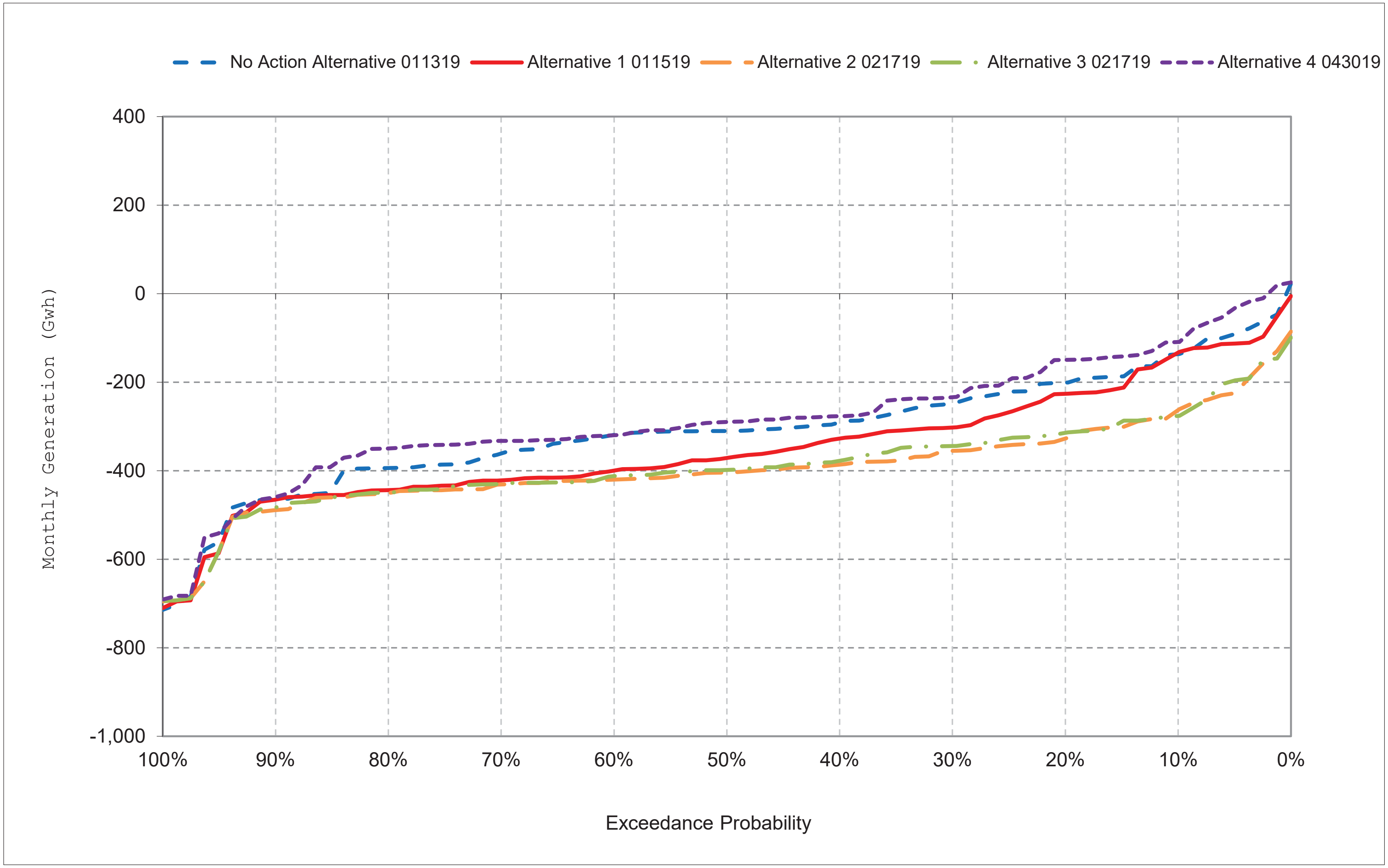
Figure 8-15. SWP Net Generation, June



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

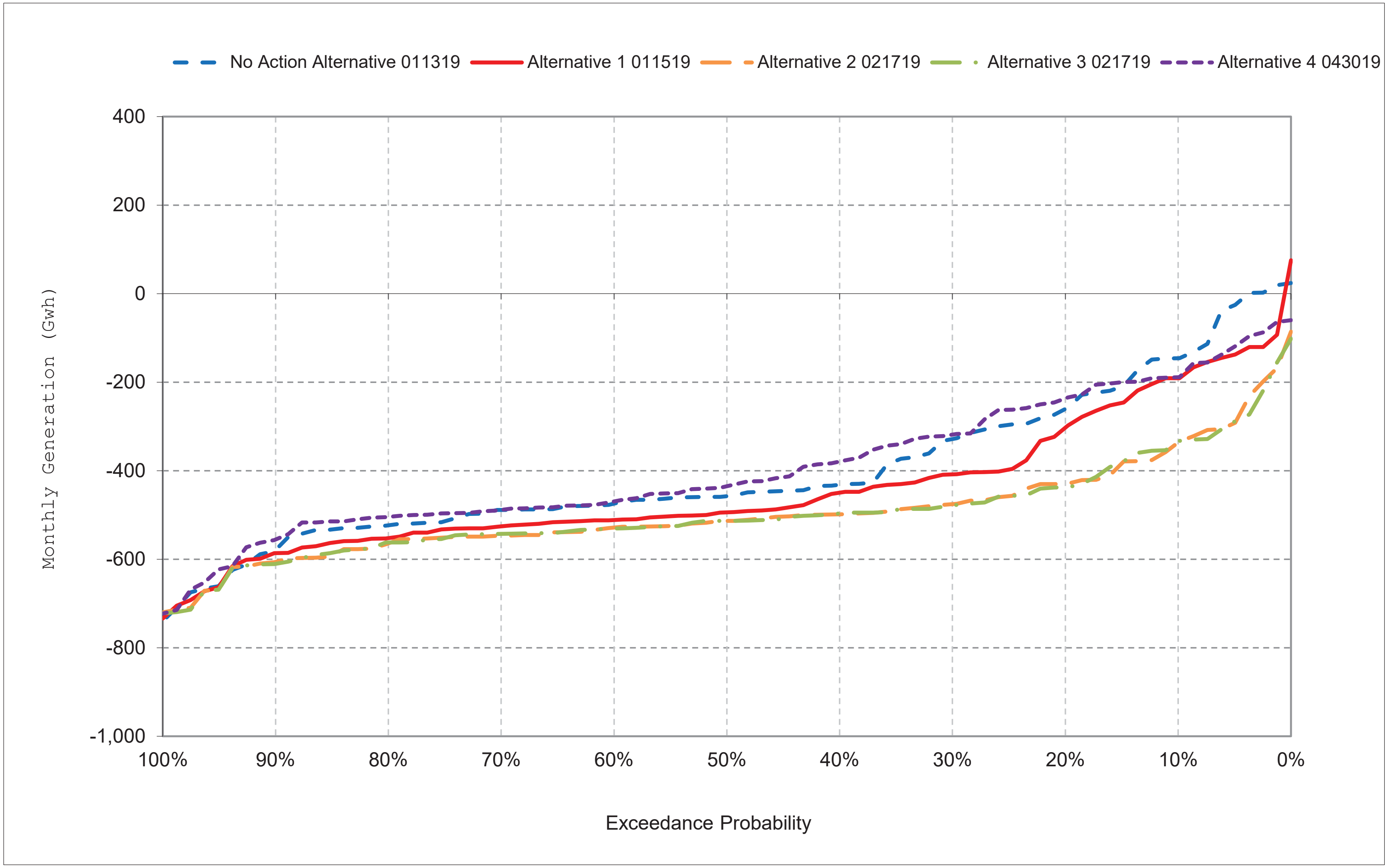
Figure 8-16. SWP Net Generation, July



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

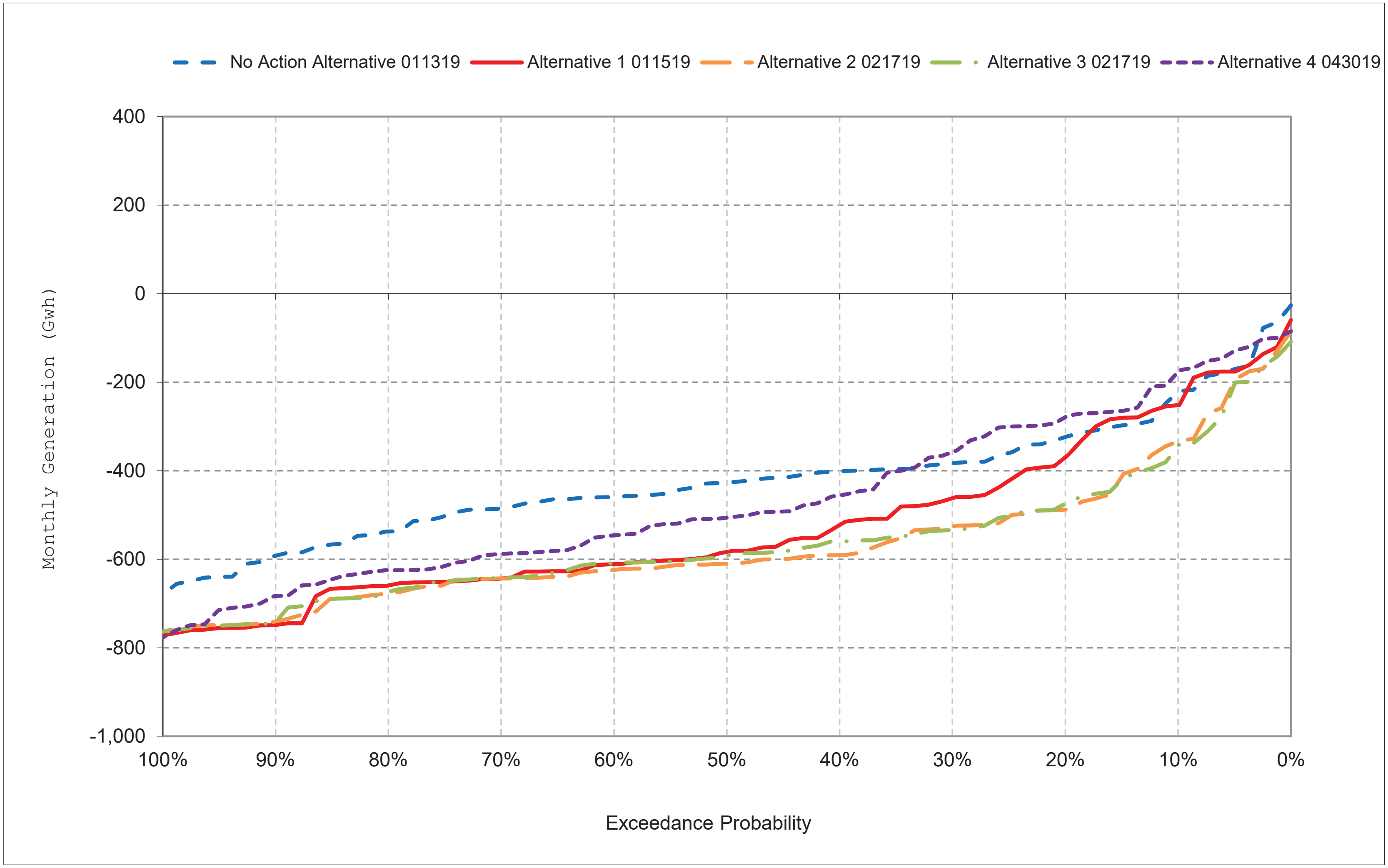
Figure 8-17. SWP Net Generation, August



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 8-18. SWP Net Generation, September



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Table 9-1. CVP and SWP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	26	-14	12	454	515	519	333	433	312	360	167	123
20%	-60	-85	-93	327	321	294	224	362	257	328	62	81
30%	-95	-122	-145	85	201	147	182	302	227	306	4	9
40%	-149	-169	-222	27	71	67	145	270	184	257	-46	-64
50%	-167	-207	-294	-6	21	10	125	241	133	229	-71	-132
60%	-210	-299	-384	-38	-39	-16	78	203	111	174	-104	-165
70%	-238	-329	-453	-70	-68	-68	3	150	64	118	-130	-224
80%	-292	-360	-529	-140	-132	-100	-62	62	-1	41	-160	-292
90%	-363	-403	-596	-189	-184	-252	-133	29	-79	-18	-197	-426
Long Term												
Full Simulation Period[a]	-179	-212	-274	79	102	80	118	225	137	189	-46	-122
Water Year Types[b,c]												
Wet (32%)	-178	-149	-341	322	283	228	172	287	31	117	-130	86
Above Normal (16%)	-226	-251	-366	61	183	101	61	176	84	290	-68	-130
Below Normal (13%)	-284	-337	-299	-85	-11	-56	65	239	190	229	-33	-357
Dry (24%)	-158	-236	-121	-55	-46	-28	85	205	249	208	16	-255
Critical (15%)	-69	-153	-261	-55	-27	40	166	165	190	166	46	-129

Alternative 1 011519

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1	-71	177	494	476	509	228	315	337	353	117	-80
20%	-83	-167	-83	250	307	261	140	283	274	319	10	-161
30%	-163	-238	-136	115	193	97	93	216	249	269	-47	-247
40%	-227	-309	-228	32	46	-2	63	163	201	232	-83	-315
50%	-321	-411	-335	-22	-35	-34	-60	115	127	190	-109	-346
60%	-352	-454	-358	-47	-61	-89	-124	61	77	137	-125	-378
70%	-385	-517	-476	-66	-113	-139	-242	-4	40	73	-150	-411
80%	-444	-561	-588	-85	-174	-205	-300	-106	2	22	-181	-431
90%	-485	-589	-635	-223	-263	-305	-367	-201	-72	-28	-222	-464
Long Term												
Full Simulation Period[a]	-265	-358	-276	62	63	24	-53	87	135	164	-81	-312
Water Year Types[b,c]												
Wet (32%)	-305	-463	-295	301	229	190	-58	97	46	80	-151	-366
Above Normal (16%)	-404	-481	-375	39	162	-20	-241	-61	79	226	-97	-395
Below Normal (13%)	-354	-413	-372	-107	7	-121	-141	43	150	196	-111	-376
Dry (24%)	-183	-247	-131	-71	-98	-61	-5	152	247	207	-24	-269
Critical (15%)	-79	-134	-285	-54	-82	-14	160	157	189	175	23	-120

Alternative 1 011519 minus No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-25	-57	165	40	-39	-10	-105	-118	25	-7	-50	-203
20%	-23	-82	10	-78	-13	-33	-84	-79	17	-9	-52	-242
30%	-68	-117	9	30	-9	-50	-90	-86	22	-37	-51	-256
40%	-77	-140	-6	5	-25	-69	-83	-106	17	-24	-37	-251
50%	-154	-205	-41	-16	-56	-45	-185	-125	-6	-39	-37	-214
60%	-142	-155	25	-9	-22	-73	-202	-143	-34	-37	-21	-214
70%	-147	-188	-23	4	-45	-71	-245	-153	-24	-45	-20	-188
80%	-152	-201	-59	55	-42	-105	-238	-168	3	-18	-21	-139
90%	-122	-186	-40	-34	-79	-53	-234	-230	7	-9	-25	-38
Long Term												
Full Simulation Period[a]	-86	-146	-3	-17	-38	-56	-171	-138	-2	-25	-35	-190
Water Year Types[b,c]												
Wet (32%)	-128	-314	47	-21	-53	-38	-230	-190	15	-37	-21	-452
Above Normal (16%)	-178	-230	-9	-22	-21	-121	-302	-237	-4	-64	-28	-265
Below Normal (13%)	-70	-76	-74	-21	19	-65	-206	-196	-40	-32	-79	-19
Dry (24%)	-25	-11	-10	-15	-52	-33	-90	-53	-2	-2	-40	-14
Critical (15%)	-10	20	-24	1	-55	-53	-7	-8	-2	10	-23	8

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 9-2. CVP and SWP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	26	-14	12	454	515	519	333	433	312	360	167	123
20%	-60	-85	-93	327	321	294	224	362	257	328	62	81
30%	-95	-122	-145	85	201	147	182	302	227	306	4	9
40%	-149	-169	-222	27	71	67	145	270	184	257	-46	-64
50%	-167	-207	-294	-6	21	10	125	241	133	229	-71	-132
60%	-210	-299	-384	-38	-39	-16	78	203	111	174	-104	-165
70%	-238	-329	-453	-70	-68	-68	3	150	64	118	-130	-224
80%	-292	-360	-529	-140	-132	-100	-62	62	-1	41	-160	-292
90%	-363	-403	-596	-189	-184	-252	-133	29	-79	-18	-197	-426
Long Term												
Full Simulation Period[a]	-179	-212	-274	79	102	80	118	225	137	189	-46	-122
Water Year Types[b,c]												
Wet (32%)	-178	-149	-341	322	283	228	172	287	31	117	-130	86
Above Normal (16%)	-226	-251	-366	61	183	101	61	176	84	290	-68	-130
Below Normal (13%)	-284	-337	-299	-85	-11	-56	65	239	190	229	-33	-357
Dry (24%)	-158	-236	-121	-55	-46	-28	85	205	249	208	16	-255
Critical (15%)	-69	-153	-261	-55	-27	40	166	165	190	166	46	-129

Alternative 2 021719

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-39	-154	-13	277	386	290	193	313	352	255	-6	-134
20%	-117	-219	-222	48	139	133	87	226	280	228	-52	-254
30%	-225	-309	-328	-56	-25	18	40	161	232	207	-79	-313
40%	-283	-452	-436	-156	-102	-98	-44	128	189	173	-99	-338
50%	-338	-492	-492	-187	-173	-160	-115	79	115	143	-119	-367
60%	-379	-532	-532	-227	-239	-282	-224	33	92	100	-146	-402
70%	-412	-555	-584	-274	-300	-341	-276	-84	35	71	-171	-424
80%	-482	-578	-610	-367	-386	-406	-344	-117	-35	26	-200	-445
90%	-507	-629	-667	-476	-449	-513	-411	-232	-120	-20	-240	-484
Long Term												
Full Simulation Period[a]	-299	-424	-398	-135	-103	-134	-100	51	125	120	-120	-345
Water Year Types[b,c]												
Wet (32%)	-374	-484	-336	89	92	66	-65	83	29	82	-152	-360
Above Normal (16%)	-453	-538	-536	-247	-133	-239	-319	-151	64	190	-105	-400
Below Normal (13%)	-366	-497	-526	-386	-163	-346	-240	-8	187	122	-100	-397
Dry (24%)	-195	-357	-304	-217	-278	-266	-66	126	232	132	-136	-361
Critical (15%)	-83	-213	-423	-131	-149	-38	136	131	163	105	-61	-179

Alternative 2 021719 minus No Action Alternative 011319

Statistic	Monthly Generation (GWh)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-65	-140	-24	-177	-129	-230	-140	-120	40	-106	-173	-257
20%	-57	-135	-129	-279	-181	-161	-137	-135	23	-100	-114	-335
30%	-130	-187	-183	-141	-226	-130	-143	-141	6	-98	-83	-322
40%	-134	-283	-214	-183	-173	-165	-189	-142	5	-84	-53	-274
50%	-171	-285	-198	-181	-194	-170	-239	-161	-17	-86	-48	-236
60%	-169	-234	-148	-190	-199	-266	-302	-171	-19	-73	-42	-238
70%	-174	-225	-131	-203	-232	-272	-279	-234	-29	-46	-41	-201
80%	-190	-218	-81	-227	-254	-306	-282	-179	-34	-15	-40	-152
90%	-144	-226	-72	-287	-265	-261	-278	-261	-41	-2	-44	-58
Long Term												
Full Simulation Period[a]	-120	-211	-124	-214	-205	-214	-218	-174	-12	-69	-75	-222
Water Year Types[b,c]												
Wet (32%)	-197	-334	5	-233	-191	-162	-237	-204	-2	-35	-22	-445
Above Normal (16%)	-227	-287	-170	-308	-316	-340	-381	-328	-19	-100	-36	-270
Below Normal (13%)	-82	-160	-228	-300	-152	-290	-305	-247	-3	-107	-67	-40
Dry (24%)	-37	-121	-182	-162	-232	-237	-151	-79	-17	-76	-153	-105
Critical (15%)	-15	-60	-163	-76	-122	-78	-31	-34	-27	-61	-107	-50

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 9-3. CVP and SWP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	26	-14	12	454	515	519	333	433	312	360	167	123
20%	-60	-85	-93	327	321	294	224	362	257	328	62	81
30%	-95	-122	-145	85	201	147	182	302	227	306	4	9
40%	-149	-169	-222	27	71	67	145	270	184	257	-46	-64
50%	-167	-207	-294	-6	21	10	125	241	133	229	-71	-132
60%	-210	-299	-384	-38	-39	-16	78	203	111	174	-104	-165
70%	-238	-329	-453	-70	-68	-68	3	150	64	118	-130	-224
80%	-292	-360	-529	-140	-132	-100	-62	62	-1	41	-160	-292
90%	-363	-403	-596	-189	-184	-252	-133	29	-79	-18	-197	-426
Long Term												
Full Simulation Period[a]	-179	-212	-274	79	102	80	118	225	137	189	-46	-122
Water Year Types[b,c]												
Wet (32%)	-178	-149	-341	322	283	228	172	287	31	117	-130	86
Above Normal (16%)	-226	-251	-366	61	183	101	61	176	84	290	-68	-130
Below Normal (13%)	-284	-337	-299	-85	-11	-56	65	239	190	229	-33	-357
Dry (24%)	-158	-236	-121	-55	-46	-28	85	205	249	208	16	-255
Critical (15%)	-69	-153	-261	-55	-27	40	166	165	190	166	46	-129

Alternative 3 021719

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	-4	-158	-23	313	378	296	192	313	345	279	-18	-137
20%	-68	-225	-234	22	137	136	94	220	273	246	-58	-254
30%	-166	-294	-319	-65	-12	22	40	155	244	206	-78	-297
40%	-258	-413	-391	-132	-100	-96	-27	127	192	186	-103	-335
50%	-334	-478	-476	-190	-171	-152	-77	72	137	135	-119	-353
60%	-368	-532	-533	-222	-237	-254	-190	17	87	107	-143	-398
70%	-399	-567	-584	-244	-277	-330	-273	-74	29	76	-170	-420
80%	-448	-593	-613	-364	-385	-420	-344	-108	-17	26	-199	-440
90%	-482	-628	-677	-470	-462	-506	-400	-236	-120	-23	-239	-481
Long Term												
Full Simulation Period[a]	-271	-419	-398	-129	-102	-130	-91	51	124	127	-123	-343
Water Year Types[b,c]												
Wet (32%)	-361	-479	-339	105	83	66	-48	75	35	85	-153	-351
Above Normal (16%)	-452	-538	-513	-255	-119	-230	-320	-152	52	207	-107	-395
Below Normal (13%)	-321	-486	-521	-383	-144	-358	-230	-4	185	139	-129	-397
Dry (24%)	-128	-365	-313	-213	-272	-252	-64	134	234	131	-133	-364
Critical (15%)	-68	-189	-429	-126	-165	-35	143	132	155	112	-53	-182

Alternative 3 021719 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	**-30**	**-145**	**-35**	**-141**	**-137**	**-223**	**-141**	**-120**	34	**-82**	**-185**	**-260**
20%	**-8**	**-140**	**-141**	**-305**	**-184**	**-159**	**-130**	**-142**	16	**-82**	**-120**	**-335**
30%	**-70**	**-172**	**-174**	**-150**	**-213**	**-125**	**-142**	**-147**	18	**-100**	**-82**	**-306**
40%	**-109**	**-244**	**-168**	**-159**	**-171**	**-163**	**-173**	**-143**	8	**-71**	**-57**	**-271**
50%	**-167**	**-271**	**-182**	**-184**	**-192**	**-162**	**-202**	**-169**	4	**-94**	**-48**	**-221**
60%	**-158**	**-234**	**-150**	**-185**	**-197**	**-238**	**-268**	**-186**	**-24**	**-67**	**-40**	**-234**
70%	**-161**	**-238**	**-131**	**-174**	**-210**	**-262**	**-276**	**-224**	**-35**	**-42**	**-40**	**-196**
80%	**-157**	**-233**	**-84**	**-224**	**-253**	**-320**	**-282**	**-170**	**-17**	**-14**	**-39**	**-147**
90%	**-119**	**-225**	**-82**	**-280**	**-278**	**-253**	**-267**	**-266**	**-41**	**-5**	**-42**	**-55**
Long Term												
Full Simulation Period[a]	**-92**	**-207**	**-124**	**-208**	**-204**	**-210**	**-209**	**-174**	**-13**	**-62**	**-77**	**-220**
Water Year Types[b,c]												
Wet (32%)	**-184**	**-329**	2	**-217**	**-199**	**-162**	**-220**	**-212**	4	**-32**	**-22**	**-437**
Above Normal (16%)	**-225**	**-287**	**-148**	**-316**	**-302**	**-331**	**-381**	**-328**	**-31**	**-83**	**-39**	**-265**
Below Normal (13%)	**-37**	**-148**	**-222**	**-298**	**-132**	**-301**	**-296**	**-243**	**-5**	**-89**	**-96**	**-40**
Dry (24%)	29	**-129**	**-192**	**-157**	**-226**	**-223**	**-148**	**-71**	**-15**	**-77**	**-150**	**-108**
Critical (15%)	1	**-36**	**-169**	**-71**	**-138**	**-75**	**-24**	**-33**	**-35**	**-54**	**-99**	**-53**

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Table 9-4. CVP and SWP Net Generation, Monthly Generation

No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	26	-14	12	454	515	519	333	433	312	360	167	123
20%	-60	-85	-93	327	321	294	224	362	257	328	62	81
30%	-95	-122	-145	85	201	147	182	302	227	306	4	9
40%	-149	-169	-222	27	71	67	145	270	184	257	-46	-64
50%	-167	-207	-294	-6	21	10	125	241	133	229	-71	-132
60%	-210	-299	-384	-38	-39	-16	78	203	111	174	-104	-165
70%	-238	-329	-453	-70	-68	-68	3	150	64	118	-130	-224
80%	-292	-360	-529	-140	-132	-100	-62	62	-1	41	-160	-292
90%	-363	-403	-596	-189	-184	-252	-133	29	-79	-18	-197	-426
Long Term												
Full Simulation Period[a]	-179	-212	-274	79	102	80	118	225	137	189	-46	-122
Water Year Types[b,c]												
Wet (32%)	-178	-149	-341	322	283	228	172	287	31	117	-130	86
Above Normal (16%)	-226	-251	-366	61	183	101	61	176	84	290	-68	-130
Below Normal (13%)	-284	-337	-299	-85	-11	-56	65	239	190	229	-33	-357
Dry (24%)	-158	-236	-121	-55	-46	-28	85	205	249	208	16	-255
Critical (15%)	-69	-153	-261	-55	-27	40	166	165	190	166	46	-129

Alternative 4 043019

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	17	-36	169	396	479	641	378	450	369	423	179	-38
20%	-60	-73	41	268	269	422	278	358	299	371	79	-123
30%	-96	-151	-87	111	194	297	228	327	242	332	23	-173
40%	-154	-196	-167	64	38	230	217	300	188	288	-4	-231
50%	-214	-284	-222	-11	-25	178	193	274	151	272	-35	-272
60%	-266	-334	-285	-44	-43	141	172	258	125	226	-54	-298
70%	-318	-367	-336	-74	-64	110	131	228	94	165	-110	-327
80%	-349	-429	-426	-145	-125	68	109	181	60	113	-147	-371
90%	-415	-468	-476	-209	-184	33	42	122	-25	4	-176	-429
Long Term												
Full Simulation Period[a]	-203	-257	-182	66	75	260	210	276	168	235	-24	-252
Water Year Types[b,c]												
Wet (32%)	-297	-373	-192	307	239	383	237	305	59	140	-111	-332
Above Normal (16%)	-328	-355	-270	3	181	373	175	240	105	317	-60	-333
Below Normal (13%)	-213	-233	-196	-80	-25	212	214	324	234	293	-20	-315
Dry (24%)	-92	-126	-52	-69	-70	141	205	285	293	293	80	-174
Critical (15%)	-42	-139	-267	-32	-62	112	193	193	202	199	27	-62

Alternative 4 043019 minus No Action Alternative 011319

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Generation (GWh)											
Probability of Exceedance												
10%	-10	-22	157	-58	-37	121	45	17	57	62	12	-161
20%	0	12	134	-59	-52	127	54	-4	42	44	17	-204
30%	-1	-29	58	26	-7	150	45	24	15	27	19	-181
40%	-5	-27	55	37	-33	163	71	30	5	31	42	-167
50%	-47	-77	72	-5	-45	168	68	34	19	43	36	-141
60%	-56	-35	99	-7	-4	156	94	55	14	53	49	-133
70%	-80	-37	117	-3	4	178	129	78	30	48	20	-103
80%	-58	-69	103	-5	7	169	171	119	60	72	13	-78
90%	-52	-65	120	-19	0	285	175	92	54	22	20	-3
Long Term												
Full Simulation Period[a]	-24	-44	92	-13	-27	180	92	51	31	46	22	-129
Water Year Types[b,c]												
Wet (32%)	-119	-223	149	-15	-43	154	65	18	28	23	19	-418
Above Normal (16%)	-102	-104	96	-57	-2	272	114	64	21	27	8	-203
Below Normal (13%)	71	104	103	6	-14	268	148	85	44	64	12	42
Dry (24%)	66	110	69	-13	-24	169	120	80	43	84	63	81
Critical (15%)	27	14	-6	23	-35	72	27	27	11	34	-19	67

a Based on the 82-year simulation period.

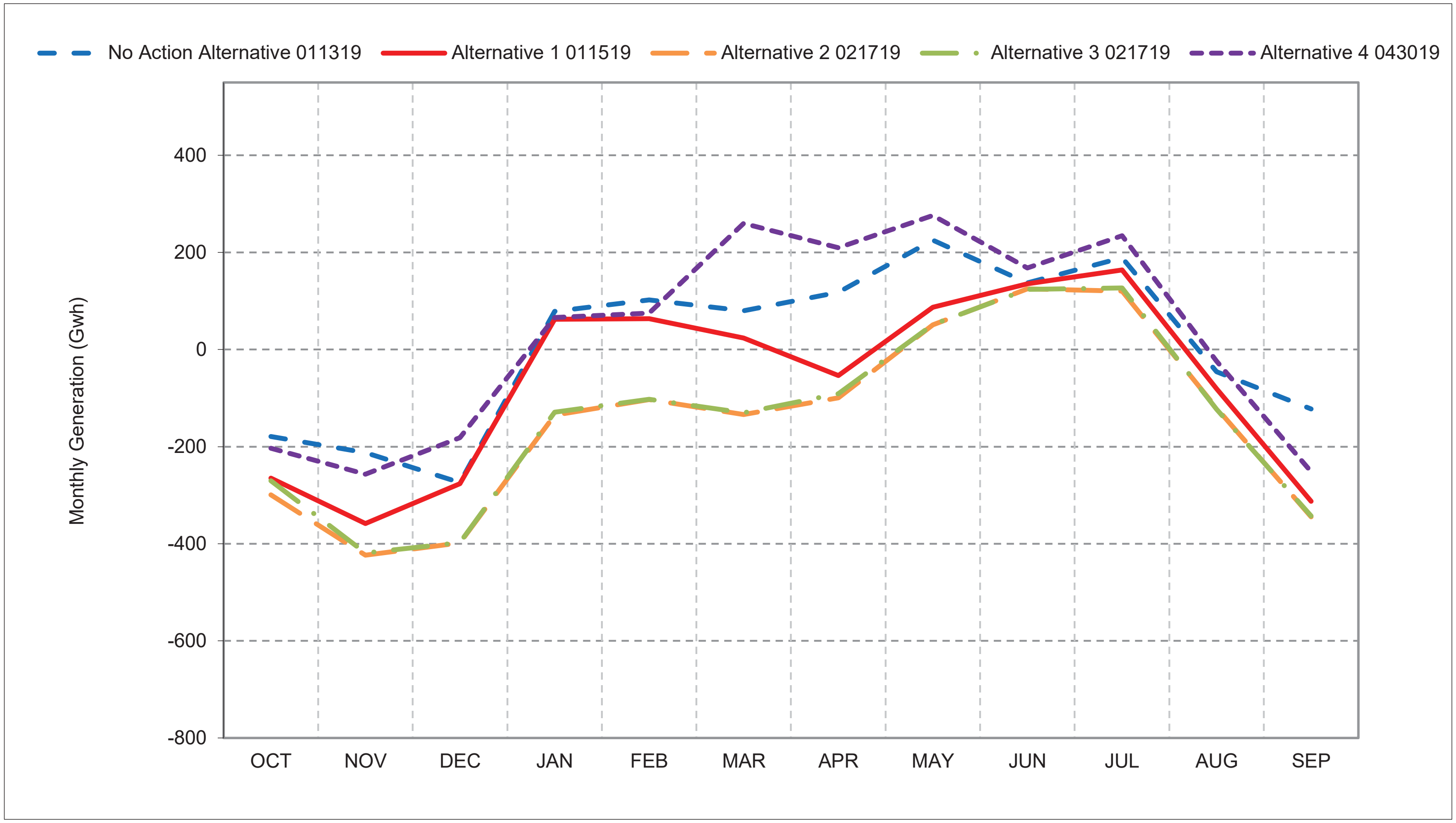
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with calendar year - year type sorting.

d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

e These are draft results meant for qualitative analysis and are subject to revision.

Figure 9-1. CVP and SWP Net Generation, Long-Term Average Generation



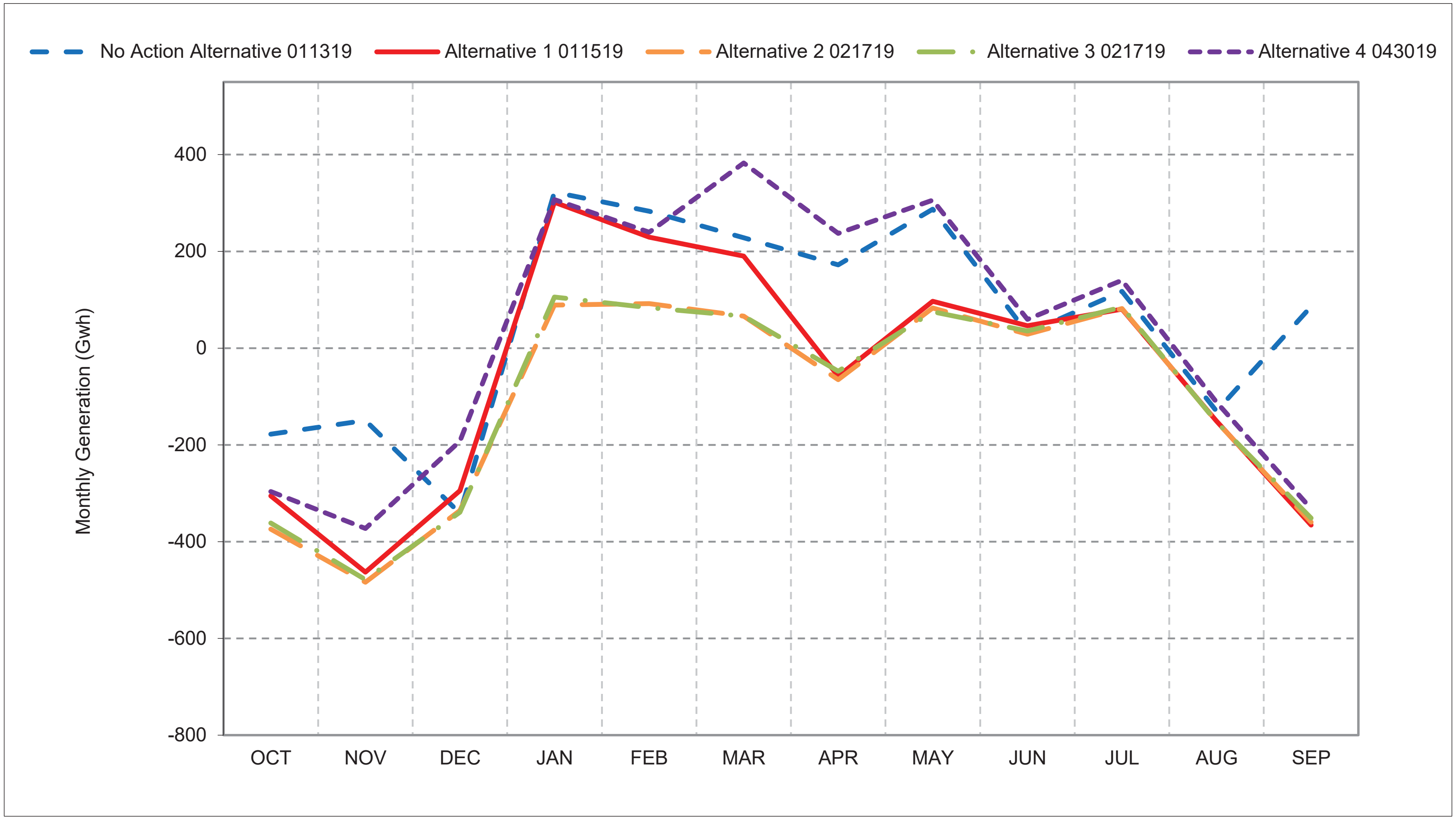
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

*These results are displayed with calendar year - year type sorting.

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

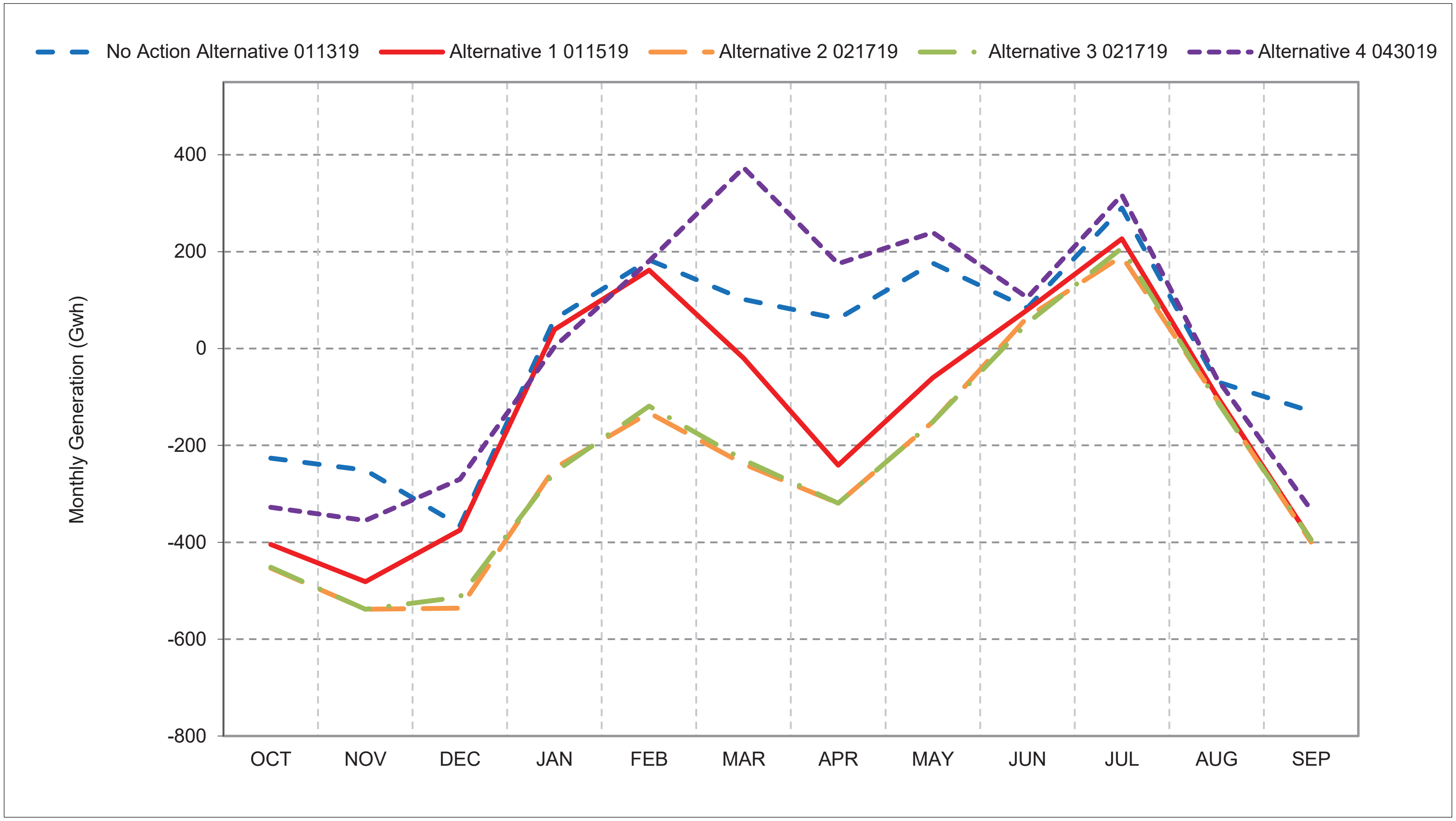
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 9-2. CVP and SWP Net Generation, Wet Year Average Generation



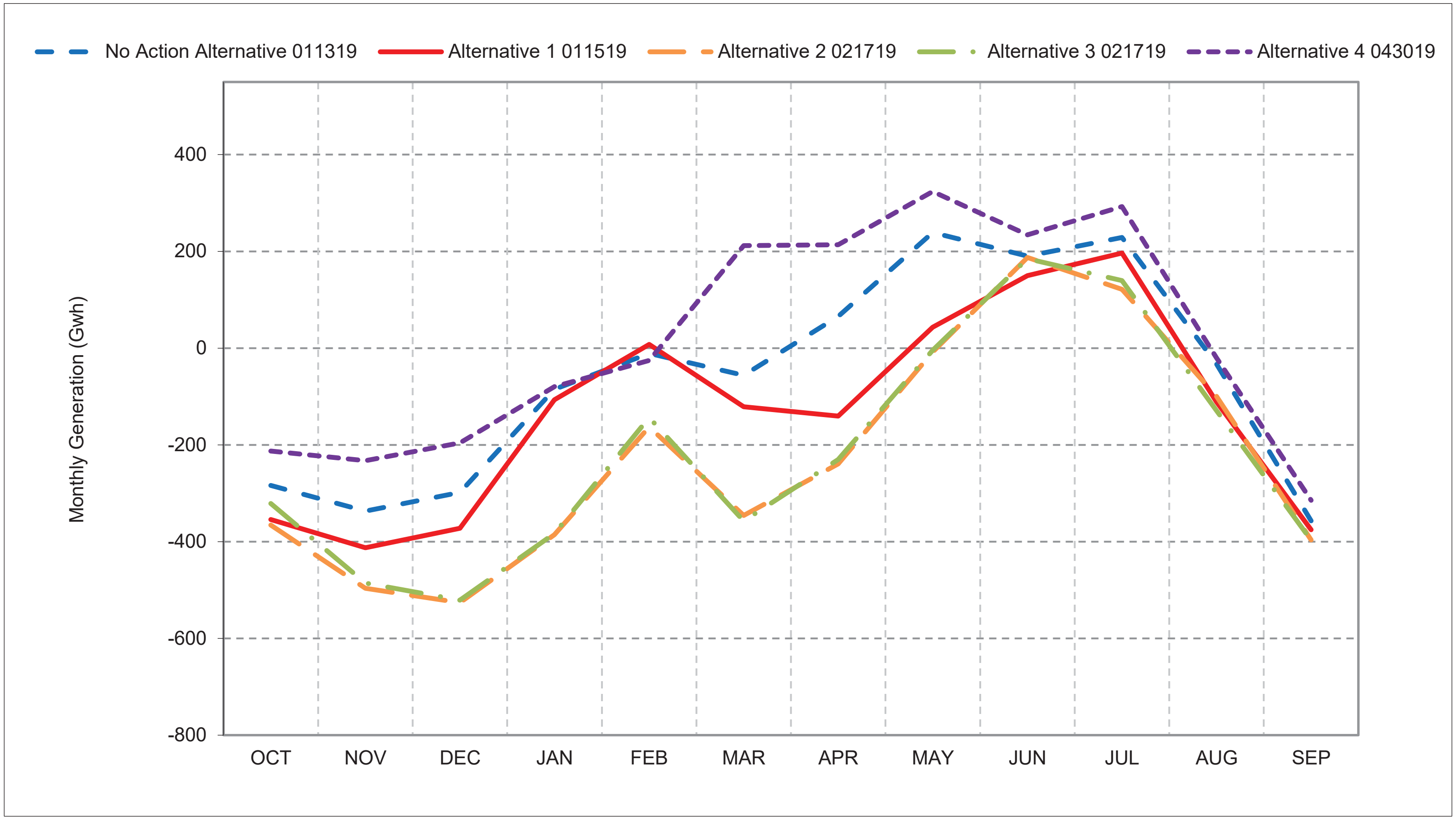
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 9-3. CVP and SWP Net Generation, Above Normal Year Average Generation



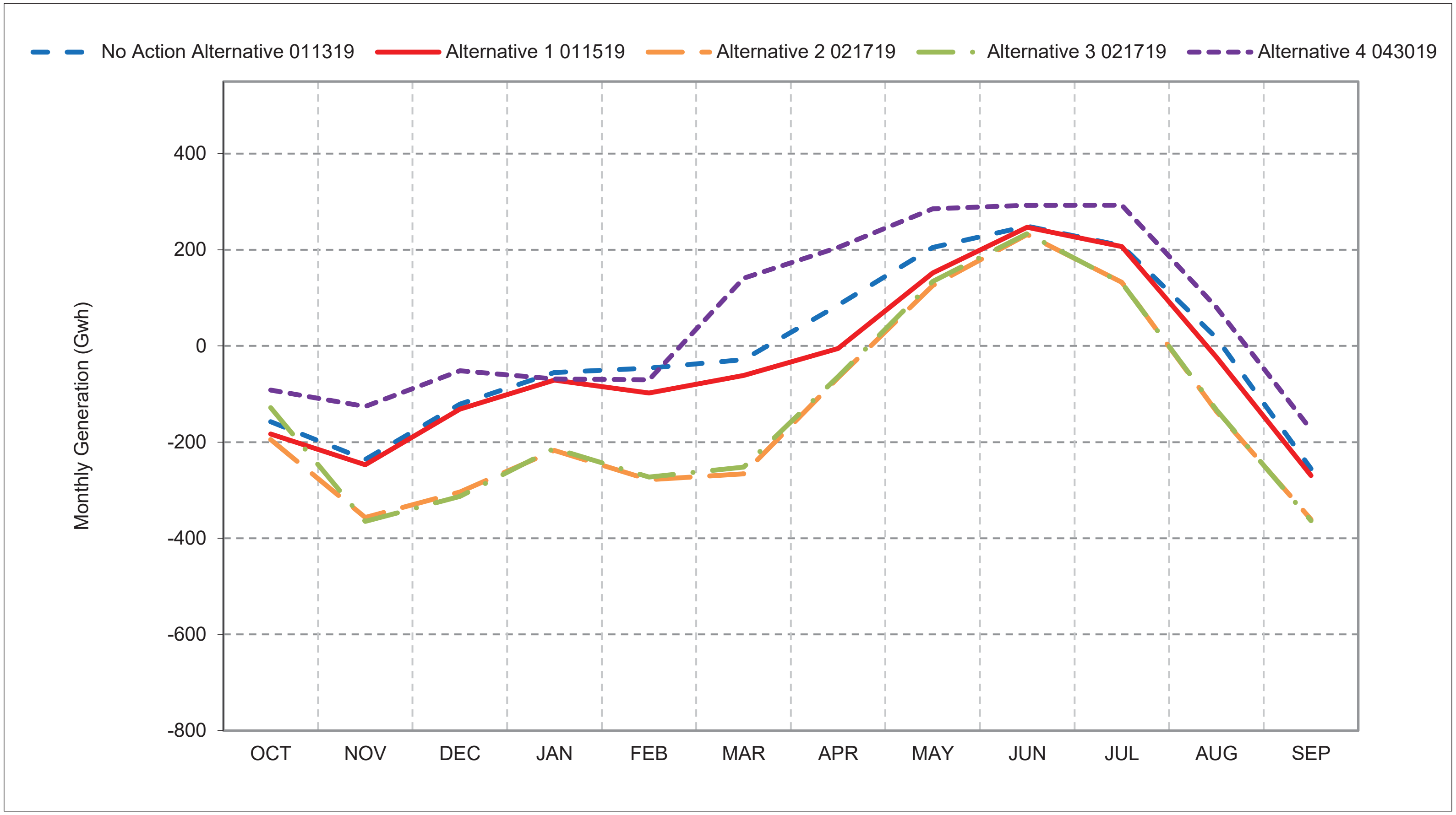
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 9-4. CVP and SWP Net Generation, Below Normal Year Average Generation



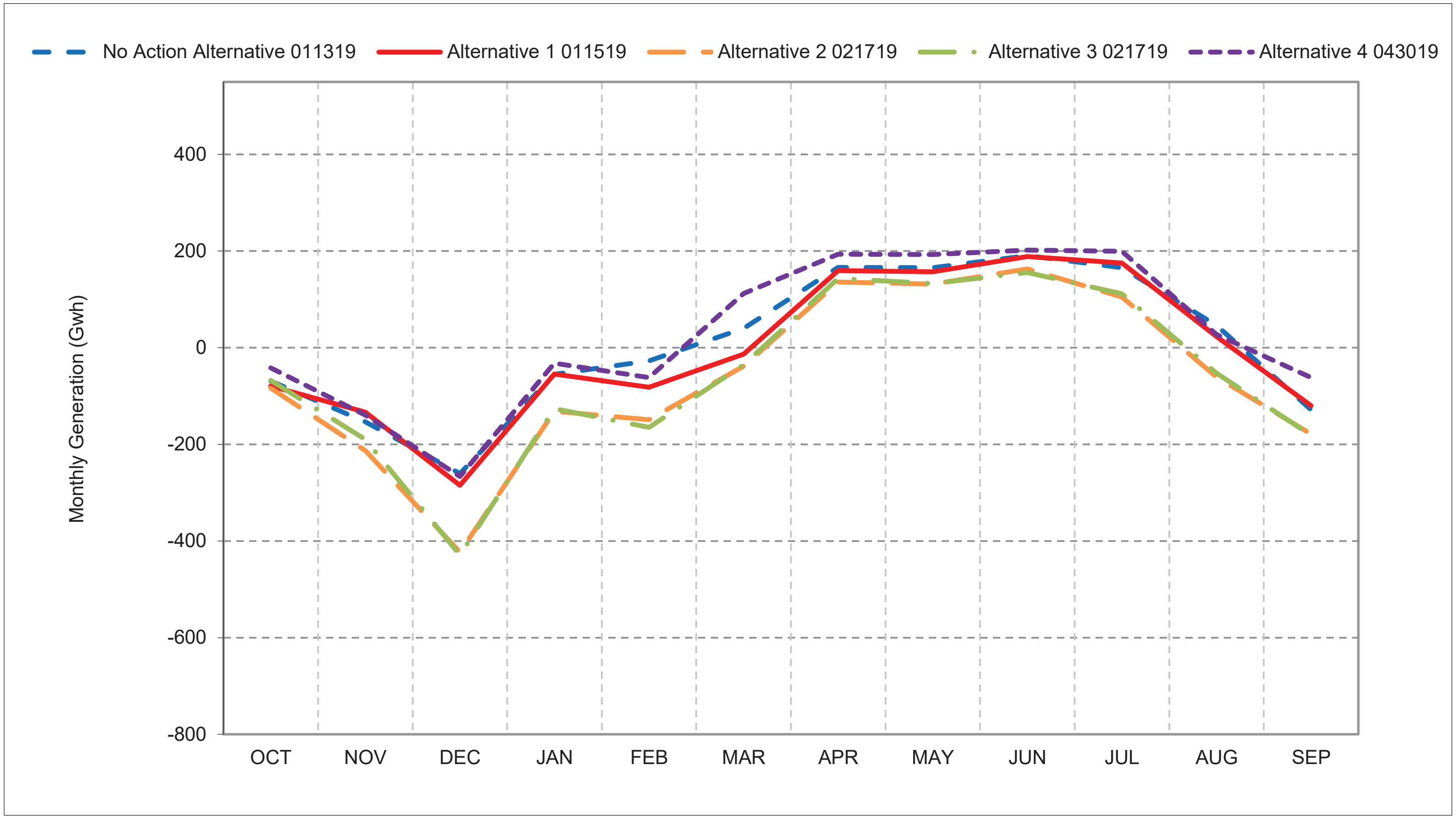
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 9-5. CVP and SWP Net Generation, Dry Year Average Generation



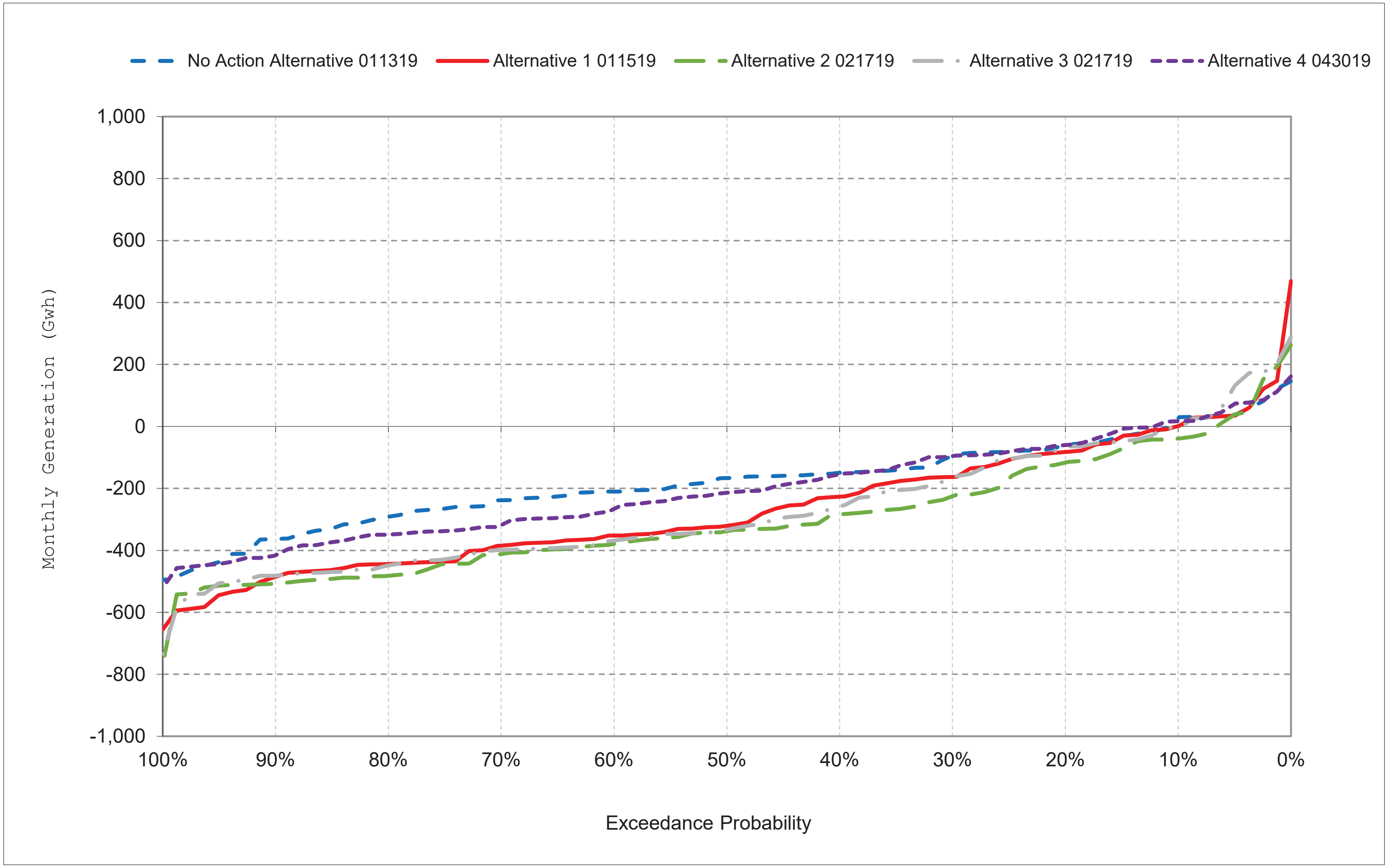
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 9-6. CVP and SWP Net Generation, Critical Year Average Generation



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with calendar year - year type sorting.
*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

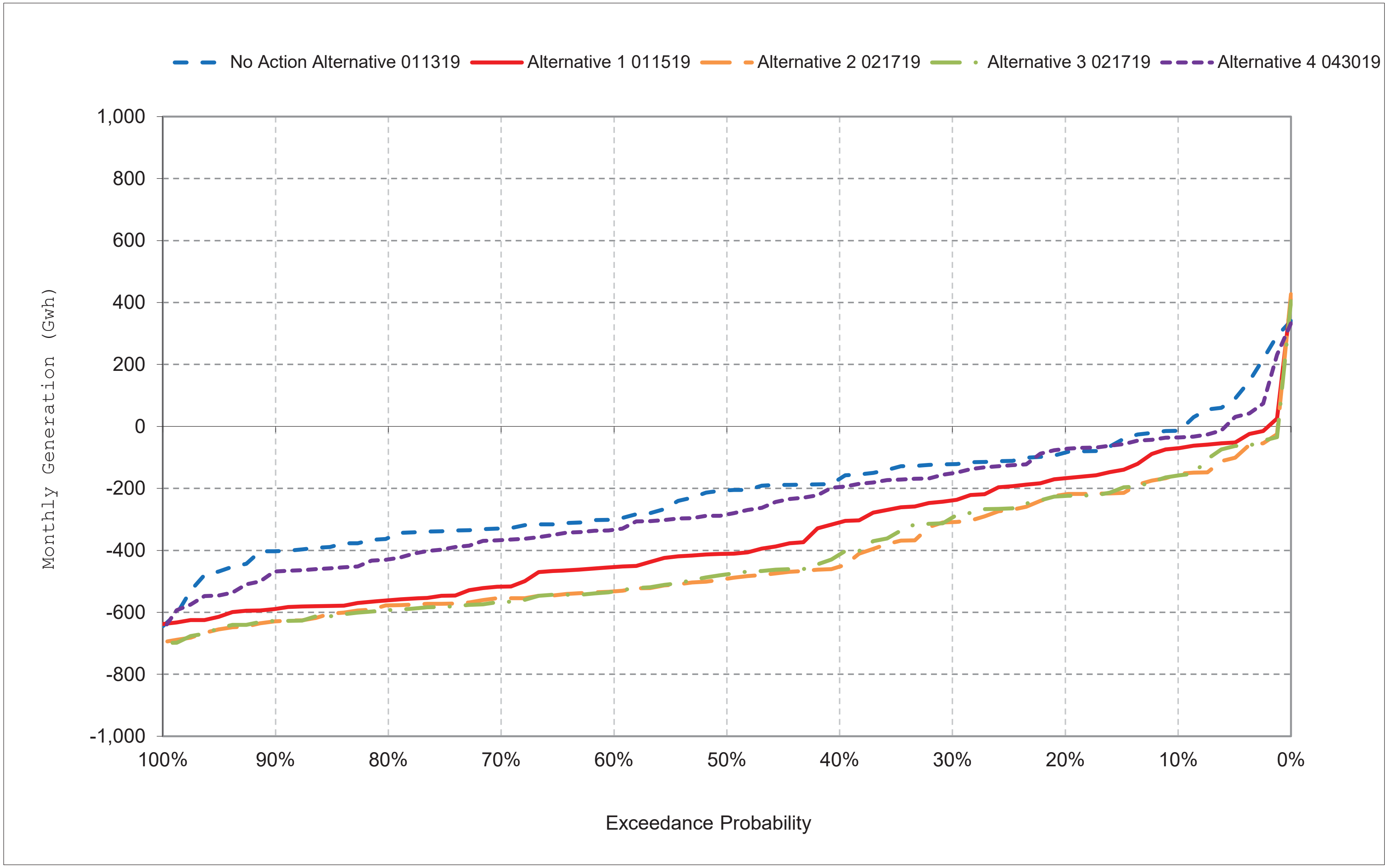
Figure 9-7. CVP and SWP Net Generation, October



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

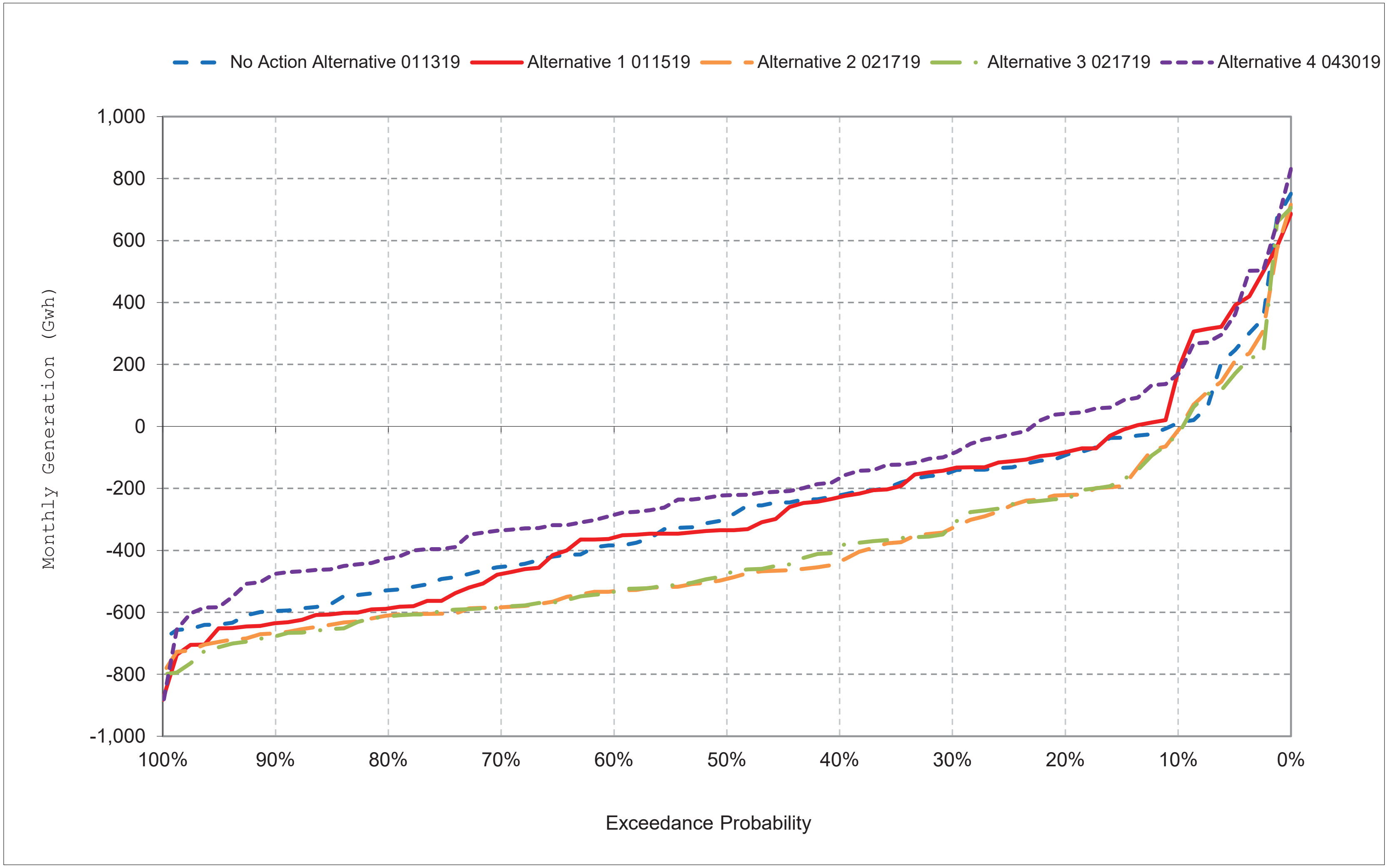
Figure 9-8. CVP and SWP Net Generation, November



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

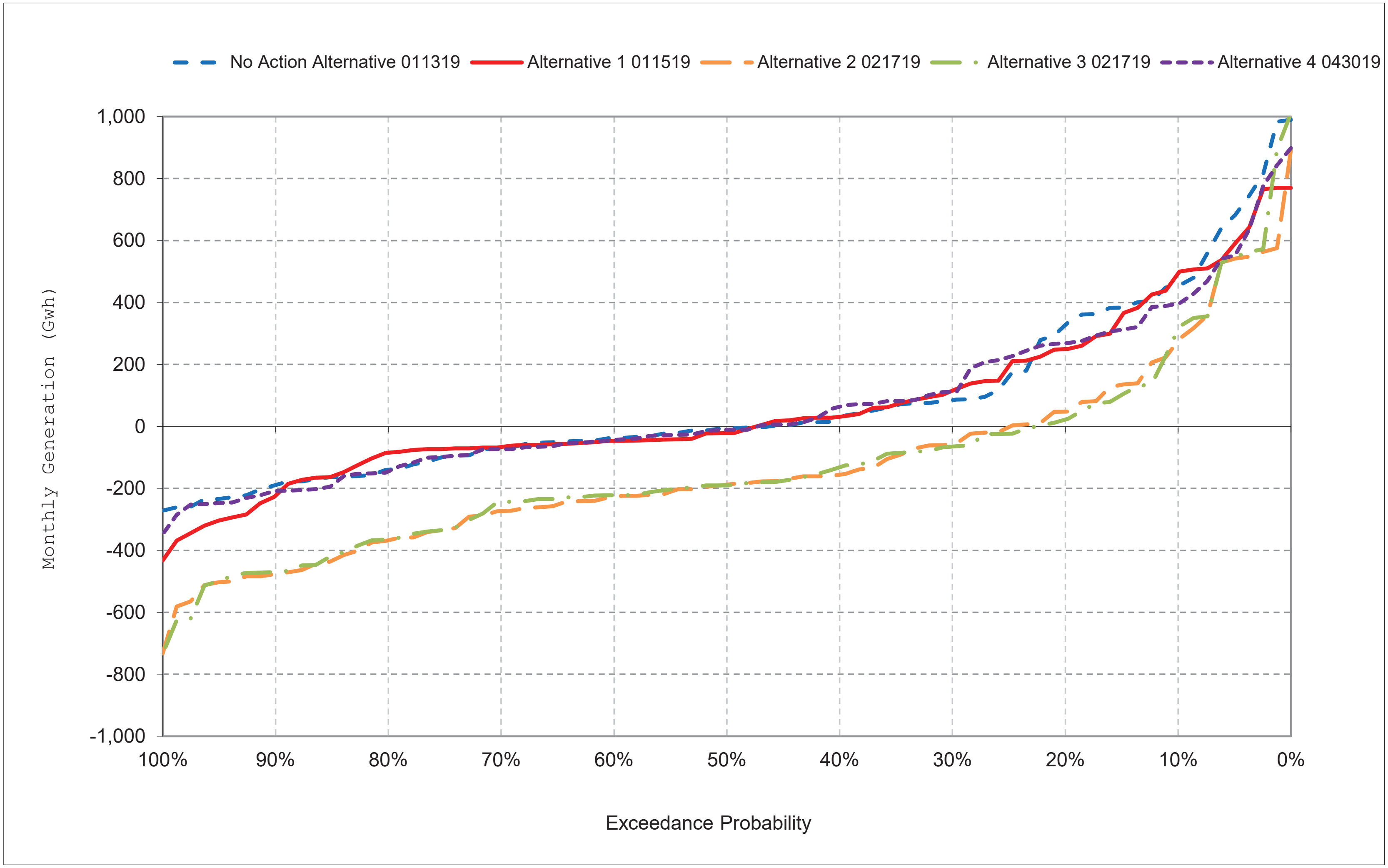
Figure 9-9. CVP and SWP Net Generation, December



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

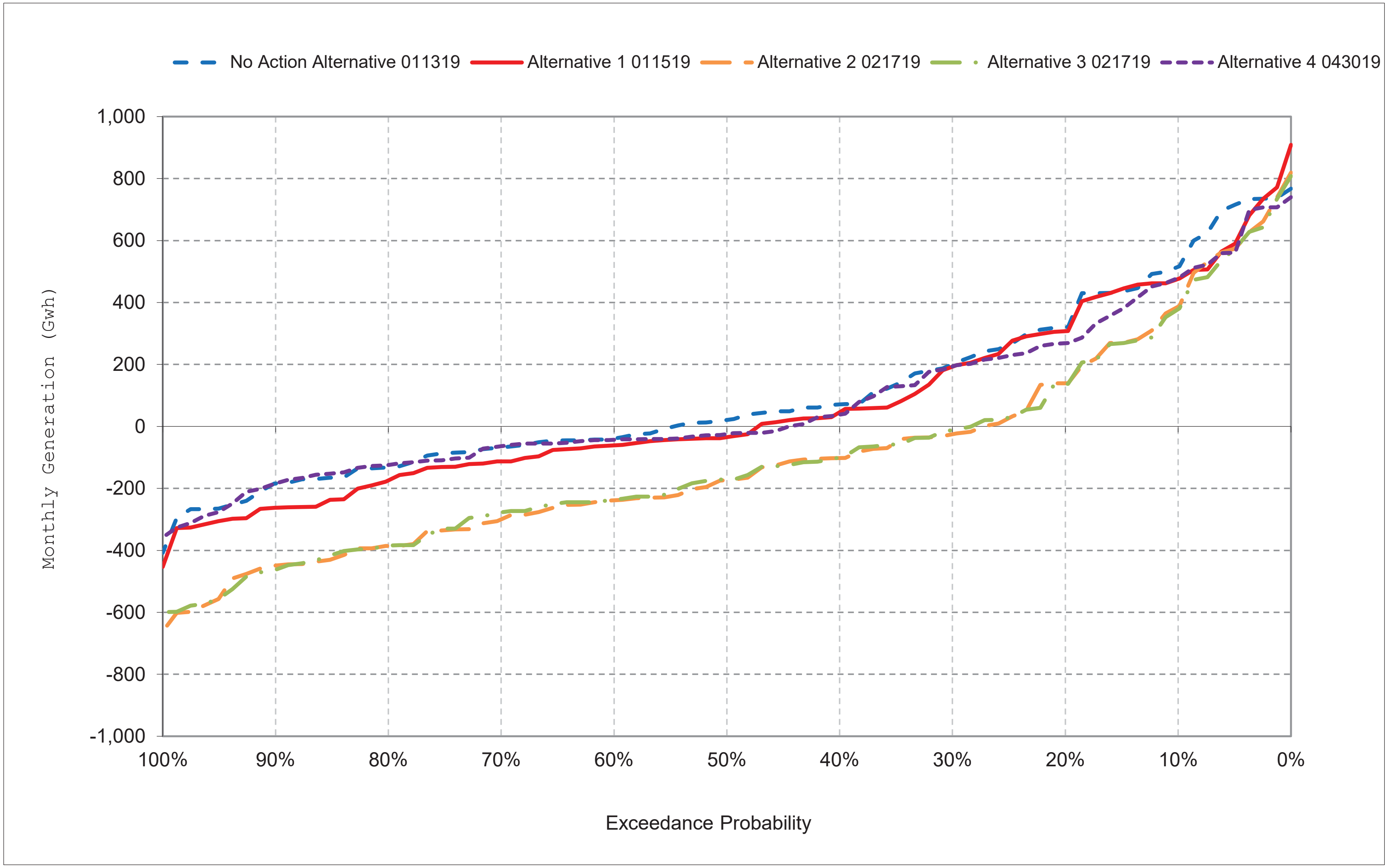
Figure 9-10. CVP and SWP Net Generation, January



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

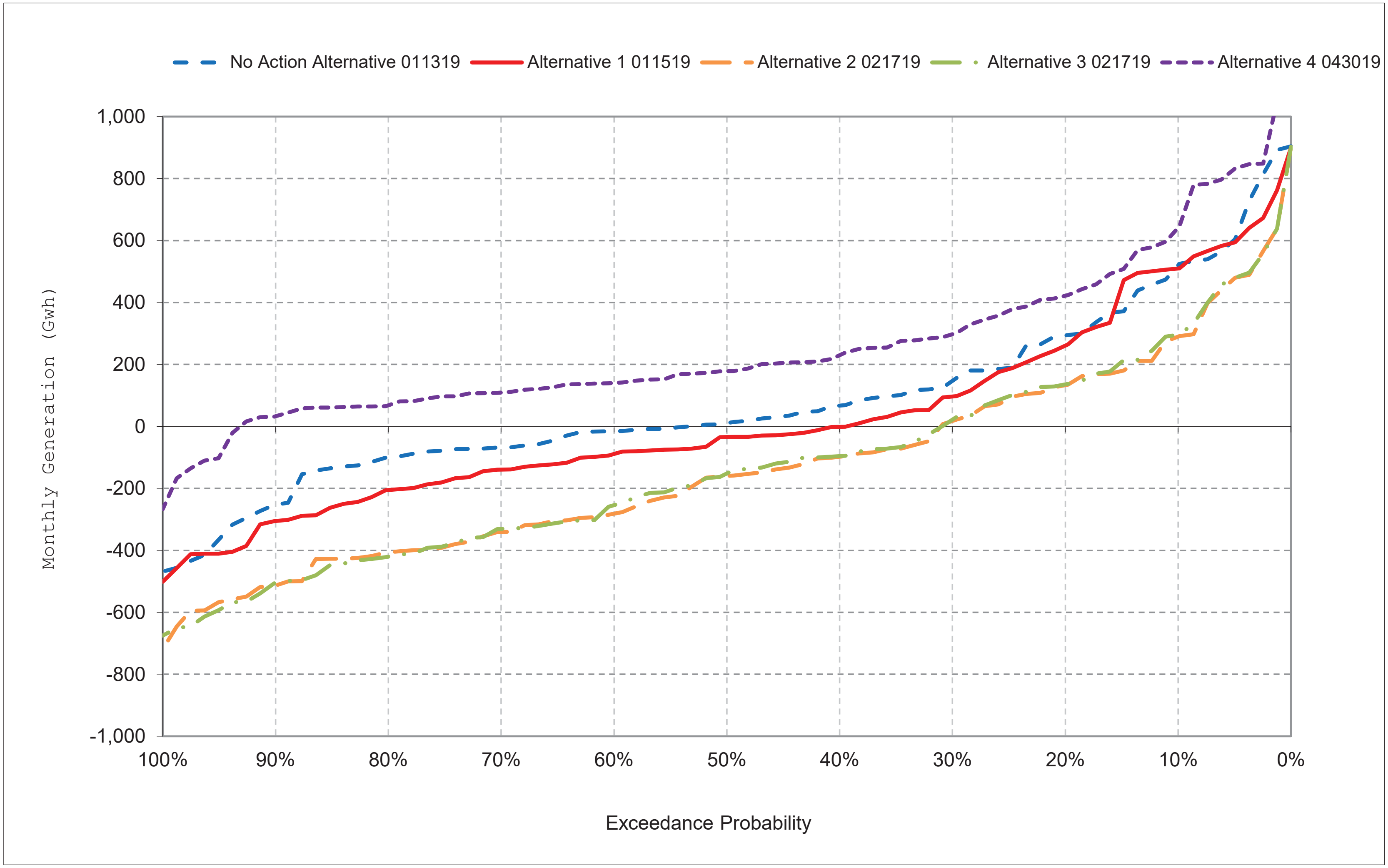
Figure 9-11. CVP and SWP Net Generation, February



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

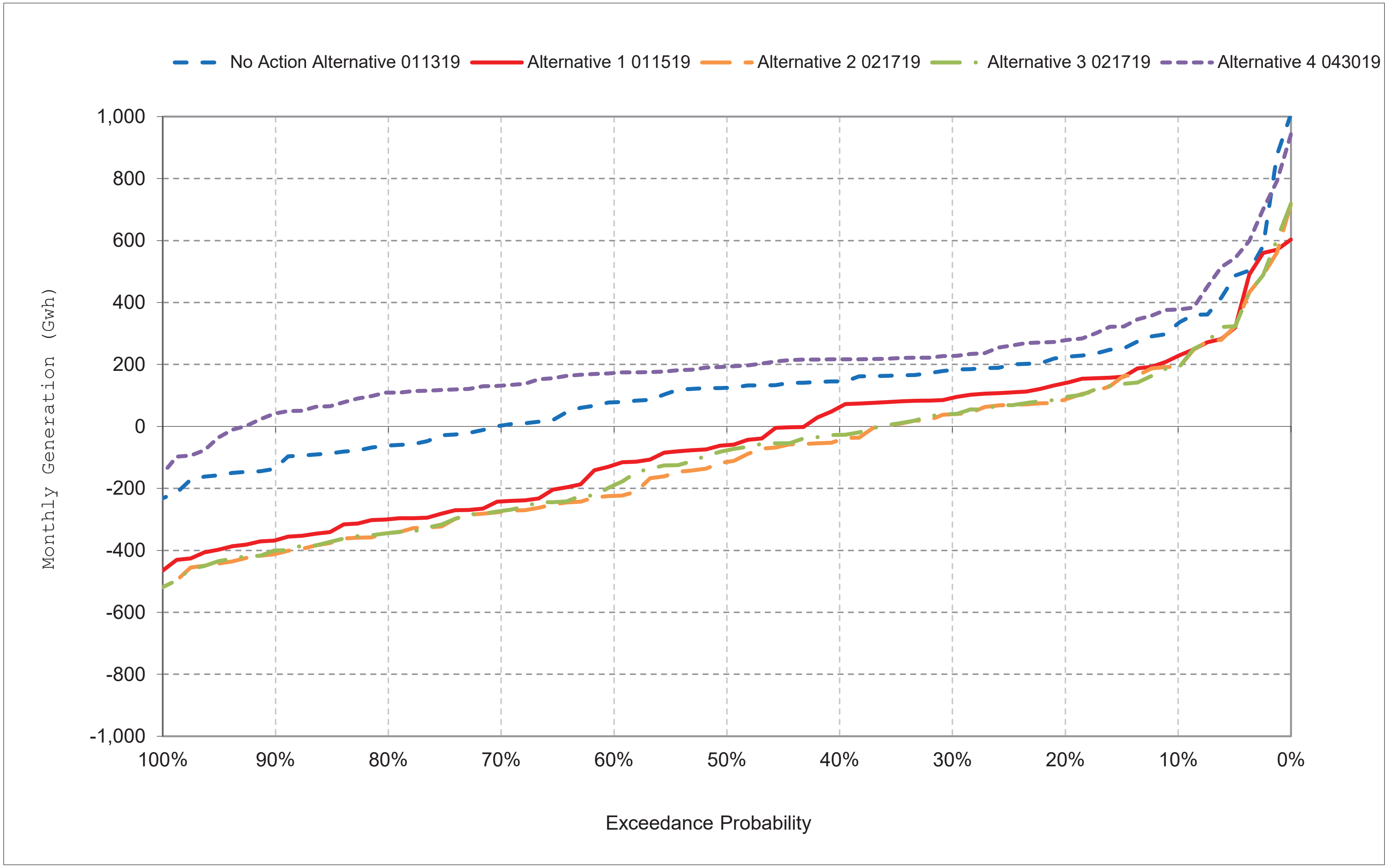
Figure 9-12. CVP and SWP Net Generation, March



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

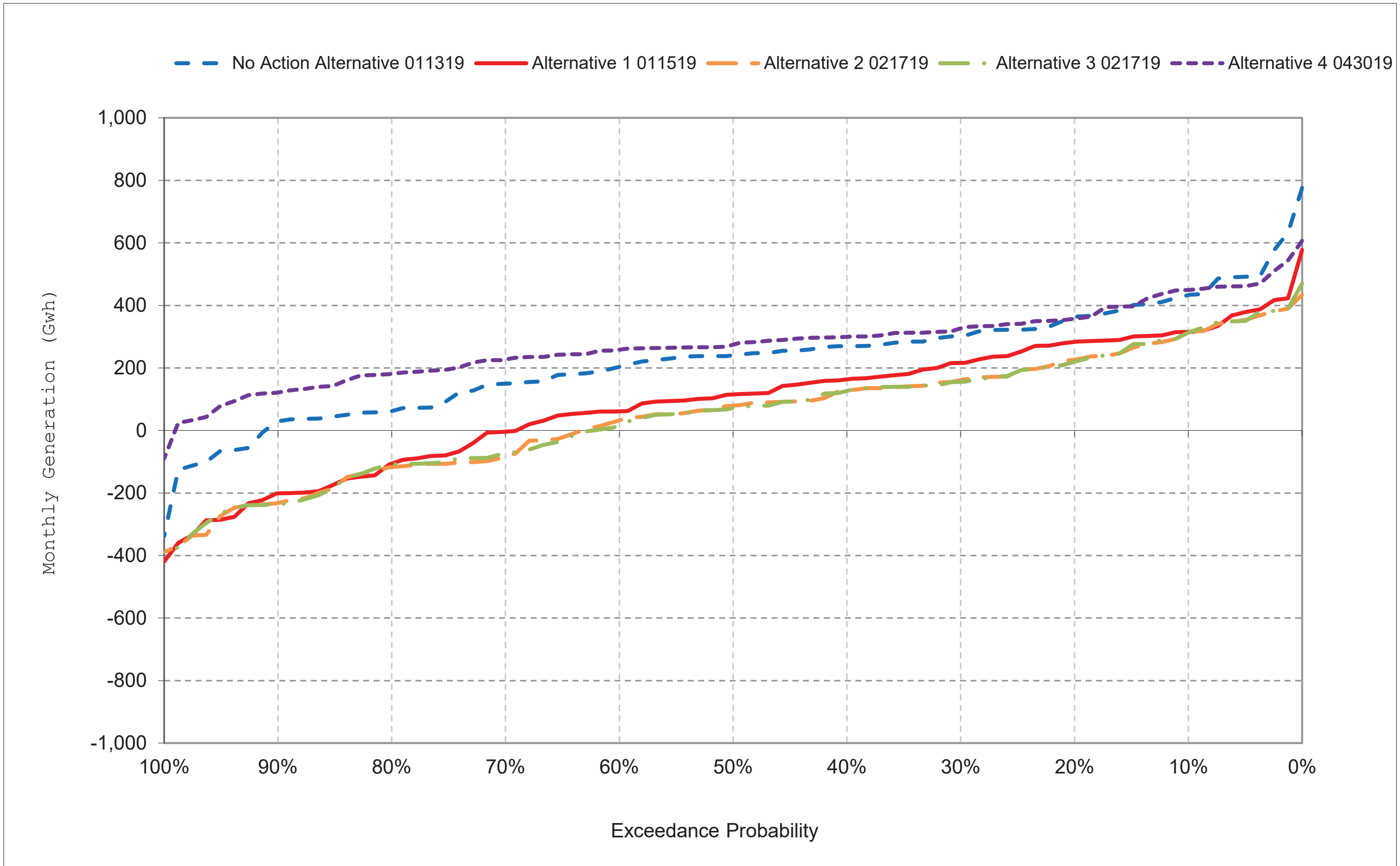
Figure 9-13. CVP and SWP Net Generation, April



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

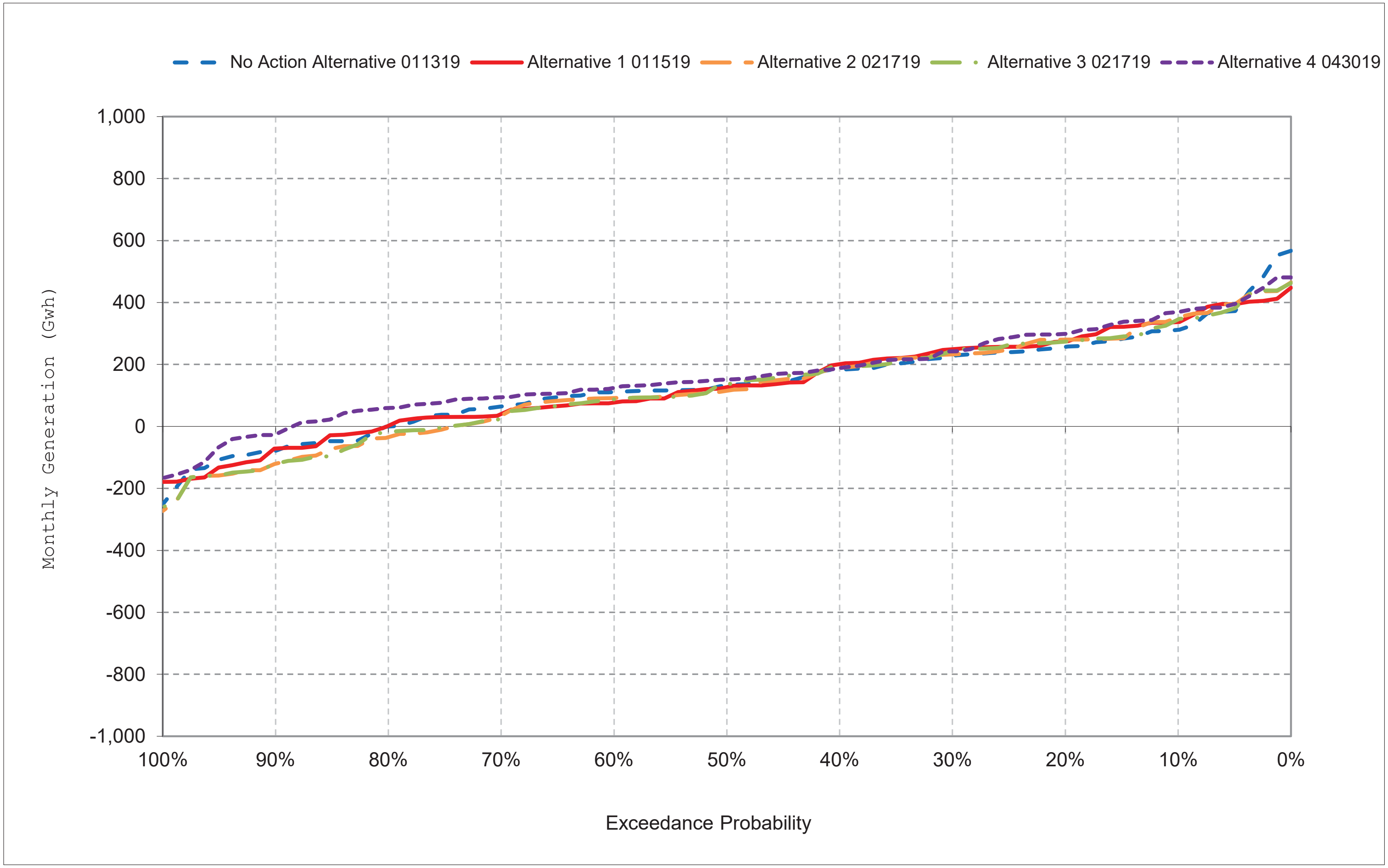
Figure 9-14. CVP and SWP Net Generation, May



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 9-15. CVP and SWP Net Generation, June



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

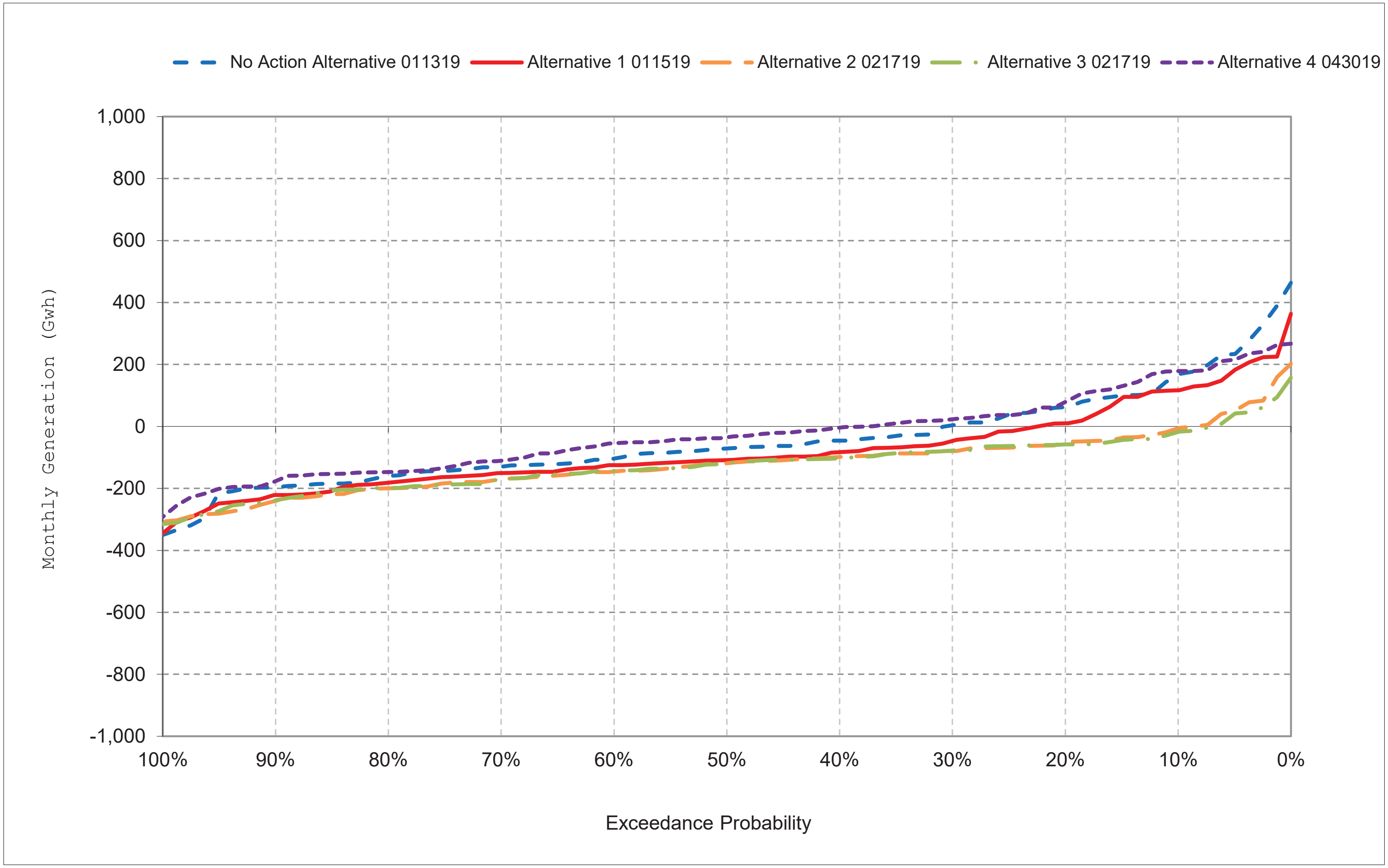
*These are draft results meant for qualitative analysis and are subject to revision.

Figure 9-16. CVP and SWP Net Generation, July

*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

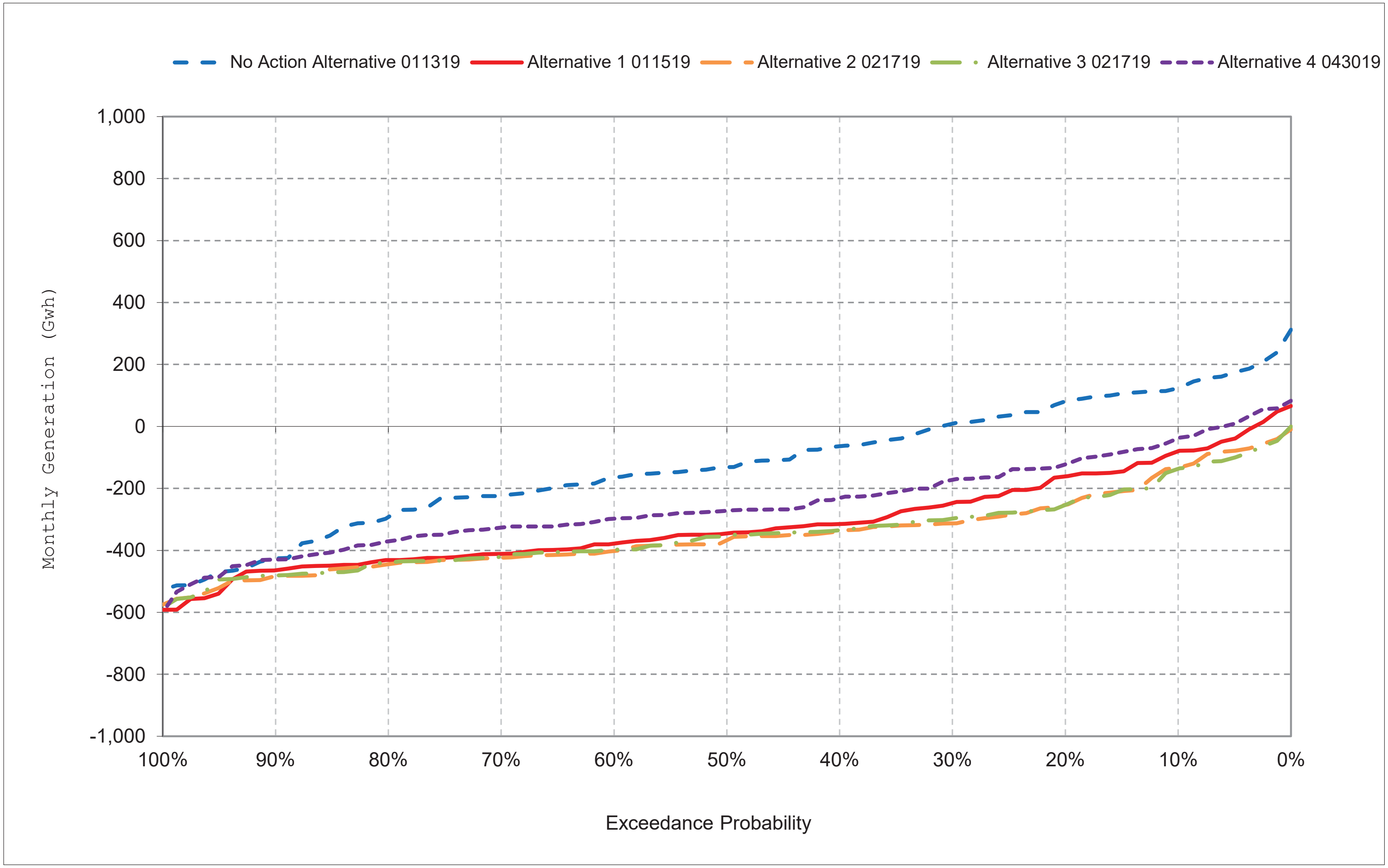
Figure 9-17. CVP and SWP Net Generation, August



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Figure 9-18. CVP and SWP Net Generation, September



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.

*These are draft results meant for qualitative analysis and are subject to revision.

Appendix T – Power

Attachment 2 – Annual Power Modeling Results (LTGen & SWP Power)

The following results of the LTGen and SWP Power models are included for energy use, energy generation at key project locations for the following alternatives:

- No Action Alternative 011319
- Alternative 1 011519
- Alternative 2 021719
- Alternative 3 021719
- Alternative 4 043019

Title	**Model Parameter**	**Table Numbers**	**Figure Numbers**
CVP Total Generation	CVP_TOTAL	2a-1 to 2a-4	2a-1
CVP Total Energy Use	CVP_TOTAL	3a-1 to 3a-4	3a-1
CVP Net Generation	CVP_TOTAL	4a-1 to 4a-4	4a-1
SWP Total Generation	SWP_TOTAL	6a-1 to 6a-4	6a-1
SWP Total Energy Use	SWP_TOTAL	7a-1 to 7a-4	7a-1
SWP Net Generation	SWP_TOTAL	8a-1 to 8a-4	8a-1
CVP and SWP Net Generation	CVP_SWP_TOTAL	9a-1 to 9a-4	9a-1

Report formats

- Exceedance tables comparing power modeling results of two scenarios
- Annual exceedance charts including all scenarios

Table 2a-1. Annual CVP Total Generation

No Action Alternative 011319

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,453.64
20%	5,752.81
30%	5,289.48
40%	4,966.67
50%	4,537.91
60%	4,026.35
70%	3,666.04
80%	3,260.65
90%	2,759.49
Long Term	
Full Simulation Period[a]	4,526.17
Water Year Types[b,c]	
Wet (32%)	6,133.18
Above Normal (16%)	5,024.97
Below Normal (13%)	4,100.68
Dry (24%)	3,563.00
Critical (15%)	2,548.30

Alternative 1 011519

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,410.11
20%	5,642.62
30%	5,173.10
40%	4,942.00
50%	4,632.99
60%	3,971.43
70%	3,655.34
80%	3,298.21
90%	2,872.28
Long Term	
Full Simulation Period[a]	4,539.01
Water Year Types[b,c]	
Wet (32%)	5,982.94
Above Normal (16%)	4,986.29
Below Normal (13%)	4,314.80
Dry (24%)	3,587.87
Critical (15%)	2,716.72

Alternative 1 011519 minus No Action Alternative

Statistic	Generation (GWh)
Probability of Exceedance[a]	
10%	-43.53
20%	-110.18
30%	-116.38
40%	-24.67
50%	95.08
60%	-54.93
70%	-10.70
80%	37.56
90%	112.79
Long Term	
Full Simulation Period[a]	12.84
Water Year Types[b,c]	
Wet (32%)	-150.23
Above Normal (16%)	-38.68
Below Normal (13%)	214.13
Dry (24%)	24.87
Critical (15%)	168.42

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 2a-2. Annual CVP Total Generation

No Action Alternative 011319

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,453.64
20%	5,752.81
30%	5,289.48
40%	4,966.67
50%	4,537.91
60%	4,026.35
70%	3,666.04
80%	3,260.65
90%	2,759.49
Long Term	
Full Simulation Period[a]	4,526.17
Water Year Types[b,c]	
Wet (32%)	6,133.18
Above Normal (16%)	5,024.97
Below Normal (13%)	4,100.68
Dry (24%)	3,563.00
Critical (15%)	2,548.30

Alternative 2 021719

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,403.50
20%	5,746.13
30%	5,301.28
40%	5,087.19
50%	4,721.89
60%	3,966.16
70%	3,717.74
80%	3,460.59
90%	2,932.34
Long Term	
Full Simulation Period[a]	4,608.71
Water Year Types[b,c]	
Wet (32%)	6,034.85
Above Normal (16%)	5,077.44
Below Normal (13%)	4,473.46
Dry (24%)	3,626.96
Critical (15%)	2,771.16

Alternative 2 021719 minus No Action Alternative

Statistic	Generation (GWh)
Probability of Exceedance[a]	
10%	-50.14
20%	-6.67
30%	11.80
40%	120.52
50%	183.98
60%	-60.19
70%	51.70
80%	199.94
90%	172.85
Long Term	
Full Simulation Period[a]	82.53
Water Year Types[b,c]	
Wet (32%)	-98.33
Above Normal (16%)	52.47
Below Normal (13%)	372.78
Dry (24%)	63.96
Critical (15%)	222.86

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 2a-3. Annual CVP Total Generation

No Action Alternative 011319

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,453.64
20%	5,752.81
30%	5,289.48
40%	4,966.67
50%	4,537.91
60%	4,026.35
70%	3,666.04
80%	3,260.65
90%	2,759.49
Long Term	
Full Simulation Period[a]	4,526.17
Water Year Types[b,c]	
Wet (32%)	6,133.18
Above Normal (16%)	5,024.97
Below Normal (13%)	4,100.68
Dry (24%)	3,563.00
Critical (15%)	2,548.30

Alternative 3 021719

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,448.62
20%	5,736.54
30%	5,244.01
40%	5,082.16
50%	4,725.95
60%	3,988.26
70%	3,712.51
80%	3,448.91
90%	2,914.24
Long Term	
Full Simulation Period[a]	4,610.48
Water Year Types[b,c]	
Wet (32%)	6,040.29
Above Normal (16%)	5,073.08
Below Normal (13%)	4,477.91
Dry (24%)	3,632.85
Critical (15%)	2,762.29

Alternative 3 021719 minus No Action Alternative

Statistic	Generation (GWh)
Probability of Exceedance[a]	
10%	-5.03
20%	-16.27
30%	-45.46
40%	115.49
50%	188.04
60%	-38.09
70%	46.46
80%	188.26
90%	154.74
Long Term	
Full Simulation Period[a]	84.30
Water Year Types[b,c]	
Wet (32%)	-92.88
Above Normal (16%)	48.11
Below Normal (13%)	377.23
Dry (24%)	69.85
Critical (15%)	214.00

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 2a-4. Annual CVP Total Generation

No Action Alternative 011319

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,453.64
20%	5,752.81
30%	5,289.48
40%	4,966.67
50%	4,537.91
60%	4,026.35
70%	3,666.04
80%	3,260.65
90%	2,759.49
Long Term	
Full Simulation Period[a]	4,526.17
Water Year Types[b,c]	
Wet (32%)	6,133.18
Above Normal (16%)	5,024.97
Below Normal (13%)	4,100.68
Dry (24%)	3,563.00
Critical (15%)	2,548.30

Alternative 4 043019

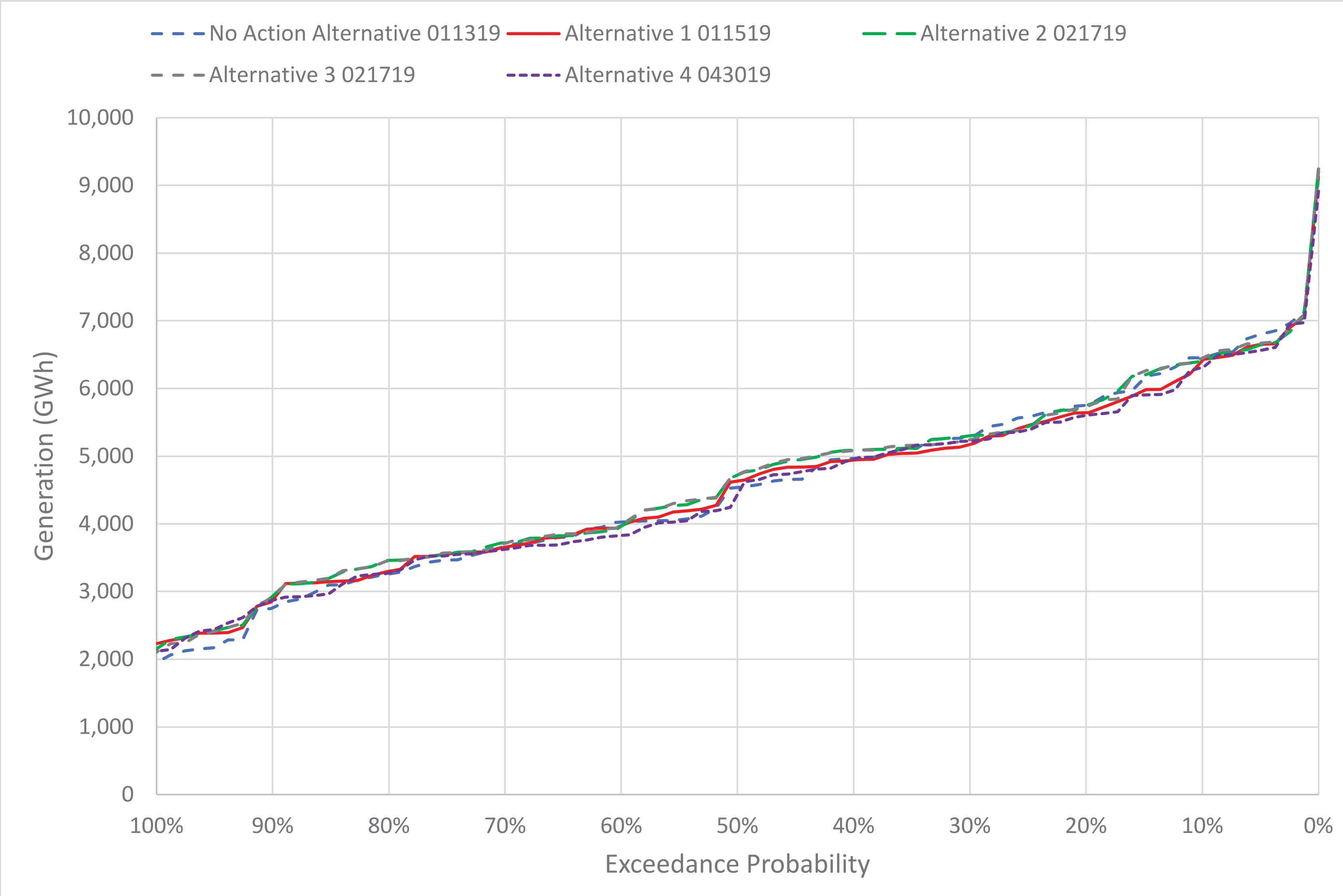
Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,313.28
20%	5,603.31
30%	5,222.27
40%	4,955.98
50%	4,433.77
60%	3,828.62
70%	3,624.81
80%	3,274.94
90%	2,871.11
Long Term	
Full Simulation Period[a]	4,488.67
Water Year Types[b,c]	
Wet (32%)	5,953.95
Above Normal (16%)	4,984.11
Below Normal (13%)	4,171.94
Dry (24%)	3,547.72
Critical (15%)	2,635.77

Alternative 4 043019 minus No Action Alternative

Statistic	Generation (GWh)
Probability of Exceedance[a]	
10%	-140.36
20%	-149.49
30%	-67.21
40%	-10.68
50%	-104.14
60%	-197.73
70%	-41.23
80%	14.29
90%	111.61
Long Term	
Full Simulation Period[a]	-37.51
Water Year Types[b,c]	
Wet (32%)	-179.23
Above Normal (16%)	-40.86
Below Normal (13%)	71.26
Dry (24%)	-15.28
Critical (15%)	87.47

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Figure 2a-1. October-September CVP Total Generation



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Table 3a-1. Annual CVP Total Energy Use

No Action Alternative 011319

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	1,496.28
20%	1,421.06
30%	1,365.89
40%	1,291.42
50%	1,242.70
60%	1,200.04
70%	1,114.48
80%	1,015.57
90%	828.57
Long Term	
Full Simulation Period[a]	1,206.94
Water Year Types[b,c]	
Wet (32%)	1,439.03
Above Normal (16%)	1,274.73
Below Normal (13%)	1,180.64
Dry (24%)	1,124.43
Critical (15%)	792.27

Alternative 1 011519

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	1,605.56
20%	1,531.01
30%	1,485.21
40%	1,444.03
50%	1,376.90
60%	1,300.08
70%	1,206.76
80%	1,105.97
90%	989.97
Long Term	
Full Simulation Period[a]	1,321.77
Water Year Types[b,c]	
Wet (32%)	1,548.26
Above Normal (16%)	1,391.57
Below Normal (13%)	1,366.80
Dry (24%)	1,220.01
Critical (15%)	883.73

Alternative 1 011519 minus No Action Alternative

Statistic	Energy Use (GWh)
Probability of Exceedance[a]	
10%	109.28
20%	109.95
30%	119.31
40%	152.61
50%	134.20
60%	100.04
70%	92.29
80%	90.40
90%	161.40
Long Term	
Full Simulation Period[a]	114.83
Water Year Types[b,c]	
Wet (32%)	109.24
Above Normal (16%)	116.84
Below Normal (13%)	186.16
Dry (24%)	95.58
Critical (15%)	91.47

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 3a-2. Annual CVP Total Energy Use

No Action Alternative 011319

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	1,496.28
20%	1,421.06
30%	1,365.89
40%	1,291.42
50%	1,242.70
60%	1,200.04
70%	1,114.48
80%	1,015.57
90%	828.57
Long Term	
Full Simulation Period[a]	1,206.94
Water Year Types[b,c]	
Wet (32%)	1,439.03
Above Normal (16%)	1,274.73
Below Normal (13%)	1,180.64
Dry (24%)	1,124.43
Critical (15%)	792.27

Alternative 2 021719

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	1,714.41
20%	1,657.60
30%	1,625.57
40%	1,584.62
50%	1,529.53
60%	1,416.65
70%	1,273.23
80%	1,180.80
90%	1,004.83
Long Term	
Full Simulation Period[a]	1,419.75
Water Year Types[b,c]	
Wet (32%)	1,624.88
Above Normal (16%)	1,570.92
Below Normal (13%)	1,515.57
Dry (24%)	1,280.98
Critical (15%)	954.95

Alternative 2 021719 minus No Action Alternative

Statistic	Energy Use (GWh)
Probability of Exceedance[a]	
10%	218.13
20%	236.53
30%	259.68
40%	293.20
50%	286.83
60%	216.61
70%	158.76
80%	165.24
90%	176.26
Long Term	
Full Simulation Period[a]	212.81
Water Year Types[b,c]	
Wet (32%)	185.86
Above Normal (16%)	296.19
Below Normal (13%)	334.93
Dry (24%)	156.55
Critical (15%)	162.69

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 3a-3. Annual CVP Total Energy Use

No Action Alternative 011319

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	1,496.28
20%	1,421.06
30%	1,365.89
40%	1,291.42
50%	1,242.70
60%	1,200.04
70%	1,114.48
80%	1,015.57
90%	828.57
Long Term	
Full Simulation Period[a]	1,206.94
Water Year Types[b,c]	
Wet (32%)	1,439.03
Above Normal (16%)	1,274.73
Below Normal (13%)	1,180.64
Dry (24%)	1,124.43
Critical (15%)	792.27

Alternative 3 021719

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	1,712.90
20%	1,661.41
30%	1,618.08
40%	1,573.84
50%	1,514.45
60%	1,396.54
70%	1,301.92
80%	1,168.93
90%	1,011.51
Long Term	
Full Simulation Period[a]	1,415.38
Water Year Types[b,c]	
Wet (32%)	1,623.02
Above Normal (16%)	1,563.44
Below Normal (13%)	1,517.93
Dry (24%)	1,272.12
Critical (15%)	949.83

Alternative 3 021719 minus No Action Alternative

Statistic	Energy Use (GWh)
Probability of Exceedance[a]	
10%	216.62
20%	240.34
30%	252.18
40%	282.42
50%	271.76
60%	196.50
70%	187.44
80%	153.36
90%	182.94
Long Term	
Full Simulation Period[a]	208.44
Water Year Types[b,c]	
Wet (32%)	184.00
Above Normal (16%)	288.71
Below Normal (13%)	337.29
Dry (24%)	147.69
Critical (15%)	157.57

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 3a-4. Annual CVP Total Energy Use

No Action Alternative 011319

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	1,496.28
20%	1,421.06
30%	1,365.89
40%	1,291.42
50%	1,242.70
60%	1,200.04
70%	1,114.48
80%	1,015.57
90%	828.57
Long Term	
Full Simulation Period[a]	1,206.94
Water Year Types[b,c]	
Wet (32%)	1,439.03
Above Normal (16%)	1,274.73
Below Normal (13%)	1,180.64
Dry (24%)	1,124.43
Critical (15%)	792.27

Alternative 4 043019

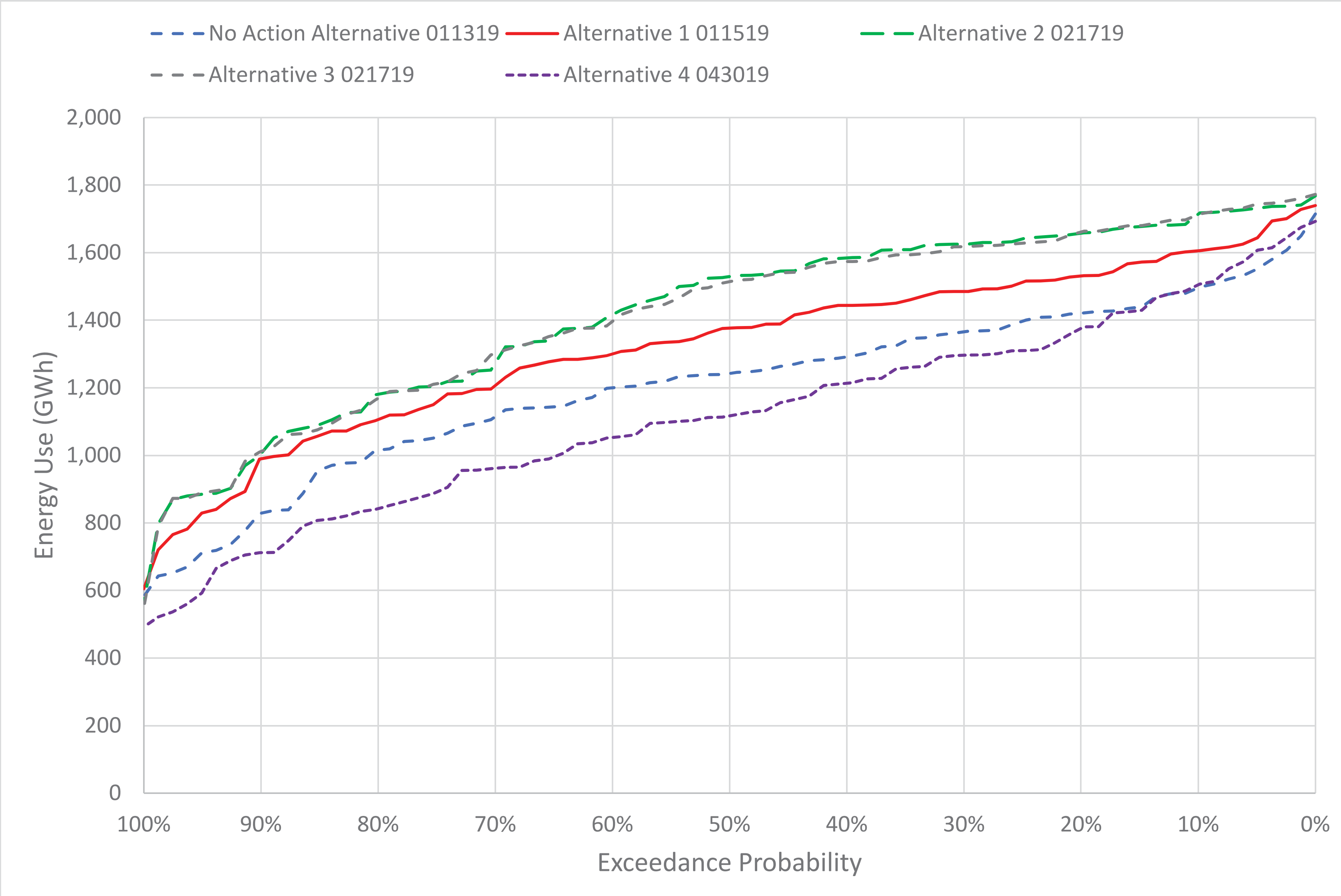
Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	1,504.79
20%	1,376.02
30%	1,296.48
40%	1,213.41
50%	1,117.05
60%	1,052.85
70%	961.84
80%	842.24
90%	711.97
Long Term	
Full Simulation Period[a]	1,116.61
Water Year Types[b,c]	
Wet (32%)	1,412.16
Above Normal (16%)	1,169.41
Below Normal (13%)	1,105.85
Dry (24%)	979.95
Critical (15%)	656.71

Alternative 4 043019 minus No Action Alternative

Statistic	Energy Use (GWh)
Probability of Exceedance[a]	
10%	8.51
20%	-45.04
30%	-69.41
40%	-78.01
50%	-125.65
60%	-147.19
70%	-152.64
80%	-173.33
90%	-116.60
Long Term	
Full Simulation Period[a]	-90.32
Water Year Types[b,c]	
Wet (32%)	-26.86
Above Normal (16%)	-105.32
Below Normal (13%)	-74.79
Dry (24%)	-144.48
Critical (15%)	-135.56

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Figure 3a-1. October-September CVP Total Energy Use



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Table 4a-1. Annual CVP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	5,005.52
20%	4,409.15
30%	4,018.51
40%	3,624.22
50%	3,246.79
60%	2,790.93
70%	2,558.25
80%	2,253.60
90%	1,894.42
Long Term	
Full Simulation Period[a]	3,326.40
Water Year Types[b,c]	
Wet (32%)	4,694.15
Above Normal (16%)	3,750.24
Below Normal (13%)	2,920.04
Dry (24%)	2,438.57
Critical (15%)	1,756.03

Alternative 1 011519

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	4,870.17
20%	4,186.04
30%	3,785.98
40%	3,566.60
50%	3,156.81
60%	2,639.32
70%	2,463.14
80%	2,184.21
90%	1,897.10
Long Term	
Full Simulation Period[a]	3,217.24
Water Year Types[b,c]	
Wet (32%)	4,434.68
Above Normal (16%)	3,594.71
Below Normal (13%)	2,948.01
Dry (24%)	2,367.86
Critical (15%)	1,832.98

Alternative 1 011519 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	-135.35
20%	-223.12
30%	-232.53
40%	-57.63
50%	-89.98
60%	-151.61
70%	-95.11
80%	-69.39
90%	2.68
Long Term	
Full Simulation Period[a]	-109.16
Water Year Types[b,c]	
Wet (32%)	-259.47
Above Normal (16%)	-155.52
Below Normal (13%)	27.97
Dry (24%)	-70.71
Critical (15%)	76.95

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 4a-2. Annual CVP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	5,005.52
20%	4,409.15
30%	4,018.51
40%	3,624.22
50%	3,246.79
60%	2,790.93
70%	2,558.25
80%	2,253.60
90%	1,894.42
Long Term	
Full Simulation Period[a]	3,326.40
Water Year Types[b,c]	
Wet (32%)	4,694.15
Above Normal (16%)	3,750.24
Below Normal (13%)	2,920.04
Dry (24%)	2,438.57
Critical (15%)	1,756.03

Alternative 2 021719

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	4,797.56
20%	4,176.20
30%	3,675.11
40%	3,517.23
50%	3,081.79
60%	2,633.54
70%	2,351.99
80%	2,198.38
90%	1,886.78
Long Term	
Full Simulation Period[a]	3,188.96
Water Year Types[b,c]	
Wet (32%)	4,409.96
Above Normal (16%)	3,506.52
Below Normal (13%)	2,957.88
Dry (24%)	2,345.98
Critical (15%)	1,816.21

Alternative 2 021719 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	-207.96
20%	-232.96
30%	-343.40
40%	-107.00
50%	-165.00
60%	-157.39
70%	-206.26
80%	-55.22
90%	-7.64
Long Term	
Full Simulation Period[a]	-137.44
Water Year Types[b,c]	
Wet (32%)	-284.18
Above Normal (16%)	-243.71
Below Normal (13%)	37.85
Dry (24%)	-92.59
Critical (15%)	60.18

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 4a-3. Annual CVP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	5,005.52
20%	4,409.15
30%	4,018.51
40%	3,624.22
50%	3,246.79
60%	2,790.93
70%	2,558.25
80%	2,253.60
90%	1,894.42
Long Term	
Full Simulation Period[a]	3,326.40
Water Year Types[b,c]	
Wet (32%)	4,694.15
Above Normal (16%)	3,750.24
Below Normal (13%)	2,920.04
Dry (24%)	2,438.57
Critical (15%)	1,756.03

Alternative 3 021719

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	4,799.88
20%	4,191.08
30%	3,675.93
40%	3,492.59
50%	3,106.34
60%	2,643.56
70%	2,364.43
80%	2,193.44
90%	1,928.46
Long Term	
Full Simulation Period[a]	3,195.10
Water Year Types[b,c]	
Wet (32%)	4,417.27
Above Normal (16%)	3,509.64
Below Normal (13%)	2,959.98
Dry (24%)	2,360.73
Critical (15%)	1,812.46

Alternative 3 021719 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	-205.64
20%	-218.07
30%	-342.58
40%	-131.64
50%	-140.44
60%	-147.38
70%	-193.82
80%	-60.16
90%	34.04
Long Term	
Full Simulation Period[a]	-131.30
Water Year Types[b,c]	
Wet (32%)	-276.88
Above Normal (16%)	-240.60
Below Normal (13%)	39.94
Dry (24%)	-77.84
Critical (15%)	56.43

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 4a-4. Annual CVP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	5,005.52
20%	4,409.15
30%	4,018.51
40%	3,624.22
50%	3,246.79
60%	2,790.93
70%	2,558.25
80%	2,253.60
90%	1,894.42
Long Term	
Full Simulation Period[a]	3,326.40
Water Year Types[b,c]	
Wet (32%)	4,694.15
Above Normal (16%)	3,750.24
Below Normal (13%)	2,920.04
Dry (24%)	2,438.57
Critical (15%)	1,756.03

Alternative 4 043019

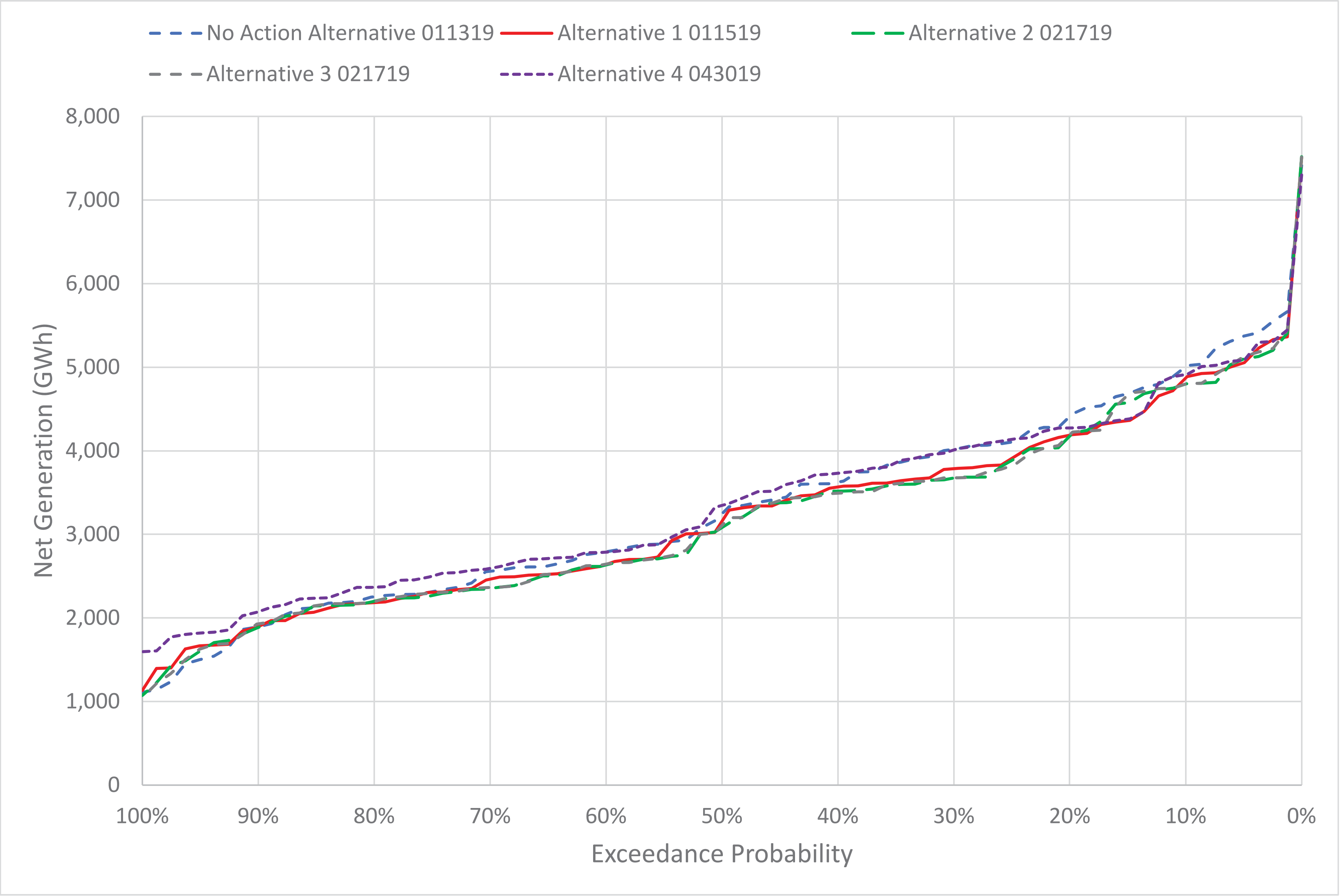
Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	4,912.27
20%	4,272.70
30%	4,009.23
40%	3,731.19
50%	3,345.98
60%	2,787.88
70%	2,593.15
80%	2,367.77
90%	2,074.53
Long Term	
Full Simulation Period[a]	3,372.05
Water Year Types[b,c]	
Wet (32%)	4,541.78
Above Normal (16%)	3,814.70
Below Normal (13%)	3,066.09
Dry (24%)	2,567.77
Critical (15%)	1,979.06

Alternative 4 043019 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	-93.25
20%	-136.46
30%	-9.28
40%	106.96
50%	99.19
60%	-3.06
70%	34.90
80%	114.16
90%	180.11
Long Term	
Full Simulation Period[a]	45.65
Water Year Types[b,c]	
Wet (32%)	-152.37
Above Normal (16%)	64.46
Below Normal (13%)	146.05
Dry (24%)	129.20
Critical (15%)	223.03

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Figure 4a-1. October-September CVP Net Generation



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Table 6a-1. Annual SWP Total Generation

No Action Alternative 011319

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,284.08
20%	5,824.89
30%	5,185.98
40%	4,353.40
50%	4,082.44
60%	3,463.96
70%	3,000.77
80%	2,541.22
90%	1,977.63
Long Term	
Full Simulation Period[a]	4,073.86
Water Year Types[b,c]	
Wet (32%)	6,021.83
Above Normal (16%)	4,422.83
Below Normal (13%)	3,772.55
Dry (24%)	2,854.12
Critical (15%)	1,784.30

Alternative 1 011519

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,665.89
20%	5,972.50
30%	5,402.33
40%	4,904.57
50%	4,494.69
60%	3,802.85
70%	3,213.03
80%	2,690.18
90%	2,026.97
Long Term	
Full Simulation Period[a]	4,348.89
Water Year Types[b,c]	
Wet (32%)	6,169.60
Above Normal (16%)	4,904.85
Below Normal (13%)	4,300.43
Dry (24%)	3,099.15
Critical (15%)	1,929.03

Alternative 1 011519 minus No Action Alternative

Statistic	Generation (GWh)
Probability of Exceedance[a]	
10%	381.82
20%	147.60
30%	216.35
40%	551.18
50%	412.25
60%	338.89
70%	212.26
80%	148.96
90%	49.34
Long Term	
Full Simulation Period[a]	275.03
Water Year Types[b,c]	
Wet (32%)	147.77
Above Normal (16%)	482.02
Below Normal (13%)	527.88
Dry (24%)	245.03
Critical (15%)	144.73

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 6a-2. Annual SWP Total Generation

No Action Alternative 011319

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,284.08
20%	5,824.89
30%	5,185.98
40%	4,353.40
50%	4,082.44
60%	3,463.96
70%	3,000.77
80%	2,541.22
90%	1,977.63
Long Term	
Full Simulation Period[a]	4,073.86
Water Year Types[b,c]	
Wet (32%)	6,021.83
Above Normal (16%)	4,422.83
Below Normal (13%)	3,772.55
Dry (24%)	2,854.12
Critical (15%)	1,784.30

Alternative 2 021719

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,638.20
20%	6,155.94
30%	5,762.50
40%	5,338.05
50%	4,872.73
60%	4,296.47
70%	3,633.33
80%	3,228.39
90%	2,356.61
Long Term	
Full Simulation Period[a]	4,679.35
Water Year Types[b,c]	
Wet (32%)	6,349.91
Above Normal (16%)	5,281.17
Below Normal (13%)	4,683.30
Dry (24%)	3,570.03
Critical (15%)	2,253.10

Alternative 2 021719 minus No Action Alternative

Statistic	Generation (GWh)
Probability of Exceedance[a]	
10%	354.12
20%	331.05
30%	576.52
40%	984.66
50%	790.29
60%	832.51
70%	632.56
80%	687.17
90%	378.98
Long Term	
Full Simulation Period[a]	605.49
Water Year Types[b,c]	
Wet (32%)	328.08
Above Normal (16%)	858.34
Below Normal (13%)	910.75
Dry (24%)	715.91
Critical (15%)	468.80

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 6a-3. Annual SWP Total Generation

No Action Alternative 011319

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,284.08
20%	5,824.89
30%	5,185.98
40%	4,353.40
50%	4,082.44
60%	3,463.96
70%	3,000.77
80%	2,541.22
90%	1,977.63
Long Term	
Full Simulation Period[a]	4,073.86
Water Year Types[b,c]	
Wet (32%)	6,021.83
Above Normal (16%)	4,422.83
Below Normal (13%)	3,772.55
Dry (24%)	2,854.12
Critical (15%)	1,784.30

Alternative 3 021719

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,544.20
20%	6,156.43
30%	5,795.58
40%	5,329.02
50%	4,922.56
60%	4,271.76
70%	3,600.85
80%	3,184.61
90%	2,379.93
Long Term	
Full Simulation Period[a]	4,658.24
Water Year Types[b,c]	
Wet (32%)	6,308.22
Above Normal (16%)	5,264.80
Below Normal (13%)	4,676.81
Dry (24%)	3,559.45
Critical (15%)	2,240.48

Alternative 3 021719 minus No Action Alternative

Statistic	Generation (GWh)
Probability of Exceedance[a]	
10%	260.12
20%	331.54
30%	609.60
40%	975.62
50%	840.12
60%	807.80
70%	600.08
80%	643.39
90%	402.29
Long Term	
Full Simulation Period[a]	584.38
Water Year Types[b,c]	
Wet (32%)	286.39
Above Normal (16%)	841.97
Below Normal (13%)	904.26
Dry (24%)	705.33
Critical (15%)	456.18

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 6a-4. Annual SWP Total Generation

No Action Alternative 011319

Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,284.08
20%	5,824.89
30%	5,185.98
40%	4,353.40
50%	4,082.44
60%	3,463.96
70%	3,000.77
80%	2,541.22
90%	1,977.63
Long Term	
Full Simulation Period[a]	4,073.86
Water Year Types[b,c]	
Wet (32%)	6,021.83
Above Normal (16%)	4,422.83
Below Normal (13%)	3,772.55
Dry (24%)	2,854.12
Critical (15%)	1,784.30

Alternative 4 043019

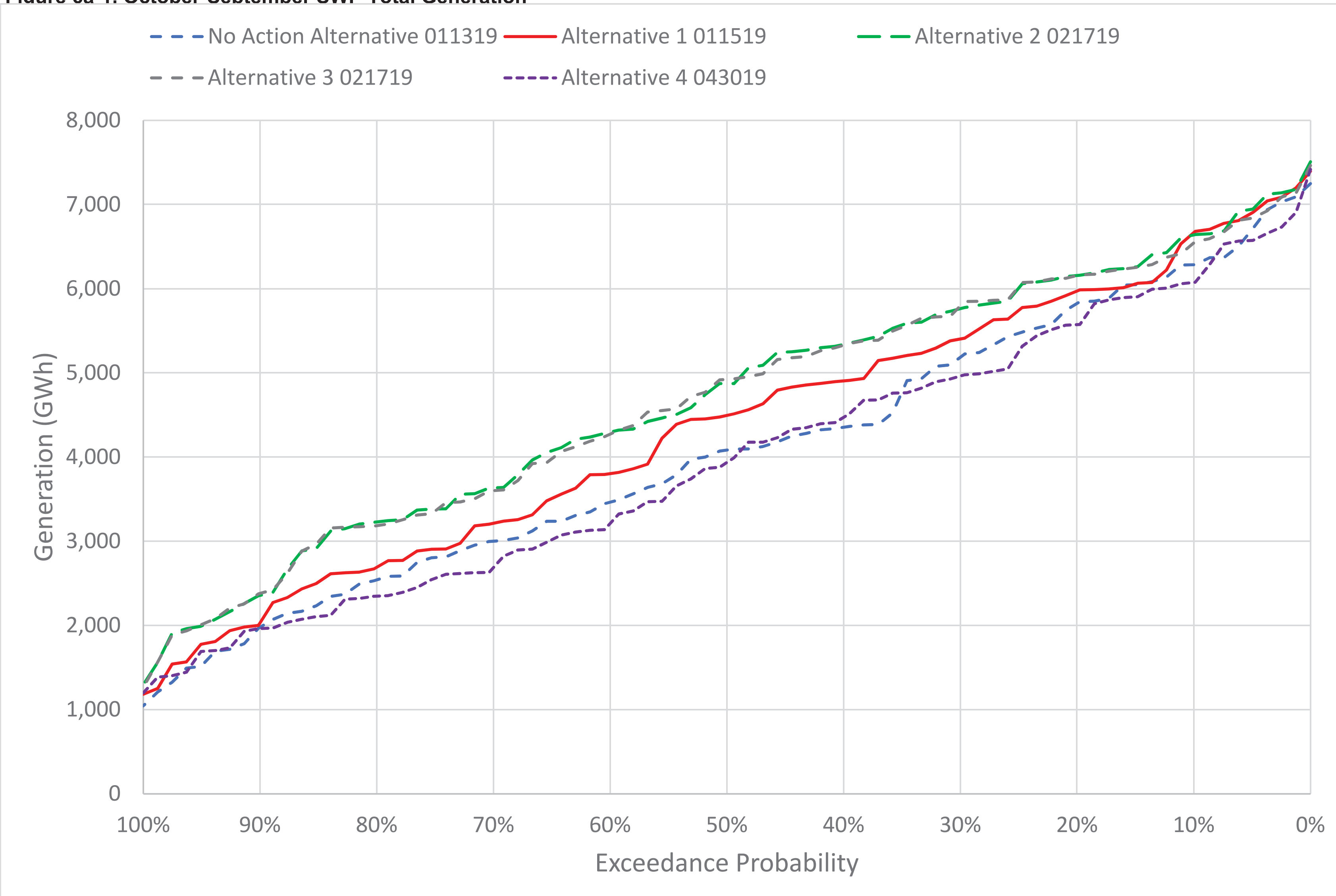
Statistic	Generation (GWh)
Probability of Exceedance	
10%	6,074.59
20%	5,572.99
30%	4,962.58
40%	4,471.88
50%	3,935.93
60%	3,211.86
70%	2,686.12
80%	2,347.67
90%	1,963.40
Long Term	
Full Simulation Period[a]	3,970.60
Water Year Types[b,c]	
Wet (32%)	5,870.61
Above Normal (16%)	4,412.76
Below Normal (13%)	3,757.51
Dry (24%)	2,643.68
Critical (15%)	1,781.76

Alternative 4 043019 minus No Action Alternative

Statistic	Generation (GWh)
Probability of Exceedance[a]	
10%	-209.49
20%	-251.90
30%	-223.40
40%	118.49
50%	-146.51
60%	-252.10
70%	-314.65
80%	-193.55
90%	-14.23
Long Term	
Full Simulation Period[a]	-103.26
Water Year Types[b,c]	
Wet (32%)	-151.21
Above Normal (16%)	-10.07
Below Normal (13%)	-15.04
Dry (24%)	-210.44
Critical (15%)	-2.54

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Figure 6a-1. October-September SWP Total Generation



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Table 7a-1. Annual SWP Total Energy Use

No Action Alternative 011319

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	10,582.90
20%	9,671.49
30%	8,884.03
40%	8,377.41
50%	7,442.86
60%	6,643.33
70%	5,829.12
80%	4,909.77
90%	3,533.14
Long Term	
Full Simulation Period[a]	7,303.93
Water Year Types[b,c]	
Wet (32%)	9,918.66
Above Normal (16%)	8,000.56
Below Normal (13%)	7,504.91
Dry (24%)	5,611.86
Critical (15%)	3,519.90

Alternative 1 011519

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	11,790.33
20%	11,083.62
30%	10,315.87
40%	9,863.44
50%	9,089.36
60%	7,879.63
70%	6,376.60
80%	5,438.63
90%	4,134.89
Long Term	
Full Simulation Period[a]	8,376.53
Water Year Types[b,c]	
Wet (32%)	11,029.32
Above Normal (16%)	9,682.99
Below Normal (13%)	8,990.52
Dry (24%)	6,360.49
Critical (15%)	4,010.72

Alternative 1 011519 minus No Action Alternative

Statistic	Energy Use (GWh)
Probability of Exceedance[a]	
10%	1,207.42
20%	1,412.12
30%	1,431.84
40%	1,486.04
50%	1,646.49
60%	1,236.29
70%	547.48
80%	528.86
90%	601.76
Long Term	
Full Simulation Period[a]	1,072.60
Water Year Types[b,c]	
Wet (32%)	1,110.66
Above Normal (16%)	1,682.43
Below Normal (13%)	1,485.60
Dry (24%)	748.63
Critical (15%)	490.83

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 7a-2. Annual SWP Total Energy Use

No Action Alternative 011319

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	10,582.90
20%	9,671.49
30%	8,884.03
40%	8,377.41
50%	7,442.86
60%	6,643.33
70%	5,829.12
80%	4,909.77
90%	3,533.14
Long Term	
Full Simulation Period[a]	7,303.93
Water Year Types[b,c]	
Wet (32%)	9,918.66
Above Normal (16%)	8,000.56
Below Normal (13%)	7,504.91
Dry (24%)	5,611.86
Critical (15%)	3,519.90

Alternative 2 021719

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	12,433.73
20%	12,076.18
30%	11,705.30
40%	11,301.89
50%	10,289.41
60%	9,518.76
70%	7,931.55
80%	7,223.37
90%	5,463.00
Long Term	
Full Simulation Period[a]	9,629.94
Water Year Types[b,c]	
Wet (32%)	11,928.61
Above Normal (16%)	11,241.84
Below Normal (13%)	10,395.90
Dry (24%)	7,947.54
Critical (15%)	5,005.14

Alternative 2 021719 minus No Action Alternative

Statistic	Energy Use (GWh)
Probability of Exceedance[a]	
10%	1,850.83
20%	2,404.68
30%	2,821.26
40%	2,924.49
50%	2,846.55
60%	2,875.43
70%	2,102.42
80%	2,313.60
90%	1,929.86
Long Term	
Full Simulation Period[a]	2,326.01
Water Year Types[b,c]	
Wet (32%)	2,009.95
Above Normal (16%)	3,241.28
Below Normal (13%)	2,890.99
Dry (24%)	2,335.68
Critical (15%)	1,485.25

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 7a-3. Annual SWP Total Energy Use

No Action Alternative 011319

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	10,582.90
20%	9,671.49
30%	8,884.03
40%	8,377.41
50%	7,442.86
60%	6,643.33
70%	5,829.12
80%	4,909.77
90%	3,533.14
Long Term	
Full Simulation Period[a]	7,303.93
Water Year Types[b,c]	
Wet (32%)	9,918.66
Above Normal (16%)	8,000.56
Below Normal (13%)	7,504.91
Dry (24%)	5,611.86
Critical (15%)	3,519.90

Alternative 3 021719

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	12,332.32
20%	11,970.53
30%	11,593.11
40%	11,124.81
50%	10,320.72
60%	9,524.98
70%	7,905.88
80%	7,165.26
90%	5,481.35
Long Term	
Full Simulation Period[a]	9,556.56
Water Year Types[b,c]	
Wet (32%)	11,809.01
Above Normal (16%)	11,168.22
Below Normal (13%)	10,374.46
Dry (24%)	7,894.82
Critical (15%)	4,950.09

Alternative 3 021719 minus No Action Alternative

Statistic	Energy Use (GWh)
Probability of Exceedance[a]	
10%	1,749.41
20%	2,299.04
30%	2,709.08
40%	2,747.40
50%	2,877.86
60%	2,881.65
70%	2,076.75
80%	2,255.49
90%	1,948.21
Long Term	
Full Simulation Period[a]	2,252.63
Water Year Types[b,c]	
Wet (32%)	1,890.36
Above Normal (16%)	3,167.67
Below Normal (13%)	2,869.55
Dry (24%)	2,282.96
Critical (15%)	1,430.19

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 7a-4. Annual SWP Total Energy Use

No Action Alternative 011319

Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	10,582.90
20%	9,671.49
30%	8,884.03
40%	8,377.41
50%	7,442.86
60%	6,643.33
70%	5,829.12
80%	4,909.77
90%	3,533.14
Long Term	
Full Simulation Period[a]	7,303.93
Water Year Types[b,c]	
Wet (32%)	9,918.66
Above Normal (16%)	8,000.56
Below Normal (13%)	7,504.91
Dry (24%)	5,611.86
Critical (15%)	3,519.90

Alternative 4 043019

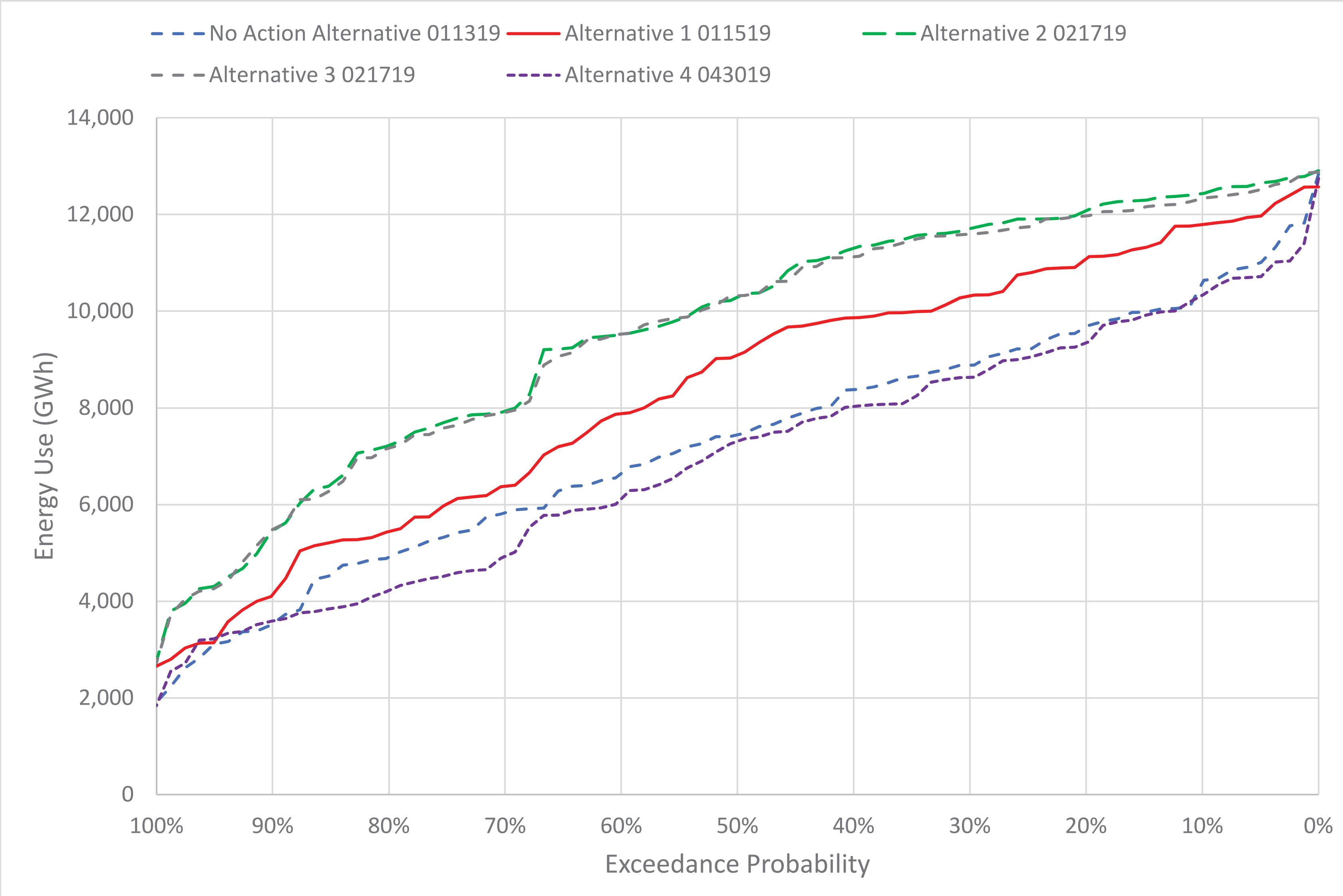
Statistic	Energy Use (GWh)
Probability of Exceedance	
10%	10,329.96
20%	9,344.50
30%	8,631.45
40%	8,028.49
50%	7,307.78
60%	6,117.49
70%	4,927.52
80%	4,220.65
90%	3,591.25
Long Term	
Full Simulation Period[a]	6,971.85
Water Year Types[b,c]	
Wet (32%)	9,732.14
Above Normal (16%)	7,748.28
Below Normal (13%)	7,040.13
Dry (24%)	4,919.35
Critical (15%)	3,508.37

Alternative 4 043019 minus No Action Alternative

Statistic	Energy Use (GWh)
Probability of Exceedance[a]	
10%	-252.95
20%	-326.99
30%	-252.58
40%	-348.92
50%	-135.08
60%	-525.85
70%	-901.61
80%	-689.12
90%	58.11
Long Term	
Full Simulation Period[a]	-332.08
Water Year Types[b,c]	
Wet (32%)	-186.52
Above Normal (16%)	-252.28
Below Normal (13%)	-464.79
Dry (24%)	-692.51
Critical (15%)	-11.53

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Figure 7a-1. October-September SWP Total Energy Use



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Table 8a-1. Annual SWP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	-1,713.81
20%	-2,467.17
30%	-2,652.72
40%	-2,910.10
50%	-3,151.25
60%	-3,440.27
70%	-3,843.79
80%	-4,302.08
90%	-4,614.93
Long Term	
Full Simulation Period[a]	-3,230.07
Water Year Types[b,c]	
Wet (32%)	-3,896.83
Above Normal (16%)	-3,577.73
Below Normal (13%)	-3,732.36
Dry (24%)	-2,757.74
Critical (15%)	-1,735.60

Alternative 1 011519

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	-2,172.24
20%	-2,700.65
30%	-3,185.62
40%	-3,894.36
50%	-4,331.72
60%	-4,691.95
70%	-4,938.81
80%	-5,149.85
90%	-5,480.04
Long Term	
Full Simulation Period[a]	-4,027.64
Water Year Types[b,c]	
Wet (32%)	-4,859.72
Above Normal (16%)	-4,778.14
Below Normal (13%)	-4,690.09
Dry (24%)	-3,261.34
Critical (15%)	-2,081.69

Alternative 1 011519 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	-458.43
20%	-233.48
30%	-532.90
40%	-984.26
50%	-1,180.47
60%	-1,251.69
70%	-1,095.02
80%	-847.77
90%	-865.12
Long Term	
Full Simulation Period[a]	-797.57
Water Year Types[b,c]	
Wet (32%)	-962.89
Above Normal (16%)	-1,200.41
Below Normal (13%)	-957.73
Dry (24%)	-503.60
Critical (15%)	-346.10

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 8a-2. Annual SWP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	-1,713.81
20%	-2,467.17
30%	-2,652.72
40%	-2,910.10
50%	-3,151.25
60%	-3,440.27
70%	-3,843.79
80%	-4,302.08
90%	-4,614.93
Long Term	
Full Simulation Period[a]	-3,230.07
Water Year Types[b,c]	
Wet (32%)	-3,896.83
Above Normal (16%)	-3,577.73
Below Normal (13%)	-3,732.36
Dry (24%)	-2,757.74
Critical (15%)	-1,735.60

Alternative 2 021719

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	-3,122.79
20%	-3,974.67
30%	-4,486.19
40%	-4,917.49
50%	-5,192.21
60%	-5,454.32
70%	-5,741.49
80%	-6,132.43
90%	-6,450.53
Long Term	
Full Simulation Period[a]	-4,950.59
Water Year Types[b,c]	
Wet (32%)	-5,578.70
Above Normal (16%)	-5,960.67
Below Normal (13%)	-5,712.60
Dry (24%)	-4,377.51
Critical (15%)	-2,752.04

Alternative 2 021719 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	-1,408.98
20%	-1,507.50
30%	-1,833.47
40%	-2,007.38
50%	-2,040.96
60%	-2,014.05
70%	-1,897.70
80%	-1,830.36
90%	-1,835.60
Long Term	
Full Simulation Period[a]	-1,720.52
Water Year Types[b,c]	
Wet (32%)	-1,681.87
Above Normal (16%)	-2,382.94
Below Normal (13%)	-1,980.24
Dry (24%)	-1,619.77
Critical (15%)	-1,016.44

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 8a-3. Annual SWP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	-1,713.81
20%	-2,467.17
30%	-2,652.72
40%	-2,910.10
50%	-3,151.25
60%	-3,440.27
70%	-3,843.79
80%	-4,302.08
90%	-4,614.93
Long Term	
Full Simulation Period[a]	-3,230.07
Water Year Types[b,c]	
Wet (32%)	-3,896.83
Above Normal (16%)	-3,577.73
Below Normal (13%)	-3,732.36
Dry (24%)	-2,757.74
Critical (15%)	-1,735.60

Alternative 3 021719

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	-3,102.57
20%	-3,941.96
30%	-4,339.02
40%	-4,867.11
50%	-5,205.59
60%	-5,411.52
70%	-5,734.02
80%	-6,069.29
90%	-6,255.16
Long Term	
Full Simulation Period[a]	-4,898.32
Water Year Types[b,c]	
Wet (32%)	-5,500.79
Above Normal (16%)	-5,903.42
Below Normal (13%)	-5,697.65
Dry (24%)	-4,335.37
Critical (15%)	-2,709.60

Alternative 3 021719 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	-1,388.76
20%	-1,474.79
30%	-1,686.30
40%	-1,957.01
50%	-2,054.34
60%	-1,971.26
70%	-1,890.22
80%	-1,767.21
90%	-1,640.23
Long Term	
Full Simulation Period[a]	-1,668.24
Water Year Types[b,c]	
Wet (32%)	-1,603.96
Above Normal (16%)	-2,325.70
Below Normal (13%)	-1,965.29
Dry (24%)	-1,577.62
Critical (15%)	-974.01

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 8a-4. Annual SWP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	-1,713.81
20%	-2,467.17
30%	-2,652.72
40%	-2,910.10
50%	-3,151.25
60%	-3,440.27
70%	-3,843.79
80%	-4,302.08
90%	-4,614.93
Long Term	
Full Simulation Period[a]	-3,230.07
Water Year Types[b,c]	
Wet (32%)	-3,896.83
Above Normal (16%)	-3,577.73
Below Normal (13%)	-3,732.36
Dry (24%)	-2,757.74
Critical (15%)	-1,735.60

Alternative 4 043019

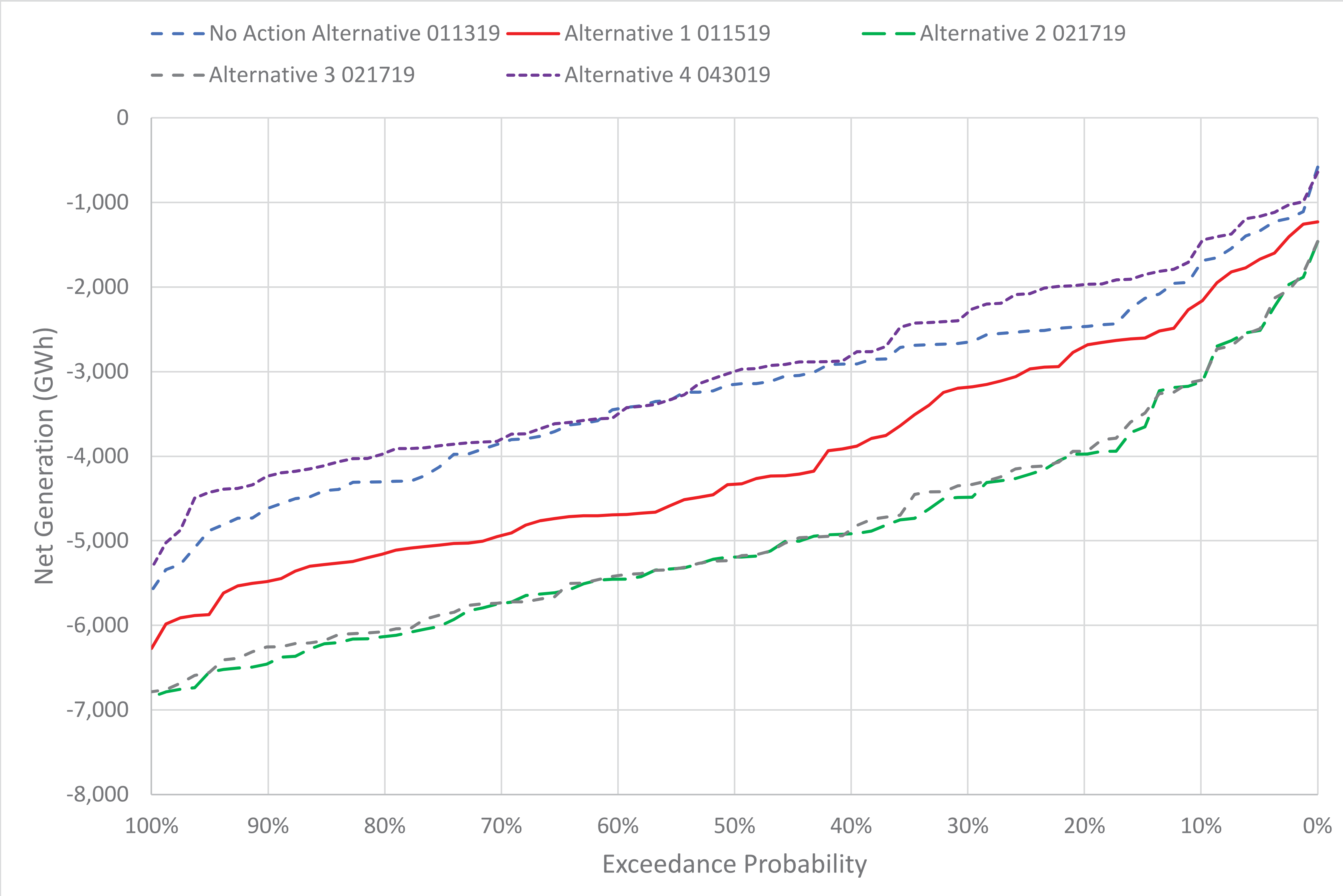
Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	-1,471.41
20%	-1,970.58
30%	-2,302.01
40%	-2,808.27
50%	-2,999.34
60%	-3,501.82
70%	-3,799.47
80%	-3,963.69
90%	-4,234.16
Long Term	
Full Simulation Period[a]	-3,001.26
Water Year Types[b,c]	
Wet (32%)	-3,861.53
Above Normal (16%)	-3,335.52
Below Normal (13%)	-3,282.62
Dry (24%)	-2,275.67
Critical (15%)	-1,726.61

Alternative 4 043019 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	242.40
20%	496.59
30%	350.71
40%	101.83
50%	151.91
60%	-61.55
70%	44.32
80%	338.38
90%	380.76
Long Term	
Full Simulation Period[a]	228.82
Water Year Types[b,c]	
Wet (32%)	35.30
Above Normal (16%)	242.21
Below Normal (13%)	449.74
Dry (24%)	482.07
Critical (15%)	8.99

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Figure 8a-1. October-September SWP Net Generation



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Table 9a-1. Annual CVP and SWP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	1,395.72
20%	983.07
30%	634.49
40%	392.28
50%	218.67
60%	58.11
70%	-350.33
80%	-556.33
90%	-1,359.86
Long Term	
Full Simulation Period[a]	96.33
Water Year Types[b,c]	
Wet (32%)	797.32
Above Normal (16%)	172.51
Below Normal (13%)	-812.32
Dry (24%)	-319.17
Critical (15%)	20.43

Alternative 1 011519

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	306.00
20%	54.68
30%	-266.97
40%	-544.14
50%	-723.73
60%	-887.79
70%	-1,189.16
80%	-1,645.84
90%	-2,109.97
Long Term	
Full Simulation Period[a]	-810.40
Water Year Types[b,c]	
Wet (32%)	-425.04
Above Normal (16%)	-1,183.43
Below Normal (13%)	-1,742.08
Dry (24%)	-893.48
Critical (15%)	-248.71

Alternative 1 011519 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	-1,089.72
20%	-928.39
30%	-901.46
40%	-936.42
50%	-942.40
60%	-945.90
70%	-838.84
80%	-1,089.51
90%	-750.11
Long Term	
Full Simulation Period[a]	-906.73
Water Year Types[b,c]	
Wet (32%)	-1,222.36
Above Normal (16%)	-1,355.94
Below Normal (13%)	-929.76
Dry (24%)	-574.31
Critical (15%)	-269.14

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 9a-2. Annual CVP and SWP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	1,395.72
20%	983.07
30%	634.49
40%	392.28
50%	218.67
60%	58.11
70%	-350.33
80%	-556.33
90%	-1,359.86
Long Term	
Full Simulation Period[a]	96.33
Water Year Types[b,c]	
Wet (32%)	797.32
Above Normal (16%)	172.51
Below Normal (13%)	-812.32
Dry (24%)	-319.17
Critical (15%)	20.43

Alternative 2 021719

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	-366.57
20%	-904.18
30%	-1,211.69
40%	-1,465.01
50%	-1,678.48
60%	-2,048.84
70%	-2,422.66
80%	-2,812.30
90%	-3,102.21
Long Term	
Full Simulation Period[a]	-1,761.63
Water Year Types[b,c]	
Wet (32%)	-1,168.73
Above Normal (16%)	-2,454.15
Below Normal (13%)	-2,754.72
Dry (24%)	-2,031.53
Critical (15%)	-935.83

Alternative 2 021719 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	-1,762.29
20%	-1,887.25
30%	-1,846.18
40%	-1,857.30
50%	-1,897.15
60%	-2,106.96
70%	-2,072.33
80%	-2,255.98
90%	-1,742.36
Long Term	
Full Simulation Period[a]	-1,857.96
Water Year Types[b,c]	
Wet (32%)	-1,966.06
Above Normal (16%)	-2,626.66
Below Normal (13%)	-1,942.39
Dry (24%)	-1,712.36
Critical (15%)	-956.26

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 9a-3. Annual CVP and SWP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	1,395.72
20%	983.07
30%	634.49
40%	392.28
50%	218.67
60%	58.11
70%	-350.33
80%	-556.33
90%	-1,359.86
Long Term	
Full Simulation Period[a]	96.33
Water Year Types[b,c]	
Wet (32%)	797.32
Above Normal (16%)	172.51
Below Normal (13%)	-812.32
Dry (24%)	-319.17
Critical (15%)	20.43

Alternative 3 021719

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	-359.47
20%	-827.18
30%	-1,208.42
40%	-1,407.15
50%	-1,583.27
60%	-2,032.59
70%	-2,239.56
80%	-2,734.28
90%	-3,105.34
Long Term	
Full Simulation Period[a]	-1,703.22
Water Year Types[b,c]	
Wet (32%)	-1,083.52
Above Normal (16%)	-2,393.79
Below Normal (13%)	-2,737.67
Dry (24%)	-1,974.64
Critical (15%)	-897.14

Alternative 3 021719 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	-1,755.19
20%	-1,810.25
30%	-1,842.91
40%	-1,799.43
50%	-1,801.94
60%	-2,090.70
70%	-1,889.23
80%	-2,177.96
90%	-1,745.48
Long Term	
Full Simulation Period[a]	-1,799.55
Water Year Types[b,c]	
Wet (32%)	-1,880.85
Above Normal (16%)	-2,566.30
Below Normal (13%)	-1,925.35
Dry (24%)	-1,655.46
Critical (15%)	-917.58

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Table 9a-4. Annual CVP and SWP Net Generation

No Action Alternative 011319

Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	1,395.72
20%	983.07
30%	634.49
40%	392.28
50%	218.67
60%	58.11
70%	-350.33
80%	-556.33
90%	-1,359.86
Long Term	
Full Simulation Period[a]	96.33
Water Year Types[b,c]	
Wet (32%)	797.32
Above Normal (16%)	172.51
Below Normal (13%)	-812.32
Dry (24%)	-319.17
Critical (15%)	20.43

Alternative 4 043019

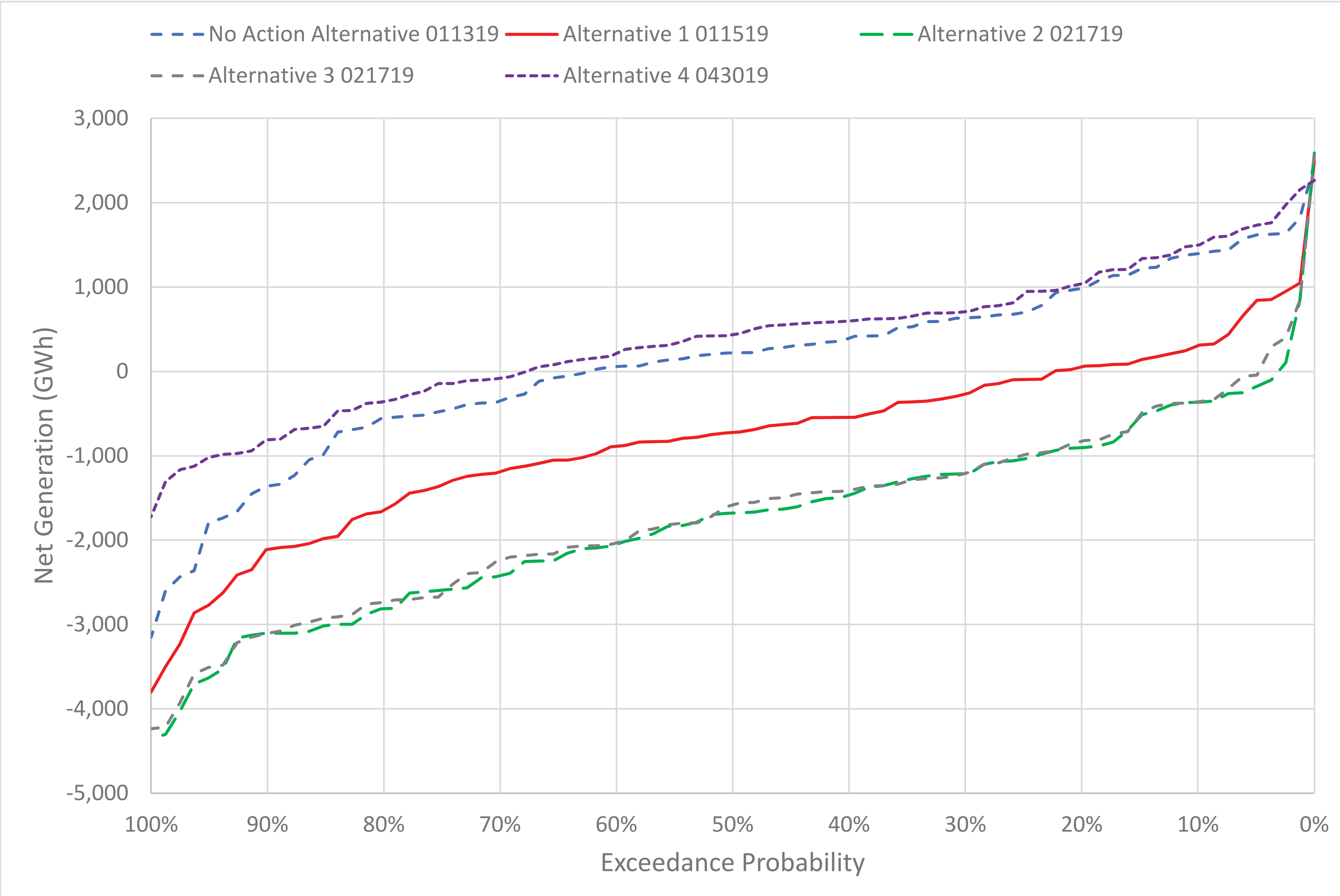
Statistic	Net Generation (GWh)
Probability of Exceedance	
10%	1,497.18
20%	1,038.47
30%	707.51
40%	597.31
50%	435.19
60%	212.49
70%	-80.67
80%	-357.98
90%	-810.41
Long Term	
Full Simulation Period[a]	370.80
Water Year Types[b,c]	
Wet (32%)	680.25
Above Normal (16%)	479.18
Below Normal (13%)	-216.53
Dry (24%)	292.10
Critical (15%)	252.45

Alternative 4 043019 minus No Action Alternative

Statistic	Net Generation (GWh)
Probability of Exceedance[a]	
10%	101.46
20%	55.40
30%	73.02
40%	205.03
50%	216.52
60%	154.38
70%	269.66
80%	198.35
90%	549.45
Long Term	
Full Simulation Period[a]	274.47
Water Year Types[b,c]	
Wet (32%)	-117.07
Above Normal (16%)	306.67
Below Normal (13%)	595.79
Dry (24%)	611.27
Critical (15%)	232.02

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with calendar year - year type sorting.
d All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
e These are draft results meant for qualitative analysis and are subject to revision

Figure 9a-1. October-September CVP and SWP Net Generation



*All scenarios are simulated at ELT (Early Long-Term) Q5 with 2025 climate change and 15 cm sea level rise.
*These are draft results meant for qualitative analysis and are subject to revision.

Appendix V Noise and Vibration Technical Appendix

This appendix documents the noise and vibration technical analysis to support the impact analysis in the EIS.

V.1 Background

This section addresses noise effects associated with the proposed program. It describes the affected environment, potential noise and vibration effects that would result from the alternatives, and mitigation measures to minimize or avoid these effects. Key sources of data and information used in the preparation of this chapter are as follows:

- Roadway Construction Noise Model User's Guide (FHWA 2006).
- *Technical Noise Supplement to the Traffic Noise Analysis Protocol* (Caltrans 2013a).
- *Transportation and Construction-Induced Vibration Guidance Manual* (Caltrans 2013b).
- *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
- *Community Noise* (USEPA 1971).

V.1.1 Noise Terminology

- A brief background discussion of noise terminology follows.
- **Sound.** A vibratory disturbance created by a vibrating object, which, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear or a microphone.
- **Noise.** Sound that is loud, unpleasant, unexpected, or otherwise undesirable.
- **Decibel (dB).** A unitless measure of sound on a logarithmic scale, which indicates the squared ratio of sound pressure amplitude to a reference sound pressure amplitude. The reference pressure is 20 micro-pascals.
- **A-Weighted Decibel (dBA).** An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear. Table F-2 shows the range of typical dBA noise levels.
- **Equivalent Sound Level (L_{eq}).** The equivalent steady state sound level that in a stated period of time would contain the same acoustical energy.
- **Maximum and minimum sound levels (L_{max} and L_{min}).** The maximum and minimum sound levels measured during a measurement period.
- **Peak Sound Level (L_{peak}).** The highest instantaneous noise level (typically lasting less than about 1/32 of a second) during the measurement period.

- **Percentile-Exceeded Sound Level (L_{xx}).** The sound level exceeded "x" percent of a specific time period. For example, L_{10} is the relatively loud sound level exceeded only 10% of the time, while the L_{90} is a relatively quiet sound exceeded 90% of the time.

Table V.1-1 lists sound levels generated by common outdoor and indoor activities.

Table V.1-1. Typical A-Weighted Sound Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	—110—	Rock band
Jet flyover at 1,000 feet		
	—100—	
Gas lawnmower at 3 feet		
	—90—	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	—80—	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawnmower, 100 feet	—70—	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	—60—	
		Large business office
Quiet urban daytime	—50—	Dishwasher in next room
Quiet urban nighttime	—40—	Theater, large conference room (background)
Quiet suburban nighttime		
	—30—	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	—20—	
		Broadcast/recording studio
	—10—	
	—0—	

Source: Caltrans 2013a.
dBA = A-weighted decibel
mph = miles per hour

The perceptibility of a new noise source that intrudes into a background noise environment depends on the nature of the intruding sound compared to the background sound. In general, if the intruding sound has the same character as the background sound (e.g., an increase in continuous traffic noise compared to background continuous traffic noise), human sound perception is such that a change in sound level of 3 dB is just noticeable, a change of 5 dB is clearly noticeable, and a change of 10 dB is perceived as doubling or halving the sound level. However, if the intruding sound is of a character different from the background sound (e.g., construction noise in an otherwise quiet neighborhood), the intruding sound can be clearly discernible even if it raises the overall dBA noise level by less than 1 dB.

All of the alternatives (including No Action Alternative) would require use of conventional construction equipment to restore habitat, and to construct setback levees and other intervention measures. Table V.1-2 lists noise levels generated by representative types of construction equipment.

Table V.1-2. Typical Construction Equipment Noise Emission Levels

Equipment	Typical Noise Level (L_{max})[1]
Air Compressor	78
Backhoe	78
Compactor	83
Crane	81
Dozer	82
Dump Truck	76
Excavator	81
Forklift[3]	75
Front-End Loader	79
Grader	85
Haul Truck[2]	76
Maintainer[5]	77
Paver	77
Pickup Truck	75
Trackhoe[4]	78
Scraper	84
Tugboat	82
Water Truck[2]	76

Sources: FHWA 2006 and FTA 2018.
L_{max} = maximum sound level
1 dBA, A-weighted decibel level, measured at 50 feet.
2 Based on data for dump truck.
3 Based on data for pickup truck.
4 Based on data for backhoe.
5 Based on data for paver.

V.1.2 Vibration Terminology

Operation of heavy construction equipment creates seismic waves that radiate along the surface of the earth. These surface waves are perceptible as groundborne vibration. Vibration from operation of heavy equipment can potentially result in effects ranging from annoyance of people to damage of structures. As seismic waves travel outward from a vibration source, they excite the particles of rock and soil through which they pass and cause them to oscillate. The actual distance soil particles move is a fraction of an inch. The rate, or velocity at which these particles move is the commonly accepted descriptor of the vibration amplitude, referred to as the “peak particle velocity” (PPV) and expressed in units of inches per second. Variations in geology over an area result in differing vibration amplitudes by frequency, and propagation of vibration with distance. As with noise, vibration levels decrease (or attenuate) as distance from the source of vibration increases.

Table V.1-3 summarizes typical human response to prolonged steady state vibration such as that produced by typical nonimpact construction activity during earthmoving activity.

Table V.1-3. Human Response to Steady State Vibration

PPV	Human Response
3.6 (at 2 Hz)–0.4 (at 20 Hz)	Very disturbing
0.7 (at 2 Hz)–0.17 (at 20 Hz)	Disturbing
0.20	Potential damage to interior plaster walls
0.10	Strongly perceptible
0.035	Distinctly perceptible
0.012	Slightly perceptible

Source: Caltrans 2013b.
PPV = peak particle velocity
Hz = hertz

Table V.1-4 summarizes ground vibration levels generated by typical construction equipment.

Table V.1-4. Vibration Source Levels for Construction Equipment

Equipment	PPV at 25 feet
Vibratory roller	0.210
Large bulldozer	0.089
Loaded trucks	0.076
Jackhammer	0.035
Small bulldozer	0.003

Source: FTA 2018.
PPV = peak particle velocity

Vibration amplitude attenuates over distance and is a complex function of how energy is transferred into the ground and the soil conditions through which the vibration is traveling. Generally, groundborne vibration from heavy non-impact construction equipment such as the equipment types listed in Table V.1-5 is expected to be discernible only for very short distances from the construction site (up to 40 feet away).

V.1.3 Existing Noise and Vibration Environment

Construction equipment and hauling activities within the action area could potentially affect receptors in restoration and intervention areas extending through several counties, as listed below by region:

- Sacramento River region: counties of Butte, Colusa, El Dorado, Glenn, Nevada, Placer, Plumas, Shasta, Sutter, Tehama, and Yuba
- San Joaquin River region: counties of Fresno, Kern, Kings, Madera, Merced, Stanislaus, and Tulare

- Delta region: counties of Contra Costa, Sacramento, San Joaquin, Solano, and Yolo
- San Francisco Bay Area region: counties of Alameda, Napa, San Benito, and Santa Clara
- Central Coast region: counties of San Luis Obispo and Santa Barbara
- Southern California region: counties of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura

Background noise levels in the action area vary between rural and urban settings. Based on historical measured noise levels taken at representative rural and urban settings (USEPA 1971), it is assumed that existing 1-hour L_{eq} noise levels at the remote rural sites are in the range of 35–50 dBA during the day and 30–40 dBA at night. Daytime noise levels at sites located within small towns are assumed to be 50–55 dBA. Daytime noise levels at sites within 100 feet of high-volume freeways or highways are assumed to be 55–65 dBA (Caltrans 2013a). Sources of ambient noise in the action area include traffic, agricultural equipment, boats, and aircraft. Some locations in the action area are within airport land use planning or influence areas, and may experience ambient noise from aircraft arrivals and departures. Rail transportation corridors in the action area are a source of rail noise and vibration from freight and commuter trains. The influence of these sources of noise on ambient levels depends on the proximity of receivers to highways, rail corridors, airports, and developed areas.

Existing groundborne vibration levels would generally not be discernible at locations beyond the road shoulders of highways or freeways. Proposed construction activity is not expected to result in perceptible levels of vibration in sensitive buildings.

The action alternatives have a negligible potential to generate groundborne noise. In a few unusual cases (e.g., a railroad tunnel constructed underneath a concert hall) ground vibration transmitted through bedrock can cause nearby structures to vibrate and generate a low frequency rumble inside the structure. However, that unusual case is not relevant to the alternatives. Therefore, this effect is not discussed further.

V.1.4 General Types of Noise-Sensitive Land Uses

Noise-sensitive land uses generally are defined as locations where people reside or where the presence of elevated noise emissions could significantly affect the use of the land. Noise-sensitive land use may be near individual construction sites and staging areas, or near access roads used for substantial haul truck traffic. Typical sensitive receptors include residences, schools, hospitals, and places of worship. Noise-sensitive receptors can also include parks, where quiet conditions are important for normal conversation between park users, and outdoor use areas at businesses, such as outdoor dining areas at restaurants.

V.1.5 Regulatory Guidance for Noise and Vibration Assessment

Construction noise and vibration effects have been assessed using analysis methods recommended by the U.S. Department of Transportation for construction of large public works infrastructure projects. The Federal Transit Administration has developed methods for evaluating construction noise levels, described in the *Transit Noise and Vibration Impact Assessment Manual* (2018). While these methods are not standardized criteria, they are often applied as guidelines for noise limits at sensitive land uses to describe levels that may potentially result in negative community reaction.

For residences, the recommended standard noise limits are 80 dBA Leq (8-hour) during daytime hours (7:00 a.m. to 10:00 p.m.), and 70 dBA Leq (8-hour) during nighttime hours (10:00 p.m. to 7:00 a.m.) These standards are appropriate for use in an impact assessment, or where no noise level criteria have been set by the applicable local jurisdiction.

Groundborne vibration was assessed using the methodology discussed in Federal Highway Administration and Federal Transit Administration guidance. Groundborne vibration during project construction is generally localized around the site of construction activity. Vibration produced at a level high enough to be perceptible inside building structures can result in annoyance and sleep disturbance to occupants of buildings. Vibration can also potentially result in building damage, depending on the level of vibration and the type of construction of the affected structures. A vibration level of 0.10 inches/second PPV is considered to be “strongly perceptible” during prolonged construction activity using non-impact equipment (Caltrans 2013b). A vibration level exceeding 0.20 inches/second PPV may potentially result in damage to non-engineered timber and masonry buildings. (FTA 2018).

Program-specific noise and vibration thresholds were developed for this effects analysis. Program- or Project-level activities would be considered to result in a significant noise or vibration effect if one or more of the following were predicted to occur:

- A significant noise effect may be considered to occur if construction noise is predicted to exceed a daytime (7 a.m. to 7 p.m.) exterior noise level (1-hour L_{eq}) of 70 dBA, or an evening/nighttime (7 p.m. to 7 a.m.) exterior noise level of 60 dBA (1-hour L_{eq}). These criteria were derived by subtracting 10 dBA from the construction noise limits specified in the federal guidance described above (FTA 2018). The minus-10 dBA adjustment was made to the Federal Transit Administration’s noise level criteria to account for the rural nature of much of the action area, where construction equipment would be more noticeable above surrounding existing ambient levels, and background noise levels are likely much lower than urban areas where transit projects are usually constructed.
- Project-related haul truck traffic is predicted to cause traffic noise to increase of 12 dBA (peak-hour L_{eq}) or more compared to the existing peak-hour L_{eq} at any noise sensitive receptor within 500 feet of the access road. The California Department of Transportation defines a 12 dB noise increase as a “substantial” noise increase. (Caltrans 2013a).
- Construction equipment is predicted to produce vibration levels that would be “strongly perceptible” inside of buildings (i.e., exceeding 0.10 inch/second PPV) for more than one hour per day.

V.2 Evaluation of Alternatives

This section describes the technical background for the evaluation of environmental consequences associated with the action alternatives and the No Action Alternative.

V.2.1 Methods and Tools

Construction activities (including construction equipment used for long-term maintenance) are the predominant source of noise and vibration associated with the program. Based on anticipated construction equipment types and methods of operation, construction noise levels for various elements of the construction process have been calculated. The magnitude of construction noise effects at noise-sensitive land uses depends on the type of construction activity, the noise level generated by various pieces of construction equipment, the distance between the activity and noise-sensitive land uses, and whether the ground between the source and the receiver is "acoustically hard" (e.g., pavement, reflective water) or "acoustically soft" (e.g., unpaved soil). Methods for calculation of construction equipment noise are based on U.S. Department of Transportation guidance.

V.2.2 No Action Alternative

The No Action Alternative would include restoration of 8,000 acres of Delta habitat. Restoration activities would require use of trucks and heavy earth moving equipment, which would potentially result in a temporary increase in noise levels at nearby sensitive receivers. Haul trucks would result in an increase in traffic noise on local roads.

V.2.3 Alternative 1

V.2.3.1 *Project-Level Effects*

Temporary and permanent equipment noise and vibration levels would be the same as the No Action Alternative. There would be no project-level effects.

V.2.3.2 *Program-Level Effects*

Potential exposure of sensitive receptors to temporary construction-related noise.

Habitat restoration and interventions would involve temporary use of construction equipment, which may result in increased ambient noise levels at sensitive receptor locations relative to the No Action Alternative. Tidal habitat restoration in the Bay-Delta region would be the same as that under the No Action Alternative and would have no increased noise level effects under Alternative 1. Construction activities are not expected to result in discernible vibration levels inside of structures.

Potential exposure of sensitive receptors along truck haul routes to a temporary increase in traffic noise

Habitat restoration, interventions, and construction activities could temporarily increase truck traffic along truck haul routes. Activities with the greatest potential for truck haul routes that would increase traffic noise are spawning and rearing habitat restoration, Delta Cross Chanel gate improvements, Delta Fish Species Conservation Hatchery construction, and the Tracy Fish Collection Facility and Skinner Fish Protective Facility improvements. Truck haul routes will be determined prior to construction; the exposure of sensitive receptors will be taken into consideration to the extent possible.

Potential exposure of sensitive receptors to intermittent noise due to long-term maintenance activity including emergency repair activities

Increased levels of long-term maintenance are anticipated for spawning and rearing habitat restoration and Delta Fish Species Conservation Hatchery production. The frequency and magnitude of maintenance will be determined for each project at a later date and captured in an operations and maintenance plan. Maintenance of the Delta Cross Channel gate and Tracy Fish Collection and Skinner Fish Protective Facilities is not expected to be greater than that under the No Action Alternative because operations and maintenance would continue in much the same manner even with the facility upgrades.

V.1.1 Alternative 2

V.2.3.3 *Project-Level Effects*

Temporary and permanent equipment noise and vibration levels would be the same as the No Action Alternative. There would be no project-level effects.

V.2.3.4 *Program-Level Effects*

Temporary and permanent equipment noise and vibration levels would be the same as the No Action Alternative. Alternative 2 does not include any program-level habitat restoration and would therefore result in less noise impacts than other action alternatives that include restoration and construction activities. There would be no program-level noise effects.

V.2.4 Alternative 3

V.2.4.1 *Project-Level Effects*

Temporary and permanent equipment noise and vibration levels would be the same as the No Action Alternative. There would be no project-level effects.

V.2.4.2 *Program-Level Effects*

Sensitive receptors could be exposed to temporary construction-related noise.

Restoration and interventions under Alternative 3 would be greater than those under Alternative 1 because the construction of 25,000 acres of habitat would be expected to involve an increased use of construction equipment over a larger area for a longer period of time. Program-level habitat restoration under Alternative 3 would involve temporary use of construction equipment such as trucks, excavators, bulldozers, and other earthmoving equipment, which may potentially result in increased ambient noise levels at more sensitive receptor locations compared to the No Action Alternative. Noise effects could occur within approximately 0.25 mile (1,320 feet) of the activity. Construction equipment such as graders, concrete mixers, and earthmoving equipment would be used for upgrades to the Tracy Fish Collection and Skinner Fish Protective Facilities, which may result in perceptible increases to ambient noise levels at noise-sensitive receivers located within 0.25 mile of these facilities. Because there is a greater potential for increased noise levels at noise-sensitive receivers relative to Alternative 1, effects under Alternative 3 would be greater than under Alternative 1.

Sensitive receptors along truck haul routes could be exposed to a temporary substantial increase in traffic noise.

Hauling activities under Alternative 3 would be greater than those under Alternative 1 because the construction of 25,000 acres of habitat would involve increased material transport over a larger area for a longer period of time. Transport of materials would serve habitat restoration projects at an increased level compared to Alternative 1, in addition to upgrades to the Tracy and Skinner fish facilities. Activities under Alternative 3 would involve temporary use of haul trucks that may result in increased ambient noise levels at more sensitive receptor locations relative to the No Action Alternative. Truck haul routes will be determined prior to construction; the exposure of sensitive receptors will be taken into consideration to the extent possible.

Sensitive receptors could be exposed to intermittent noise due to long-term maintenance activity including emergency repair activities.

Maintenance activities under Alternative 3 would be greater than those under Alternative 1 because of the additional 25,000 acres of habitat that would be constructed. Maintenance activities for 25,000 acres of habitat would be greater than those carried out under the No Action Alternative. The frequency and magnitude of maintenance will be determined for each project at a later date and captured in an operations and maintenance plan. Maintenance of the Delta Cross Channel gate and the Tracy and Skinner fish facilities is not expected to be greater than that under the No Action Alternative because operations and maintenance would continue in much the same manner even with the facility upgrades.

V.2.5 Alternative 4

V.2.5.1 *Project-Level Effects*

Temporary and permanent equipment noise and vibration levels would be the same as the No Action Alternative. There would be no project-level effects.

V.2.5.2 *Program-Level Effects*

Sensitive receptors could be exposed to temporary construction-related noise.

Construction of program-level water use efficiency measures under Alternative 4 would involve temporary use of construction equipment such as graders, concrete mixers, and earthmoving equipment, which may potentially result in increased ambient noise levels at more sensitive receptor locations compared to the No Action Alternative. Noise effects could occur within approximately 0.25 mile (1,320 feet) of the activity. Construction of measures for agricultural water use efficiency is unlikely to take place in the vicinity of sensitive receptors; however, distribution system improvements or landscape changes implemented in an urban setting would likely be within 0.24 miles of a sensitive receptor and may result in temporary construction-related noise greater than that under the No Action Alternative.

Potential exposure of sensitive receptors along truck haul routes to a temporary increase in traffic noise

Construction of water use efficiency measures under Alternative 4 could temporarily increase truck traffic along truck haul routes as compared to the No Action Alternative. Activities with the greatest potential for truck haul routes that would increase traffic noise are installation of new irrigation systems, distribution system improvements, new supplier spill and tailwater systems, and landscape transformation. Truck haul routes will be determined prior to construction; the exposure of sensitive receptors will be taken into consideration to the extent possible.

Potential exposure of sensitive receptors to intermittent noise due to long-term maintenance activity including emergency repair activities

Increased levels of long-term maintenance could occur under Alternative 4 for actions which alter land use or construct new structures such as tail water systems. Maintenance of existing systems which are improved under Alternative 4 is not expected to be greater than that under the No Action Alternative because operations and maintenance would continue in much the same manner even with the upgrades. Upgraded systems even have the potential to reduce long-term maintenance due to improved operation and technology. The frequency and magnitude of maintenance will be determined for each project at a later date and captured in an operations and maintenance plan.

V.2.6 Mitigation Measures

To avoid and minimize for adverse noise effects as compared to the No Action Alternative, Mitigation Measure NOI-1, Employ Standard Measures to Reduce Noise Levels from Heavy Equipment, has been identified. Where applicable, Reclamation and DWR will implement best practices to reduce construction noise levels at noise-sensitive land uses to reduce the potential for negative community reaction.

Mitigation Measure NOI-1: Employ Standard Measures to Reduce Noise Levels from Heavy Equipment

Where applicable, Reclamation will implement best practices to reduce construction noise levels at noise-sensitive land uses to reduce the potential for negative community reaction. These methods would be implemented to limit construction noise levels to 70 dBA Leq(1h) during daytime hours (7:00 a.m. to 7:00 p.m.) and 60 dBA Leq(1h) during evening and nighttime hours (7:00 p.m. to 7:00 a.m.) wherever possible.

Potential measures identified to limit construction noise include the following:

- Limiting noise-generating construction operations to daytime hours.
- Locating stationary equipment (e.g., generators, compressors, rock crushers, cement mixers, idling trucks) as far as possible from noise-sensitive land uses.
- Prohibiting gasoline or diesel engines from having unmuffled exhaust.
- Requiring that all construction equipment powered by gasoline or diesel engines have sound-control devices that are at least as effective as those originally provided by the manufacturer and that all equipment be operated and maintained to minimize noise generation.
- Preventing excessive noise by shutting down idle vehicles or equipment.
- Using noise-reducing enclosures around noise-generating equipment.
- Selecting haul routes that affect the fewest number of people.
- Constructing barriers between noise sources and noise-sensitive land uses or taking advantage of existing barrier features (e.g., terrain, structures) to block sound transmission to noise-sensitive land uses. Barriers would be designed to obstruct the line of sight between the noise-sensitive land use and on-site construction equipment.
- Notifying adjacent residents in advance of construction work.

V.1.2 Summary of Impacts

Table V.2-1 includes a summary of impacts, the magnitude and direction of those impacts, and potential mitigation measures for consideration.

Table V.2-1. Impact Summary

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential exposure of sensitive receptors to temporary construction-related noise (Program-Level)	No Action	A temporary increase in ambient noise levels from heavy equipment during restoration projects and facility construction.	–
	1	A temporary increase in ambient noise levels from heavy equipment during restoration projects and facility construction.	MM NOI-1
	2	No effects	–
	3	A temporary increase in ambient noise levels from heavy equipment during restoration projects and facility construction.	MMNOI-1
	4	A temporary increase in ambient noise levels from heavy equipment during installation and upgrade of water use efficiency measures.	MMNOI-1
Potential exposure of sensitive receptors along truck haul routes to a temporary increase in traffic noise (Program-Level)	No Action	A temporary increase in truck traffic during restoration activities.	–
	1	A temporary increase in truck traffic during restoration and facility construction and upgrades.	MMNOI-1
	2	No effects	–
	3	A temporary increase in truck traffic primarily due to tidal habitat restoration activities.	MMNOI-1
	4	A temporary increase in truck traffic primarily due to facility upgrades.	MMNOI-1
Sensitive receptors could be exposed to intermittent noise due to long-term maintenance activity including emergency repair activities (Program-Level)	No Action	Increase in noise levels due to maintenance activities at new restoration sites	
	1	Increase in noise level due to maintenance activities at new restoration sites.	MMNOI-1

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	2	No effects	–
	3	Increase in noise level due to maintenance activities at new restoration sites and a tidal habitat restoration sites.	MMNOI-1
	4	Increase in noise level due to maintenance activities at new facilities and potential decreases in maintenance activities at existing, upgraded facilities/systems.	MMNOI-1

V.2.7 Cumulative Effects

V.2.7.1 *Project-Level*

Temporary and permanent equipment noise and vibration levels under the action alternatives would be the same as the No Action Alternative. There would be no project-level cumulative effects.

V.2.7.2 *Program-Level*

The No Action Alternative would not change CVP and SWP operations, and temporary increases in noise from construction equipment would be due to planned program-level actions. As such, there would be no program-level cumulative effects from implementation of the No Action Alternative.

Implementation of Alternatives 1, 3, or 4 may result in an increase in ambient noise at sensitive receptor locations, such as residences, on a temporary basis. The temporary increase in noise levels would be due to use of heavy equipment and trucks during construction and maintenance of restoration projects and associated facilities. Alternative 2 has no program-level construction actions.

Several past, present, and reasonably foreseeable projects, described in Appendix Y, *Cumulative Methodology*, include the use of construction equipment or the operation of facilities that would introduce one or more new noise sources. The cumulative projects include actions in many regions to develop new water storage and conveyance infrastructure, transportation infrastructure, and construction of new facilities. Regional growth across California would induce other development and infrastructure improvement projects not listed in Appendix Y that have the potential to influence noise levels, such building of new residential or commercial development areas.

The use of construction equipment for Alternatives 1, 3, or 4 simultaneously with other planned projects may result in a temporary cumulative increase in noise levels where projects are located within 0.5 mile of one another. The timing and location of many program-level projects is unknown; however, the cumulative effect of simultaneous construction projects could result in a cumulative increase in noise and vibration levels if the timing of construction of two or more projects overlap.

While cumulative projects overlapping with construction under the action alternatives have the potential to cause a cumulative increase in noise levels, the effect would be temporary and intermittent. If a cumulative effect is likely, coordination of construction phasing of simultaneous projects would minimize construction-related noise effects. Therefore, Alternatives 1, 3, or 4 are not expected to contribute to a cumulative noise effect. Alternative 2 has no program-level construction actions, and therefore, no cumulative noise effects.

V.3 References

California Department of Transportation (Caltrans). 2013a. *Technical Noise Supplement to the Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects.* May. Sacramento, CA.

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Federal Highway Administration. 2006. *Construction Noise Handbook*. August. U.S. Department of Transportation. Available: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/. Accessed: December 7, 2012.

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Appendix W Hazards and Hazardous Materials Technical Appendix

This appendix documents the hazards and hazardous materials technical analysis to support the impact analysis in the EIS.

W.1 Background Information

This section describes the following potential public and environmental hazards that could occur in the study area resulting from implementation of the alternatives considered in this EIS.

W.1.1 Mosquito-Borne Disease

There are more than 50 species of mosquitos in California, including members of the four major genera: 24 species of *Aedes*, 5 species of *Anopheles*, 11 species of *Culex*, and 4 species of *Culiseta* (CDPH and MVCAC 2012). Not all of these species are known to transmit mosquito-borne viruses. Approximately 15 mosquito-borne viruses occur in California; however, of those, only St. Louis encephalitis virus (SLEV), western equine encephalomyelitis virus (WEEV), and West Nile virus (WNV) have caused significant human disease (CDPH et al. 2017a). Although malaria, also a mosquito-borne disease, was naturally occurring in parts of the United States, including California, until the mid 20th Century, currently over 99% of malaria cases diagnosed in U.S. residents are acquired during travel outside of the United States (CDPH 2017a). The *Culex* genus has been identified as the primary transmitting vector of WNV. The genus also transmits SLEV, and WEEV in some species. The mosquito life cycle requires water for the egg, larva, and pupa stages. Some of the species are more associated with irrigated agriculture, and others are more associated with urban communities (CDPH et al. 2014). Most of the diseases are not treatable and vaccines are not available for humans. Methods to prevent mosquitoes from becoming adults and methods to prevent mosquitos from biting humans are the only available and practical methods to protect public health.

Irrigated agricultural lands, and tidal, riparian, floodplains, and other aquatic habitat can provide suitable breeding habitat for mosquitos (Tick and Mosquito Project 2017). Stagnant water (e.g., ditches, marshy areas, horse troughs), as well as areas of non-stagnant standing water, such as the edges of lakes, and ponds subject to daily tidal flushes or wind-driven wave action can provide optimal conditions for mosquito growth and reproduction. Tidally influenced marshes that lack sufficient tidal flow can also provide suitable breeding habitat for mosquitoes (Rey et al. 2012). Breeding habitat varies depending on the species of mosquito. The majority of mosquito species prefer water sheltered from the wind by grass and weeds. The availability of preferable mosquito breeding habitat in the study area varies by season, and is reduced during dry periods of the year. Available open water habitat can be expected to increase during the wet season. In general, the potential for mosquito breeding habitat increases with more emergent vegetation and within water bodies with water levels that slowly increase or recede compared to water levels that are stable or that rapidly fluctuate.

Climate, primarily high and low temperature extremes, and precipitation patterns, influences mosquito-borne disease transmission. Rising temperatures, changing precipitation patterns, and a higher frequency of extreme weather events have been identified as factors of climate change that will influence the distribution and abundance of mosquitoes that transmit WNV, for example, by changing the availability of aquatic habitat and the rates of mosquito and viral reproduction. In the U.S., projected temperature increases in spring through fall are likely to increase the total number of days annually when temperatures are ideal for mosquito breeding (i.e., 50 to 95°F) (Climate Nexus n.d.). Climate change projections for WNV indicate that the disease will increase in the northern and southeastern U.S. as a result of rising temperatures and declining precipitation, respectively, and potentially decrease across the central U.S. (Beard et al. 2016), and that *Culex* species will likely emerge earlier in the year and remain active longer into the fall (Brown et al., 2015).

California Health and Safety Code (Chapter 1, Article 5, §§ 2060–2061) stipulates that landowners are legally responsible to eliminate public nuisances from their properties, including mosquito breeding habitat. Federal, state, and local agencies supplement the preventive activities of individual landowners for the purpose of protecting humans and domestic animals from mosquito-borne diseases. The California Department of Public Health (CDPH) monitors mosquito populations throughout the state. In 1915, the state legislature enacted the Mosquito Abatement Act to allow local mosquito abatement special districts. The local mosquito and vector control districts (MCVDs) monitor mosquito populations and implement best management practices (BMPs) such as eliminating breeding sites, using biological control (predators such as mosquitofish) as well as chemical control to reduce mosquito populations size (CDPH et al. 2017a). MCVDs perform ongoing surveillance of mosquitos and other vectors to determine the threat of disease transmission and lower annoyance levels, and promote cooperation and communication with property owners, residents, social and political groups, duck clubs and other recreational groups, as well as other governmental agencies to help in these efforts. Furthermore, to address public health concerns regarding mosquito production in existing managed wetlands and tidal areas, MVCDs have developed guides and habitat management strategies to reduce mosquito production. MVCDs encourage integrated pest management (IPM), which incorporates multiple strategies to achieve effective control of mosquitoes, including designing wetlands and agricultural operations to be inhospitable to mosquitos; implementing monitoring and sampling programs to detect early signs of mosquito population problems; and biological and chemical control. The Mosquito and Vector Control Association of California (MVCAC) recommends that policymakers, planning officials, and project proponents incorporate relevant considerations from the CDPH and MVCAC publication *Best Management Practices for Mosquito Control for Mosquito Control in California* (CDPH and MCVAC 2012) into the planning and review process. This BMP guidance was developed by the CDPH in collaboration with MVCAC to reduce or eliminate mosquito production from temporary and permanent water sources, and to reduce the transmission of mosquito-borne diseases.

W.1.1.1 *St. Louis Encephalitis*

The SLEV is a mosquito-borne virus that circulates among birds and is transmitted to humans by primarily the *Culex* mosquitos (CalSurv 2019; CDPH 2017b). SLEV infection in humans can cause mild to severe fever and headaches caused by inflammation of the brain (encephalitis). In severe cases, the illness can cause disorientation, coma, and death. Elderly people can become more severely ill than young children with SLEV, in contrast to WEEV. Since the SLEV was first recognized in 1933 in St. Louis, Missouri, outbreaks have been reported throughout the United States, Canada, and northern Mexico, generally between August and October (CalSurv 2019). Seven total reported cases occurred in California in 2016 and 2017 (CDC 2017).

W.1.1.2 *Western Equine Encephalitis*

The WEEV is another mosquito-borne virus that circulates among birds and is transmitted to horses and humans by mosquitoes (SYMVCD 2019). Most cases of western equine encephalitis, like St. Louis encephalitis, occur during mid- to late summer (July and August) (SYMVCD 2019). In general, WEEV outbreaks have occurred in the Central Valley when wet winters are followed by warm summers (CDPH et al. 2017a). Symptoms of western equine encephalitis are similar to St. Louis encephalitis. Infants and small children are more severely afflicted with WEEV, compared to SLEV. There is a vaccine for horses, but not for humans. There have been no recent recorded cases of WEEV in humans in California (CDPH et al. 2017a).

W.1.1.3 *West Nile Virus*

WNV infection can cause mild to severe illness in humans, other mammals, and birds. The virus circulates among birds and is transmitted to humans primarily by *Culex* mosquitoes (CDPH 2016). Human WNV infection was first detected in North America in New York in 1999 (Sejvar 2003), and it has subsequently spread to 48 states (including California), Canada, and Mexico.

In 2017, there were 553 symptomatic and 47 asymptomatic identified WNV infections in California (CDPH 2018a). Of the 553 cases, approximately 50% occurred in Los Angeles County, and the majority of reported cases overall occurred in southern California. In addition to Los Angeles County, there were reported human cases of WNV infection in the following 21 counties of the study area in 2017: Alameda, Butte, Contra Costa, Fresno, Imperial, Kern, Kings, Merced, Orange, Riverside, Sacramento, San Bernardino, San Diego, San Francisco, San Joaquin, Solano, Stanislaus, Tulare, Ventura, Yolo, and Yuba (CDPH et al. 2017b).

In humans, WNV may not result in any symptoms (approximately 80% of people infected) or only mild viral symptoms (up to 20% of people infected), including mild fever, headache, body aches, skin rash, and swollen lymph glands. Less than 1% of people who are infected with WNV will develop severe neurological illnesses (e.g., encephalitis or meningitis). People over the age of 60 and individuals with existing medical conditions (e.g., cancer, diabetes, donor organ recipients) are more likely to develop serious symptoms from WNV infection (CDPH 2016).

W.1.1.4 *Malaria*

Malaria is a mosquito-borne disease caused by a parasite (*Plasmodium*) that destroys the red blood cells of its host. Malaria symptoms often include fever, chills, and flulike illness that can lead to death (CDPH and MCVAC 2012). Malaria is no longer endemic in California, or in the rest of the United States, because of intense mosquito control efforts and anti-malarial drugs. However, the disease is diagnosed every year, especially in people who have traveled outside the United States. In 2017, 133 confirmed human cases of malaria were reported in California (CDPH 2018a). Of the 133 cases, 130 patients had traveled to malaria-endemic countries (i.e., in Africa, Asia, India, South America, and Central America) (CDPH 2018a). *Anopheles* mosquitoes can transmit the parasite to humans and are prevalent in California (CDPH and MCVAC 2012).

W.1.2 Valley Fever

Valley fever is an illness that is caused by inhaling the spores of a soil-dwelling fungi, *Coccidioides* (CDC 2019a). This fungus lives in the top layers of some soils within 2 to 12 inches from the ground surface (Cal/OSHA 2017). When the soil is disturbed by digging, vehicles, cultivation, or wind, the fungal spores are dispersed and can be inhaled by people in the area. Irrigated soils are less likely to contain the fungus than dry, previously undisturbed soils.

Coccidioides forms in subsoil strata that are moist during the wet season and dry throughout the rest of the year. Generally, heavy rainfall periods followed by very dry weather conditions create optimal conditions for increased incidence of Valley fever. Airborne *Coccidioides* spores do not generally come from irrigated agriculture land (SJVAPCD 2012), and *Coccidioides* typically does not grow in tilled and irrigated farmland soils (American Geosciences Institute 2017). Rather, it is believed that propagation of the spores and air entrainment occurs on soils that remain unirrigated during dry seasons (e.g., natural environments, undeveloped land, and grazing areas). (SJVAPCD 2012).

Studies indicate that climate influences seasonal and yearly Valley fever infection patterns, and that drought and increased temperature contribute to an expanding geographic range for *Coccidioides.* Accordingly, increasing temperatures, and more intense and prolonged droughts of climate change may be conducive to the spread of *Coccidioides.* (Bell et al. 2016).

Coccidioides is endemic in many areas of the southwestern United States, Mexico, Central America, and South America (CDC 2019a). Although Valley fever cocci grow in localized areas of the southwestern United States, the San Joaquin Valley and Central Coast are the major endemic regions in California (CDPH 2017c). In 2017, there were 14,364 cases of Valley fever in the United States reported to the CDC. Of these cases, there were 6,925 reported cases of Valley fever in California (CDC 2019b). The highest Valley fever incidence in California in 2017 were reported in counties in the San Joaquin Valley and Central Coast regions, including, in descending order of incidence, Kern, Kings, San Luis Obispo, Fresno, Tulare, Madera, and Monterey (CDPH 2018b and 2018c). Incidence of Valley fever in the northern Central Valley and Bay Area is relatively low (CDPH 2018c).

In general, the people who have the highest risk of exposure to the fungus include construction workers, archeologists, geologists, wildland fire fighters, military personnel, mining or gas/oil extraction workers, and agricultural workers in non-irrigated areas (CDPH 2019) known to contain *Coccidioides*. Other employees also may be at risk. For example, members of the cast and crew of a television film became ill with Valley fever after working on an outdoor set in Ventura County (CDCP 2014).

Valley fever is difficult to diagnose. It is estimated that approximately 60% of Valley fever infections result in no symptoms or a mild clinical illness that is indistinguishable from other illnesses such as flu or pneumonia, and therefore, a large percentage of cases of Valley fever go undiagnosed. For most cases that are diagnosed, symptoms also include rash, fever, and joint pain. In about 0.5% of diagnosed cases, the fungal infection spreads from the lungs to other parts of the body including the skin, bones, joints, and brain meninges (membranes). There are no vaccines to prevent Valley fever. (SJVAPCD 2012)

W.1.3 Bioaccumulation of Methylmercury in Fish and Shellfish

Appendix G, *Water Quality Technical Appendix*, provides a discussion of mercury and methylmercury as water quality constituents, a description of mercury and methylmercury occurrence in the study area, and identifies the water bodies in the study area that are currently impaired by these water contaminants.

Mercury is a statewide water quality issue and is being addressed through various state and federal water quality efforts. In aquatic environments, sulfur-reducing bacteria convert inorganic mercury to methylmercury, and this process is enhanced by multiple environmental variables in water and sediment including temperature, pH, oxygen, sulfate, and the presence of organic matter (USGS 2014). Conversion of inorganic mercury to methylmercury occurs in flooded fine sediments subjected to drying-out periods; methylmercury production is greatest in high marshes that experience wet and dry periods over the highest monthly tidal cycles, and production is lower in low marshes that are always inundated and not subject to dry periods (Alpers et al. 2008).Total mercury concentrations in sediment positively correlate with methylmercury levels in sediment and water (Central Valley Water Board 2010). Positive correlations also exist between methylmercury in water and fish tissue. High concentrations of mercury in the form of methylmercury can bioaccumulate in fish and shellfish through food consumption and absorption from water based upon the water quality. Consumption of contaminated fish is the major pathway for human exposure to mercury (via methylmercury from fish tissue). Bioaccumulation is the process by which organisms, including humans, can, over time, accumulate certain contaminants in their tissues (from sources including water, air, and diet) more rapidly than can be eliminated through metabolism and excretion.

Fish and shellfish consumption is the most common route of human exposure to mercury. Nearly all people have at least some methylmercury in their bodies because it is so widespread in the environment; however, generally blood mercury concentrations in most people are lower than those associated with health effects. Exposure to methylmercury at high concentrations can result in effects on the central nervous system. Prenatal exposure to methylmercury can adversely affect the developing central nervous system. (USEPA 2018, 2019)

The California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA) evaluates concentrations of potentially toxic substances in edible tissues of fish and shellfish harvested in water bodies in California). Based upon the evaluation, general and specific safe eating guidelines are developed for the fish and shellfish, as summarized in Table W-1.1. For the water bodies in the study area, the primary water contaminants that have triggered the development of safe eating guidelines are mercury, dieldrin, and/or polychlorinated biphenyls (PCBs). Other contaminants are present, including selenium; however, the concentrations of these contaminants do not exceed thresholds that would trigger safe-eating guidelines. The OEHHA develops two separate guidelines: (1) guidelines for children from 1 to 17 years old and women from 18 to 49 years; old and (2) guidelines for women over 50 years and older and men 18 years and older (OEHHA 2019). The guidelines recommend the number of servings per week by fish or shellfish harvested from specific waters (Table W.1-1).

Table W.1-1. Summary of Safe Eating Guidelines for Fish and Shellfish from Water Bodies in the study area Based on Mercury and PCB (servings[1] per week)

Region	Water Body	Fish and Shellfish[2]	Guidelines for Children (1–17 Years) and Women (18–45 Years)[3]	Guidelines for Men (18+ Years) and Women (46+ Years)[3]
Trinity River Region	Trinity Lake	Rainbow Trout, Brown Trout, Catfish	2	5
		Black Bass species	do not eat	1
	Lewiston Lake	Trout	5	7
Sacramento River Region	Sacramento River and Northern Delta (includes all	American Shad, Rainbow Trout	3[4]	7[4]
		Chinook (king) Salmon, Steelhead Trout	2	7
		Asian Clam (*Corbicula*)	7	7

Region	Water Body	Fish and Shellfish[2]	Guidelines for Children (1–17 Years) and Women (18–45 Years)[3]	Guidelines for Men (18+ Years) and Women (46+ Years)[3]
	waterbodies in the Delta north of State Route 12)	Sunfish species, Common Carp, Goldfish, Catfish, Crappie, Crayfish, Hardhead, Hitch, Sacramento Sucker	1	3
		Black Bass species, Sacramento Pikeminnow, White Sturgeon	do not eat	1
		Striped Bass	do not eat	2
Feather River Region	Lake Oroville	Sunfish species	2	5
		Carp, Coho Salmon	1	2
		Black Bass species, Catfish	do not eat	1
	Lower Feather River	American Shad	3	7
		Chinook (King) Salmon, Steelhead Trout	2	7
		Carp, Hardhead, Sucker	1	2
		Sunfish species	1	3
		Black Bass, Catfish, Pikeminnow, White Sturgeon	do not eat	1
		Striped Bass	do not eat	2
American River Region	Folsom Lake	Sunfish species, Rainbow Trout (16 inches or less)	2	5
		Channel Catfish; Chinook (King) Salmon; Black Bass species, Rainbow Trout (over 16 inches)	do not eat	1
	Lake Natoma	Sunfish species, Rainbow Trout (16 inches or less)	2	5
		Chinook (King) Salmon; Black Bass species, Rainbow Trout (over 16 inches)	do not eat	1
		Channel Catfish	do not eat	do not eat
	Lower American River	American Shad,	3	7
		Chinook (King) Salmon, Steelhead Trout	2	7
		Sunfish species, Sacramento Sucker, Catfish	1	2
		Striped Bass	do not eat	2
		Black Bass species, Sacramento Pikeminnow	do not eat	1
San Joaquin River Region	Lower Mokelumne River	American Shad	3	7
		Chinook (King) Salmon, Steelhead Trout	2	7
		Asian Clam (*Corbicula*)	7	7

Region	**Water Body**	**Fish and Shellfish**[2]	**Guidelines for Children (1–17 Years) and Women (18–45 Years)**[3]	**Guidelines for Men (18+ Years) and Women (46+ Years)**[3]
		Sunfish species, Crayfish, Catfish	1	2
		Striped Bass	do not eat	2
		Black Bass species, Pikeminnow, White Sturgeon	do not eat	1
	San Joaquin River (Friant Dam to Port of Stockton)[4]	Steelhead Trout	2	7
		Sunfish species	2	5
		American Shad	3	7
		Common Carp, Catfish, Sacramento Sucker	1	2
		Striped Bass	do not eat	2
		Black Bass species, White Sturgeon	do not eat	1
		Any fish or shellfish from the Port of Stockton	do not eat	do not eat
Bay-Delta Region	Central and south Delta (includes all waterbodies in the Delta south of State Route 12, except the Sacramento River and San Joaquin River south of Stockton)[4]	American Shad	3	7
		Catfish, Crayfish	2	5
		Steelhead Trout, Sunfish species	2	7
		Asian Clam (*Corbicula*)	7	7
		Black Bass species, Common Carp, Crappie, Sacramento Sucker	1	2
		Striped Bass	do not eat	2
		White Sturgeon	do not eat	1
		Any fish or shellfish from the Port of Stockton	do not eat	do not eat
	San Francisco Bay	Chinook (King) Salmon	2	7
		Brown Rockfish, Red Rock Crab	2	5
		Jacksmelt	2	2
		California Halibut	1	2
		White Croaker	1	1
		Sharks, White Sturgeon	do not eat	1
		Striped Bass	do not eat	2
		Surfperches	do not eat	do not eat
	San Pablo Reservoir	Crappie	2	5
		Rainbow Trout	5	5
		Black Bass species	do not eat	1
		Carp, Channel Catfish	do not eat	do not eat
	Lafayette Reservoir	Channel Catfish	3	7
		Black Bass species	1	2

Region	**Water Body**	**Fish and Shellfish**[2]	**Guidelines for Children (1–17 Years) and Women (18–45 Years)**[3]	**Guidelines for Men (18+ Years) and Women (46+ Years)**[3]
		Goldfish	do not eat	2
		Rainbow Trout	5	5
	Lake Chabot	Rainbow Trout	7	7
		Sunfish species	2	4
		Channel Catfish	2	7
		Goldfish	do not eat	2
		Black Bass species	do not eat	1
		Common Carp	do not eat	1
Southern California Region	Pyramid Lake	Rainbow Trout	7	7
		Channel Catfish	1	2
		Black Bass species	do not eat	1
		Bullhead	do not eat	do not eat
	Silverwood Lake	Rainbow Trout	7	7
		Tule Perch	1	1
		Black Bass species, Sunfish species, Channel Catfish	do not eat	1
		Striped Bass, Blackfish, Tui Chub	do not eat	do not eat
Statewide	All lakes and reservoirs without site-specific guidelines	Rainbow Trout	2	6
		Bullhead, Catfish, Sunfish species, Brown Trout (16 inches or less)	1	2
		Black Bass species, Carp, Brown Trout (over 16 inches)	do not eat	1
	All rivers estuaries, and coastal waters without site-specific guidelines	American Shad, Chinook (King) Salmon, Steelhead Trout	2 to 3	7
		Striped Bass	do not eat	2
		White Sturgeon	do not eat	1

Sources: OEHHA 2012, 2018a–2018u.

[1] A “serving size” is 4 ounces of fish for an adult and approximately 2 ounces children ages 4 to 7 (OEHHA 2017).

[2] All fish and shellfish names are as they appear in the OEHHA guidelines.

[3] The OEHHA guidelines refer to the total number of servings of fish per week for one water body, not just the total for a specific species. For example, OEHHA guidelines for men eating fish from Trinity Lake would include no more than five servings of rainbow trout, brown trout, or white catfish; or one serving of largemouth bass or smallmouth bass.

[4] Guidelines for children (1–17 years) and women (18–49 years), and men (18+ years) and women (50+ years)

W.1.4 Wildfires

In general, wildfire is a serious hazard in undeveloped areas with extensive areas of nonirrigated vegetation. Complex terrain, Mediterranean climate, productive natural plant communities, and ample natural and aboriginal ignition sources make California a complex wildfire-prone and fire-adapted landscape. While natural wildfires support ecosystem health and are critical to maintaining the structure and function of ecosystems, wildfires pose a significant threat to life, public health, infrastructure, properties, and natural resources. In accordance with Public Resources Code Sections 4201–4204 and Government Code Sections 51175–51189, the California Department of Forestry and Fire Prevention (CAL FIRE) has mapped areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors. The zones are referred to as Fire Hazard Severity Zones and represent the risks associated with wildland fires. Under CAL FIRE regulations, areas within very high fire-hazard risk zones must comply with specific building and vegetation requirements intended to reduce property damage and loss of life within these areas.

According to CAL FIRE, fires in California are becoming more frequent, larger, and more severe, and this trend is likely to continue (CAL FIRE 2018). Statewide, the Wildland-Urban Interface (WUI), areas where homes are build near or among lands susceptible to wildland fires (IAFC 2019), spans nearly 18 million acres. This includes 1.3 million acres of Intermix class areas (sparsely developed areas interspersed with areas with wildland characteristics) (CAL FIRE 2018); 1 million acres of Interface class areas (dense urban development adjacent to wildland (CAL FIRE 2018); and an approximate 15 million acre "influence zone", which is the 1.5 mile area around Interface and Intermix classes that has fuels to influence those two class areas (CAL FIRE 2018).

CAL FIRE manages the State Responsibility Areas, and local fire districts manage Local Responsibility Areas. First responders are typically the local fire districts. The U.S. Forest Service provides wildfire protection both independently and cooperatively with the California Department of Forestry and Fire Protection. In addition, the U.S. Department of the Interior National Park Service and Bureau of Land Management provide resource management and fire protection on portions of federal lands.

Firefighting actions frequently involve helicopter transport of water from reservoirs located close to wildfires, including reservoirs owned by U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR). Wildfires are also managed by applying chemical fire retardants, controlled or prescribed burning, pumping water from lakes or streams, and placement of containment lines, which are physical barriers that can help inhibit embers from spreading (Brooks 2018). Containment lines can be natural barriers such as rivers or can be created by bulldozers by clearing vegetation to create areas of bare soil (Brooks 2018).

W.1.5 Bird-Aircraft Strikes at or near Airports

"Hazardous wildlife", as defined in the Draft FAA Advisory Circular 150/5200-33C, are wildlife species (birds, mammal, reptiles), including feral animals and domesticated animals not under control, that are associated with aircraft strike problems, are capable of causing structural damage to airport facilities, or act as attractants to other wildlife that pose a strike hazard (FAA 2019). The presence of hazardous wildlife at or near airports creates a collision hazard to operating aircraft. Bird-aircraft strikes constitute 97% of the reported civil aircraft strikes (FAA 2018). Agricultural fields, grasslands, wetlands, open water, and urban areas near airports all increase the risk of bird-aircraft strikes (USDA 2017). Over the 28-year period from 1990 to 2017, pigeons/doves (14%), raptors (13%), gulls (11%), shorebirds (9%), and waterfowl (5%) are the bird groups most frequently involved in bird-aircraft strikes. During this same 28-year period, waterfowl were involved in a greater percentage of damaging strikes (28%) than the other bird types (FAA and USDA 2019). Most bird strikes (53%) occurred between July and October, which is generally during migration season, and when populations are at their annual peak in North America following the nesting season (FAA and USDA 2019). From 1990 to 2017, there were 33 human fatalities and 313 human injuries caused by wildlife-aircraft strikes; more than half of the human fatalities were the result of bird-aircraft strikes specifically (FAA and USDA 2019).

The Federal Aviation Administration (FAA) discourages the improvement of wildlife habitat in proximity to public-use airports to reduce the risk of bird-aircraft strikes. The FAA recommends a separation distance of 5,000 feet between hazardous wildlife attractants and airports used by piston-powered aircraft and of 10,000 feet for airports used by turbine-powered aircraft. In addition, for all airports, the FAA recommends a distance of 5 miles between an airport's approach or departure space. (FAA 2019)

The FAA requires commercial service airports to maintain safe operations, including conducting hazard assessments for wildlife attractants (Wildlife Hazard Assessment) within 5 miles of an airport. A Wildlife Hazard Assessments is required of any certificated airport when specific "wildlife events" occur, including multiple wildlife-aircraft strikes on or near an airport (14 CFR §139.337 (b)(1-4). Hazard assessments are submitted to the FAA, which determines if it is necessary for the airport to develop a Wildlife Hazard Management Plan (15 CFR Part 139). Wildlife Hazard Management Plans must identify and provide information on wildlife attractants on or near the airport, identify appropriate wildlife management techniques to minimize the wildlife hazard, and identify personnel responsible for implementing each phase of the plan, among other requirements (FAA and USDA 2005).

The FAA Draft Advisory Circular 150/5200-33C provides guidance on land uses that have the potential to attract hazardous wildlife on or near public-use airports (FAA 2019).

W.1.6 Common Hazardous Materials Used During Construction

Construction activities would be expected to involve the transport, handling, and use of a variety of hazardous materials. Typical construction-related hazardous materials include petroleum products (e.g., fuel, oils, solvents) for refueling and maintenance of construction equipment, concrete, paints and other coatings, and cleaning agents. Improper use and onsite storage of these types of materials could result in accidental release to the environment and contaminate soil, surface water, and groundwater.

W.2 Evaluation of Alternatives

This section describes the technical background for the evaluation of environmental consequences associated with the Project alternatives and the No Action Alternative.

W.2.1 Methods and Tools

The No Action Alternative and action alternatives may introduce public and environmental hazards to the study area through the following mechanisms.

- Habitat restoration could increase mosquito breeding habitat in restored areas, and thus increase the potential for public exposure to mosquito-borne diseases.
- A reduction in surface water supplies could result in an increase in agricultural land fallowing and a consequent increase in dust, which could increase the potential for exposure to Valley fever fungal spores.
- Habitat restoration could disturb and resuspend sediments containing methylmercury, thereby mobilizing mercury to enter the food chain and bioaccumulate in fish and shellfish, potentially resulting in human exposure via fish and shellfish consumption.
- CVP and SWP operations could affect water and fish tissue methylmercury concentrations.
- Habitat restoration could increase the potential for bird-aircraft strikes, and thus increase potential air safety hazards.
- Construction and operation and maintenance activities related to facility improvements and habitat restoration, and operation and maintenance activities could increase the potential for creating a public or environmental hazard through the use or accidental release of hazardous materials (fuels, oils, lubricants, etc.) or disruption of underground existing infrastructure (e.g., natural gas pipelines).

Reservoirs that store water in the Bay-Delta and CVP and SWP export areas are managed to store water supplies as part of short-term conveyance management or storage for regional and local water supplies using water from numerous sources. Water available for wildfire firefighting in those areas is not known, and therefore, is not analyzed in this EIS. Stored water in water supply reservoirs is used for fighting wildfires in the California foothills and mountains, including water stored in Central Valley Project (CVP) and State Water Project (SWP) reservoirs. During drier periods, reduced storage levels could affect the availability of water for wildlife firefighting. However, as discussed in Appendix S, *Recreation Technical Appendix*, reservoir levels in the study area would be roughly the same as, or higher than, the No Action Alternative. Given this, and given that there are multiple methods that are used in fighting wildfires (see Section W.1.5) aside from drawing water from reservoirs via helicopter, particularly to create defensible areas at the wildland urban interface , implementation of the action alternatives would not substantially impair the ability to fight wildfires in the study area. Therefore, this topic is not addressed further in this analysis.

The evaluation of potential effects related to hazards and hazardous materials resulting from implementation of the No Action Alternative and the action alternatives is based on review of conclusions from Appendix G, *Water Quality Technical Appendix*, regarding changes in concentrations of methylmercury in fish tissue in the Delta and Suisun Marsh, and the qualitative assessment related to potential effect of habitat restoration on enhancing mercury bioavailability and risk, and Appendix R, *Land Use and Agricultural Resources Technical Appendix*, regarding changes in irrigated agricultural acreage, as well as best professional judgement.

W.2.2 No Action Alternative

Under the No Action Alternative, Reclamation would continue with current operations of the CVP, as described in Chapter 4, *Alternative Descriptions*. The proposed operational changes, habitat restoration, and facility improvements, as well as habitat restoration, facility improvements, or intervention measures, under Alternative 1 would not occur under the No Action Alternative.

Potential changes in the potential for mosquito-borne diseases related to habitat restoration.

Under the No Action Alternative, there would be 8,000 acres of tidal habitat restoration in Suisun Marsh and/or the north Delta. It is not likely that the potential for an increase in mosquito-borne diseases because of habitat restoration under the No Action Alternative would differ substantially from existing conditions; Suisun Marsh and the Delta currently provide suitable mosquito breeding habitat and these areas are existing sources of mosquitoes. It is assumed that all restoration activities would be designed to minimize the potential for stagnant water and other conditions favorable to the production of mosquitoes, and that these activities would occur in consultation with applicable MCVDs. Therefore, implementation of the No Action Alternative would not increase the public's risk of exposure to mosquito-borne diseases relative to existing conditions.

Potential changes in the potential for Valley fever related to agricultural land irrigation.

As described in Section W.1.3, *Coccidioides* typically does not grow in tilled, irrigated farmland. Rather, spores are more likely to occur on agricultural land that is idle because of agricultural practices or reduced water supply availability. CVP and SWP operations under the No Action Alternative relative to existing conditions would not result in an increase in nonirrigated agricultural land. Therefore, the potential for creating land conditions conducive to the growth of *Coccidioides* in the study area under the No Action Alternative would be the same as under existing conditions, and there would no adverse effect related to Valley fever.

Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption.

Restoration of approximately 8,000 acres of tidal habitat in Suisun Marsh and/or the north Delta under the No Action Alternative could temporarily mobilize existing mercury and methylmercury within sediments. Mobilization would be expected in varying degrees depending on the location of restoration projects because the study area is generally known to be out of compliance with methylmercury levels. The temporary mobilization of mercury and methylmercury caused by habitat restoration construction would be localized around the area of construction. Once operational, tidal habitat restoration could contribute to methylmercury production as a result of biogeochemical processes and sediment conditions established in tidal wetlands. Potential methylmercury production would be addressed with minimization measures (e.g., measures to monitor and adaptively manage methylmercury production). Therefore, the potential for increased bioaccumulation of mercury in fish and shellfish and consequent human exposure to mercury under the No Action Alternative would be the same as under existing conditions.

Potential changes in the potential for bird-aircraft strikes related to habitat restoration.

Tidal habitat restoration in Suisun Marsh and/or the north Delta that would occur under the No Action Alternative could potentially attract waterfowl and other birds to areas in proximity to existing airport flight zones, which could increase the potential for bird-aircraft strikes relative to existing conditions. However, where habitat restoration may occur within 5 miles of public-use airport, Reclamation will comply with FAA safety guidelines on wetlands and wildlife attractants as identified in the FAA Draft Advisory Circular 150/5200-33C Sections 1 and 2.4, to avoid or minimize the potential for bird-aircraft strikes because of habitat restoration. As such, there would be no increase in the potential for bird-aircraft strikes relative to existing conditions.

Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials.

Construction or operation and maintenance of any CVP or SWP projects that are planned or currently under way, or any ongoing operations and maintenance activities that may require the use of heavy equipment (e.g., front loaders, dump trucks, excavators, cranes), which require the use of hazardous materials including fuels, lubricants, and solvents, could create a hazard to the public and environment through the accidental release of those hazardous materials or disruption of existing gas pipelines where deep excavation may be required. For example, the temporary rock barriers in the south Delta at Middle River, Old River near Tracy, and Grant Line Canal would be installed, maintained, and removed annually (as conditions allow) to improve water levels and circulation for agricultural diversions during the irrigation season. The barriers are typically installed between April and September each year. In general, installation of the barriers requires stockpiling of quarry rock on the waterside of the levee crown and use of heavy equipment to place the stockpiled rock and other structures (e.g., culverts, flashboard structures, concrete reinforcing mats) into the channel. As the rock barrier is extended into the channel, heavy equipment can use the top of the barrier to move farther into the channel to place additional material. Construction typically takes 1–3 weeks. The barriers are removed in the fall by reversing the installation procedure. Construction of the barriers entails the use of hazardous chemicals such as fuel small amounts of hazardous materials, such as fuel and motor oil to power and maintain construction equipment, respectively. Given the in-water location of the barriers and bankside staging area, there is potential for accidental spills of these hazardous materials, particularly if heavy equipment is fueled and maintained on-site during construction. Were this to occur, there could be temporary adverse effects on water quality.

Therefore, under this alternative, construction and/or operation and maintenance of facilities could create the potential for hazards to the public or environment through the transport, use, accidental release, or disposal of hazardous materials. However, because these projects have already undergone state and/or federal environmental review, it is assumed that any potential impacts related to hazards or hazardous material use, storage, or transport will be avoided or minimized through adherence to current environmental permits. As such, relative to existing conditions, the No Action Alternative would not result in adverse effects related to hazards or hazardous materials.

W.2.3 Alternative 1

W.2.3.1 *Project-Level Effects*

Potential changes in mosquito-borne diseases related to habitat restoration.

No project-level actions related to habitat restoration would increase potential for mosquito-borne diseases under Alternative 1.

Potential changes in the potential for Valley fever related to agricultural land irrigation.

As discussed in Appendix R, SWAP modeling results indicate that relative to the No Action Alternative, in the Sacramento River Region there would be no reduction of irrigated agricultural land in dry/critical years or in years with average precipitation. There would be an increase in irrigated agricultural land in the San Joaquin River region of 2,770 acres in average years, and 23,668 acres in dry/critical years, relative to the No Action Alternative.

As described in Section W.1.3, generally, *Coccidioides* propagation and air entrainment occurs on soils that remain unirrigated during dry seasons, and the San Joaquin Valley and Central Coast are the major endemic regions in California. Because there would be no reduction of irrigated agricultural land in the Sacramento River and San Joaquin River regions under Alternative 1 relative to the No Action Alternative, there would not be in an increased potential for Valley fever due to CVP and SWP operations under this alternative.

Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption.

As discussed in Appendix G, based on the overall lower fish tissue methylmercury concentrations at almost all modeled Delta locations, and modeled water concentrations, water operations under Alternative 1 would not contribute to the additional water quality degradation associated with methylmercury, or increased health risks to humans consuming fish from the Delta, Suisun Bay, and San Francisco Bay relative to the No Action Alternative.

Potential changes in the potential for bird-aircraft strikes related to habitat restoration

No project-level actions related to habitat restoration would result in an increased potential for bird-aircraft strikes under Alternative 1.

Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials

Under Alternative 1, as under the No Action Alternative, agricultural barriers in the south Delta at Middle River, Old River near Tracy, and Grant Line Canal would be installed, maintained, and removed annually (as conditions allow).The installation of the south Delta agricultural barriers has already undergone environmental review and permitting, and will continue to be implemented pursuant to environmental permit conditions, to avoid or minimize impacts related to hazards or hazardous material use, storage, or transport. Therefore, relative to the No Action Alternative, installation of the agricultural barriers would not result in an adverse effect related to hazards or hazardous materials.

Mechanical and chemical aquatic weed removal and algae treatments would be implemented on an as-needed basis at Clifton Court Forebay (CCF). Chemical weed control and algae treatments would involve the use of toxic herbicides, as described in Chapter 4, *Alternatives Description*. These chemicals, if not handled or applied in a manner consistent with product labeling, could be hazardous to those applying the herbicide or those in close proximity. In addition, inadvertent spills into the forebay or over-application of herbicides would result in an adverse water quality effects. As described in Appendix G, the application of herbicides and algaecides at CCF would require coverage under the *Statewide General National Pollutant Discharge Elimination System (NPDES) Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications (*General Pesticide

Permit; NPDES No. CAG990005; Water Quality Order No. 2013-0002-DWQ, as amended by Orders 2014-0078-DWQ and 2015-0029-DWQ) (SWRCB 2016). To obtain coverage under the General Pesticide Permit, the applicant must submit an Aquatic Pesticides Application Plan that includes BMPs for applying herbicides at an appropriate rate, preventing spill, coordinating with water diverters so that beneficial uses of water are not impacted, and other measures. Because weed removal at CCF would not occur under the No Action Alternative, the potential for adverse hazardous effects related to accidental herbicide spills or inappropriate use would be greater under Alternative 1. However, BMP implementation would be required pursuant to the General Pesticide Permit conditions. As such, there would be no adverse effects related to hazards or hazardous materials due to and chemical aquatic weed removal and algae treatments relative to the No Action Alternative.

W.2.3.2 *Program-Level Effects*

Potential changes in mosquito-borne diseases related to habitat restoration.

Tidal habitat and floodplain habitat restoration that would occur under Alternative 1 has the potential to create mosquito breeding habitat. Implementation of spawning and rearing habitat restoration would create and/or restore areas of floodplain habitat in the study area. Tidal wetlands and floodplains provide habitat for mosquito breeding, especially in tidally influenced wetlands with slow-moving water and in floodplains after the majority of the water recedes. Under this alternative, floodplain habitat would be created or modified in locations throughout the study area, including in the American River, upper Sacramento River, and lower San Joaquin River basins, as part of spawning and rearing projects. In addition, as described in Chapter 3, *Alternatives*, as required by the USFWS BiOp , approximately 8,000 acres of tidal habitat restoration in Suisun Marsh and/or the north Delta, as would also occur under the No Action Alternative. Accordingly, the potential for an increase in the public's risk of exposure to mosquito-borne diseases resulting from increased mosquito breeding habitat under Alternative 1 would be greater than under the No Action Alternative. Implementation of Mitigation Measure HAZ-1 could avoid or minimize the potential for adverse effects related to increased mosquito breeding habitat through Reclamation's coordination with appropriate MCVDs in the study area during all phases of restoration (including design, implementation, and operations) to develop and implement site-specific mosquito management plans, which will include applicable BMPs from *Best Management Practices for Mosquito Control in California* (CDPH and MVCAC 2012).

Potential changes in the potential for Valley fever related to agricultural land irrigation.

As described in Appendix R, some changes in the total irrigated agricultural acreage in the Sacramento River, San Joaquin River, and Delta regions is possible with implementation of program actions of Alternative 1 (e.g., spawning and rearing habitat restoration actions, and Tracy Fish Facility improvements). However, agricultural land could potentially be converted to non-agricultural use not as fallowed or idled land, but to another land use to accommodate these actions. Therefore, it is not expected that these actions would create large areas of open, undeveloped, dry land that may be conducive to the growth of *Coccidioides.*

Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption.

As discussed in Appendix G, newly created tidal habitat areas have the potential to become new sources of methylmercury, and irrigated agricultural land in the Delta can be a substantial source of methylmercury. As discussed in Section W.1.3, methylmercury can bioaccumulate in aquatic organisms residing in or near these habitat/land types. Under Alternative 1, some habitat restoration would likely occur on lands in the Delta formerly used for irrigated agriculture. However, it is uncertain the degree to which new tidal habitat areas may be future sources of methylmercury to the aquatic environment of the Delta. The specific siting and design of the restored tidal habitat areas would be factors that affect the potential for methylmercury generation and transport. However, the amount of tidal habitat restoration proposed for Alternative 1 is the same as what would occur under the No Action Alternative. Therefore, the potential for increased bioaccumulation of mercury in fish and shellfish and consequent human exposure to mercury under the Alternative 1would be the same as under the No Action Alternative, and there would be no adverse effect.

Potential changes in the potential for bird-aircraft strikes related to habitat restoration.

Like the No Action Alternative, 8,000 acres of tidal habitat restoration in Suisun Marsh and/or the north Delta would also occur under Alternative 1. In addition, under Alternative 1, floodplain habitat would be restored at multiple locations in the study area. Increased tidal habitat and floodplain habitat in the study area could potentially attract waterfowl and other birds to these areas. If these restored areas are in proximity to existing airport flight zones, there could be an increase in the potential for bird-aircraft strikes. Because there would be more habitat restoration under Alternative 1 relative to the No Action Alternative, depending on the location of habitat restoration, the potential for bird-aircraft strikes would be greater under Alternative 1. However, for habitat restoration within 5 miles of a public-use airport, Reclamation will implement Mitigation Measure HAZ-2 and comply with FAA safety guidelines on wetlands and wildlife attractants as identified in the FAA Draft Advisory Circular 150/5200-33C Sections 1 and 2.4 (FAA 2019), to avoid or minimize the potential for bird-aircraft strikes resulting from habitat restoration.

Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials

Certain program-level components of Alternative 1 (e.g., spawning and rearing habitat restoration, small screen program, tidal habitat restoration, and facility improvements) would involve the use of construction equipment in the study area. Potential hazards to the public associated with construction, as well as operation and maintenance activities, would be similar in nature to those discussed for the No Action Alternative. In addition, if digging or deep excavation were required for habitat restoration or facility improvements, underground natural gas pipelines could be damaged and potentially expose construction workers or others in close proximity to gas fumes. However, any construction requiring excavation will be designed to avoid affecting existing pipelines and other facilities.

As described in Appendix G, the State Water Resources Control Board's (SWRCB's) National Pollution Discharge Elimination System (NPDES) stormwater program requires permits for discharges from construction activities that disturb one or more acres. SWRCB adopted a general NPDES permit for stormwater discharges associated with construction activity (Construction General Permit). Obtaining coverage under the Construction General Permit requires preparation and implementation of a stormwater pollution prevention plan (SWPPP), which specifies BMPs to reduce or eliminate pollutants in stormwater as well as non-stormwater discharges. The Construction General Permit requires implementation of BMPs that control pollutant discharges using best available technology economically achievable for toxic contaminants, and best conventional technology for conventional contaminants, and any other necessary BMPs to meet water quality standards. Implementation of the necessary BMPs, as required by the Construction General Permit, would reduce potential adverse effects related to the accidental release of hazardous materials during construction.

In addition, as described in Appendix G, implementation of Mitigation Measure WQ-1 (spill prevention, control, and countermeasure plan [SPCCP]) would minimize the potential for, and effects from, spills of hazardous, toxic, and petroleum substances during construction and maintenance. No hazardous material would be used in reportable quantities (pursuant to California Code of Regulations [CCR], Title 19, Division 2) unless approved in advance by the California Office of Emergency Services (OES), in which case a hazardous materials management plan (HMMP) would be prepared and implemented, as described under Mitigation Measure HAZ-3. Therefore, the potential for Alternative 1 to result in hazards to the public associated with the use of hazardous materials during construction or operation of program components would be similar to the No Action Alternative, and there would be no adverse effects.

W.2.4 Alternative 2

W.2.4.1 *Project-Level Effects*

Potential changes in mosquito-borne diseases related to habitat restoration.

No project-level actions related to habitat restoration would increase potential for mosquito-borne diseases under Alternative 2.

Potential changes in the potential for Valley fever related to agricultural land irrigation.

As discussed in Appendix S, SWAP modeling results indicate that relative to the No Action Alternative, in the Sacramento River Region there would be no reduction of irrigated agricultural land in dry/critical years or in years with average precipitation under Alternative 2. There would be an increase in irrigated agricultural lands in the San Joaquin River region of 4,541 acres in average years and 56,147 acres in dry/critical years, relative to the No Action Alternative.

Because there would be no reduction in irrigated agricultural land in the study area under Alternative 2 relative to the No Action Alternative, there would be no increased potential for Valley fever due to CVP and SWP operations under this alternative.

Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption.

As discussed in Appendix G, based on the overall lower fish tissue methylmercury concentrations at almost all modeled Delta locations, and modeled water concentrations, relative to the No Action Alternative, water operations under Alternative 2 would not contribute to additional water quality degradation with respect to methylmercury, or increased health risks to humans consuming fish from the Delta, Suisun Bay, and San Francisco Bay.

Potential changes in the potential for bird-aircraft strikes related to habitat restoration.

No project-level actions related to habitat restoration would result in an increased potential for bird-aircraft strikes under Alternative 2.

Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials

No project-level actions would result in potential hazards associated with construction and operation activities under Alternative 2.

W.2.4.2 *Program-Level Effects*

Potential changes in mosquito-borne diseases related to habitat restoration.

Under Alternative 2, there would be no tidal habitat restoration as would occur under the No Action Alternative, and no other habitat types would be restored under this alternative. Accordingly, there would be no increased potential for mosquito-borne diseases in the study area under Alternative 2.

Potential changes in the potential for Valley fever related to agricultural land irrigation.

There are no program-level actions under Alternative 2 that would affect irrigated agricultural land in the study area. Therefore, there would be no change in the potential for Valley fever under Alternative 2 relative to the No Action Alternative.

Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption.

Under Alternative 2, there would be no tidal habitat restoration as would occur under the No Action Alternative, and no other habitat types would be restored under this alternative. Thus, relative to the No Action Alternative, Alternative 2 would not increase the potential for human exposure to mercury in the study area caused by increased bioaccumulation of methylmercury in fish and shellfish.

Potential changes in the potential for bird-aircraft strikes related to habitat restoration.

Under Alternative 2 there would be no habitat restoration as would occur under the No Action Alternative. Accordingly, there would be no increased potential for bird-aircraft strikes in the study area under this alternative relative to the No Action Alternative.

Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials.

No program-level actions would result in potential hazards associated with construction and operation activities under Alternative 2.

W.2.5 Alternative 3

W.2.5.1 *Project-Level Effects*

Potential changes in mosquito-borne diseases related to habitat restoration.

No project-level actions related to habitat restoration would increase potential for mosquito-borne diseases under Alternative 3.

Potential changes in the potential for Valley fever related to agricultural land irrigation.

As discussed in Appendix S, SWAP modeling results indicate that relative to the No Action Alternative, in the Sacramento River region there would be no reduction of irrigated agricultural land in dry/critical years or in years with average precipitation under Alternative 3. There would be an increase in irrigated agricultural acreage in the San Joaquin River region of 2,674 acres in average years, and 56,039 acres in dry/critical years).

Because there would be no reduction in irrigated agricultural land in the study area under Alternative 3 relative to the No Action Alternative, there would be no increased potential for Valley fever due to CVP and SWP operations under this alternative.

Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption.

As discussed in Appendix G, based on the overall lower methylmercury fish tissue concentrations at almost all modeled Delta locations, and modeled water concentrations, relative to the No Action Alternative, water operations under Alternative 3 would not contribute to additional water quality degradation with respect to methylmercury, or in increased health risks to humans consuming fish or shellfish from the Delta, Suisun Bay, and San Francisco Bay.

Potential changes in the potential for bird-aircraft strikes related to habitat restoration.

No project-level actions related to habitat restoration would result in an increased potential for bird-aircraft strikes under Alternative 3.

Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials.

As would occur under the No Action Alternative, the south Delta agricultural barriers would be installed, operated and removed annually (as conditions allow) under Alternative 3. There would be no site-specific habitat restoration or CVP or SWP facility improvements, or any other site-specific actions under Alternative 3 that would require construction activities. As such, Alternative 3 would not result in adverse effects related to hazards or hazardous materials relative to the No Action Alternative.

W.2.5.2 *Program-Level Effects*

Potential changes in mosquito-borne diseases related to habitat restoration.

Tidal habitat and floodplain habitat restoration under Alternative 3 has the potential to create mosquito breeding habitat. Implementing spawning and rearing habitat restoration would create or restore areas of floodplain habitat in the study area. As would occur under Alternative 1, floodplain habitat would be created or modified in locations throughout the study area, including in the American River, upper Sacramento River, and lower San Joaquin River basins, as part of the spawning and rearing projects. In addition, Reclamation would also restore approximately 8,000 acres of tidal habitat restoration in Suisun Marsh and/or the north Delta, as would occur under the No Action Alternative. An additional 25,000 acres of habitat in the Delta would be restored under Alternative 3.

The habitat restoration under Alternative 3 could increase the public's risk of exposure to mosquito-borne diseases due to increased mosquito breeding habitat. This effect would likely be substantially greater than under the No Action Alternative because the habitat restoration that would occur under Alternative 3 is substantially greater in magnitude than would occur under the No Action Alternative. However, it is important to note that the additional 25,000 acres of habitat would be restored where potentially suitable vector habitat already exists, and this habitat restoration would likely increase the number of mosquito predators as well. Regardless, implementation of Mitigation Measure HAZ-1 could avoid or minimize the potential for adverse effects related to increased mosquito breeding habitat through Reclamation's coordination with appropriate MCVDs in the study area during all phases of restoration (including design, implementation, and operations) to develop and implement site-specific mosquito management plans, which will include applicable BMPs from *Best Management Practices for Mosquito Control in California* (CDPH and MVCAC 2012).

Potential changes in the potential for Valley fever related to agricultural land irrigation.

As described in Appendix S, some changes in the total irrigated agricultural acreage in the Sacramento River, San Joaquin River, and Delta regions is possible with implementation of program actions of Alternative 3 (e.g., Delta Fish Species Conservation Hatchery, and Lower San Joaquin River habitat restoration). However, agricultural land could potentially be converted to non-agricultural use not as fallowed or idled land, but to another land use to accommodate these actions. Therefore, it is not expected that these actions would create large areas of open, undeveloped, dry land that may be conducive to the growth of *Coccidioides.*

Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption.

As discussed in Appendix G, newly created tidal habitat areas and lands formerly used for irrigated agriculture have the potential to become new sources of methylmercury. Under Alternative 3, given that there would be 6,000 acres of tidal habitat restoration and an additional 25,000 acres of habitat restoration implemented in the Delta and Suisun Marsh, it is reasonable to assume that some habitat restoration would likely occur on lands formerly used for irrigated agriculture; thus, the new tidal habitat would not necessarily be a new source of methylmercury to the Delta. However, the degree to which new tidal habitat areas may be future sources of methylmercury to the aquatic environment is uncertain. The specific siting and design of the restored areas would be factors that affect the potential for methylmercury generation, transport and bioaccumulation. OEHHA standards for the consumption of fish in the study area would continue to be implemented and thus would serve to protect people against the overconsumption of fish with increased body burdens of mercury.

Potential changes in the potential for bird-aircraft strikes related to habitat restoration.

Under Alternative 3, the increased tidal habitat and floodplain habitat in the study area, relative to the No Action Alternative, could potentially attract waterfowl and other birds to these restored locations. If these restored locations are in proximity to existing airport flight zones, there could be an increase in the potential for bird-aircraft strikes. Because there would be substantially more habitat restoration under Alternative 3 compared to the No Action Alternative, depending on the location of restored sites, the potential for bird-aircraft strikes would be greater under Alternative 3. However, for habitat restoration within 5 miles of a public-use airport, Reclamation will implement Mitigation Measure HAZ-2 and comply with FAA safety guidelines on wetlands and wildlife attractants as identified in the FAA Draft Advisory Circular 150/5200-33C Sections 1 and 2.4 (FAA 2019), to avoid or minimize the potential for bird-aircraft strikes resulting from habitat restoration.

Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials.

Certain program-level components of Alternative 3 (e.g., habitat restoration, small screen program, and other facility improvements) would involve the use of construction equipment. Potential hazards to the public associated with construction and operation and maintenance activities would be similar in nature to those discussed in Section W.2.3.1 for Alternative 1. In addition, if digging were required for facility improvements, underground natural gas pipelines could be damaged and potentially expose construction workers or others in close proximity to gas fumes. However, any construction requiring excavation will be designed to avoid affecting existing pipelines and other facilities. Access points and staging areas will be established for equipment storage and maintenance. As described for Alternative 1, for construction of facilities (including facility improvements that require construction activities) disturbing one or more acres, BMPs would be implemented under the Construction General Permit to control pollutant discharges. In addition, as described in Appendix G, implementation of Mitigation Measure WQ-1 would minimize the potential for, and effects from, spills of hazardous, toxic, and petroleum substances during construction and maintenance. No hazardous materials would be used in reportable quantities (pursuant to CCR, Title 19, Division 2) unless approved in advance by the OES, in which case a HMMP would be prepared and implemented, as described under Mitigation Measure HAZ-3. Accordingly, the potential for Alternative 3 to result in hazards to the public associated with hazardous materials would be similar to the No Action Alternative, and there would be no adverse effects.

W.2.6 Alternative 4

W.2.6.1 *Project-Level Effects*

Potential changes in mosquito-borne diseases related to habitat restoration.

No project-level actions related to habitat restoration would increase potential for mosquito-borne diseases under Alternative 4.

Potential changes in the potential for Valley fever related to agricultural land irrigation.

As discussed in Appendix R, SWAP modeling results indicate that relative to the No Action Alternative, in the Sacramento River Region there would be an overall reduction of irrigated agricultural land by 60 acres (less than 0.005 percent decrease) in average water years, and 2,427 acres (an approximate 0.1 percent decrease) in dry/critical years. There would be an overall reduction in irrigated agricultural land in the San Joaquin River region of 5,758 acres (an approximate 0.1 percent decrease) in average water years, and 12,333 acres (an approximate 0.3 percent decrease) in dry/critical years, relative to the No Action Alternative.

As described in Section W.1.3, generally, *Coccidioides* propagation and air entrainment occurs on soils that remain unirrigated during dry seasons, and the San Joaquin Valley and Central Coast are the major endemic regions in California. As such, because there would be an overall nominal reduction in irrigated acreage in the study area in the Sacramento River region, and because this region is not an endemic area for *Coccidioides,* it is unlikely that CVP and SWP operations in that region under Alternative 4 would result in an increased potential for Valley fever. Similarly, although *Coccidioides* is endemic to the San Joaquin Valley, in both dry/critical and average water year types there would be less than an 0.4 percent decrease in irrigated agricultural land in the entire San Joaquin River region relative to the No Action Alternative; therefore, it is unlikely that this minor reduction in irrigated land due to CVP and SWP operations would increase the potential for Valley fever in the region. Also, as discussed in Appendix R, Mitigation Measure AG-1 could reduce effects by encouraging water agencies to diversify their water portfolios, thus increasing likelihood that water users would have adequate water for agricultural irrigation.

Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption

As discussed in Appendix G, based on the overall lower fish tissue methylmercury concentrations at almost all modeled Delta locations, and modeled water concentrations, relative to the No Action Alternative, water operations under Alternative 4 would not contribute to additional water quality degradation with respect to methylmercury, or increased health risks to humans consuming fish from the Delta, Suisun Bay, and San Francisco Bay.

Potential changes in the potential for bird-aircraft strikes related to habitat restoration

No project-level actions related to habitat restoration would result in an increased potential for bird-aircraft strikes under Alternative 4.

Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials

As would occur under the No Action Alternative, the south Delta agricultural barriers would be installed, operated and removed annually (as conditions allow) under Alternative 4. There would be no site-specific habitat restoration or CVP or SWP facility improvements, or any other project-level site-specific actions under Alternative 4 that would require construction activities. As such, Alternative 4 would not result in adverse effects related to hazards or hazardous materials relative to the No Action Alternative.

As described for Alternative 1, for construction of facilities disturbing one or more acres, BMPs would be implemented under the Construction General Permit to control pollutant discharges. In addition, as described in Appendix G, implementation of Mitigation Measure WQ-1 would minimize the potential for, and effects from, spills of hazardous, toxic, and petroleum substances during construction and maintenance. No hazardous materials would be used in reportable quantities (pursuant to CCR, Title 19, Division 2) unless approved in advance by the OES, in which case a HMMP would be prepared and implemented, as described under Mitigation Measure HAZ-3. Accordingly, the potential for Alternative 4 to result in hazards to the public associated with hazardous materials would be similar to the No Action Alternative, and there would be no adverse effects.

W.2.6.2 *Program-Level Effects*

Potential changes in mosquito-borne diseases related to habitat restoration.

Under Alternative 4, there would be no tidal habitat restoration as would occur under the No Action Alternative, and no other habitat types would be restored under this alternative. Accordingly, there would be no increased potential for mosquito-borne diseases in the study area under Alternative 4.

Potential changes in the potential for Valley fever related to agricultural land irrigation.

Program-level actions under Alternative 4 that have the potential to affect irrigated agricultural land in the study area are related to alteration of land use for water efficiency. This may involve the conversion of land with exceptionally high water use or with irrigation problems to a different crop or to nonagricultural use. However, agricultural land could potentially be converted to non-agricultural use not as fallowed or idled land, but to another land use altogether (e.g., developed land). Conversion to another land use could reduce the potential for the growth of *Coccidioides* and thus the risk of Valley fever. Conversion to a different crop or implementation of other water-use efficiency measures (e.g., recycled water use, or improving pump efficiencies in distribution systems) would not result in a change in the potential for growth of *Coccidioides*. Therefore, there could potentially be a benefit due to agricultural land conversion or no change in the potential for Valley fever relative to the No Action Alternative.

Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption.

Under Alternative 4, there would be no tidal habitat restoration as would occur under the No Action Alternative, and no other habitat types would be restored under this alternative. Thus, relative to the No Action Alternative, Alternative 4 would not increase the potential for human exposure to mercury in the study area caused by increased bioaccumulation of methylmercury in fish and shellfish.

Potential changes in the potential for bird-aircraft strikes related to habitat restoration.

Under Alternative 4 there would be no habitat restoration as would occur under the No Action Alternative. Accordingly, there would be no increased potential for bird-aircraft strikes in the study area under this alternative relative to the No Action Alternative.

Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials.

Under Alternative 4, agricultural water users would increase irrigation efficiency by implementing efficient water management practices (EWMP). The implementation of some EWMPs could include construction, as well as operation and maintenance activities (e.g., lining irrigation canals, replacing irrigation canals with pipes, spill and tailwater systems).

As described for Alternative 1, for construction of facilities disturbing one or more acres, BMPs would be implemented under the Construction General Permit to control pollutant discharges. In addition, as described in Appendix G, implementation of Mitigation Measure WQ-1 would minimize the potential for, and effects from, spills of hazardous, toxic, and petroleum substances during construction and maintenance. No hazardous materials would be used in reportable quantities (pursuant to CCR, Title 19, Division 2) unless approved in advance by the OES, in which case a HMMP would be prepared and implemented, as described under Mitigation Measure HAZ-3. Accordingly, the potential for Alternative 4 to result in hazards to the public associated with hazardous materials would be similar to the No Action Alternative, and there would be no adverse effects.

W.2.7 Mitigation Measures

Mitigation Measure HAZ-1: Prepare and implement site-specific mosquito management plans

Reclamation will consult/coordinate with appropriate Mosquito and Vector Control Districts (MVCDs) in the study area prior to implementing tidal and floodplain habitat restoration to develop and implement site-specific mosquito management plans to aid in mosquito management. The mosquito management plans, which will include applicable BMPs from *Best Management Practices for Mosquito Control in California* (CDPH and MVCAC 2012), will address habitat design considerations, water management practices, vegetation management, biological controls, and restored habitat maintenance.

Mitigation Measure HAZ-2: Comply with FAA safety guidelines on wetlands and wildlife attractants as identified in the FAA Draft Advisory Circular 150/5200-33C

For habitat restoration in the study area that is within 5 miles of a public use airport and has the potential to attract waterfowl and other birds, Reclamation will comply with FAA safety guidelines on wetlands and wildlife attractants, as identified in the FAA Draft Advisory Circular 150/5200-33C Sections 1 and 2.4 (FAA 2019), to avoid or minimize the potential for bird-aircraft strikes resulting from habitat restoration.

Mitigation Measure HAZ-3: Prepare and Implement a Hazardous Materials Management Plan for Actions that will Require Handling Hazardous Materials in Reportable Quantities (CCR, Title 19, Division 2)

For actions that will require handling hazardous materials in quantities equal to or greater than 55 gallons of a liquid, 500 pounds of a solid, or 200 cubic feet of compressed gas, or extremely hazardous substances above the threshold planning quantity (40 CFR, Part 355, Appendix A), Reclamation will prepare and implement a HMMP. The HMMP will contain, at minimum, the following:

- A site plan;
- An emergency plan;
- An inventory of hazardous materials;
- A description of preventative measures to be implemented to avoid accidental spills, hazardous materials management, and storage;
- A description of the actions that will be taken in the event of a hazardous material spill;
- A training program for employees on the safe use, storage of hazardous materials on site.

Mitigation Measure AG-1: Diversify water portfolios.

Please refer to Appendix R, *Land Use and Agricultural Resources Technical Appendix*, for a description of this mitigation measure.

Mitigation Measure WQ-1: Implement a spill prevention, control, and countermeasure plan

Please refer to Appendix G, *Water Quality Technical Appendix,* for a description of this mitigation measure.

W.2.8 Summary of Impacts

Table W.2-1 includes a summary of impacts, the magnitude and direction of those impacts, and potential mitigation measures for consideration.

Table W.2-1. Impact Summary

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential changes in mosquito-borne diseases related to habitat restoration (Project-Level)	No Action	No impact	–
	1	No impact	–
	2	No impact	–
	3	No impact	–
	4	No impact	–
Potential changes in mosquito-borne diseases related to habitat restoration (Program-Level)	No Action	No impact	–
	1	Program-level tidal and floodplain habitat restoration could provide suitable mosquito breeding habitat in the study area, which would potentially increase the public's risk of exposure to mosquito-borne diseases.	MM HAZ-1
	2	No impact	–
	3	Program-level tidal and floodplain habitat restoration components could provide suitable mosquito breeding habitat in the study area, which would potentially increase the public's risk of exposure to mosquito-borne diseases.	MM HAZ-1
	4	No impact	–
Potential changes in the potential for Valley fever related to agricultural land irrigation (Project-Level)	No Action	No impact	–
	1	No impact	–
	2	No impact	–
	3	No impact	–
	4	Irrigated farmland acreage would decrease in the San Joaquin River region, which could change the potential for Valley fever.	MM AG-1
Potential changes in the potential for Valley fever related to agricultural land irrigation (Program-Level)	No Action	No impact	–
	1	No impact	–
	2	No impact	–
	3	No impact	–
	4	Potential beneficial effect as a result of conversion of agricultural land to non-agricultural uses.	–

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption (Project-Level).	No Action	No impact	–
	1	No impact	–
	2	No impact	–
	3	No impact	–
	4	No impact	–
Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption (Program-Level).	No Action	No impact	–
	1	No impact	–
	2	No impact	–
	3	Program-level habitat restoration in the Delta could result in a greater potential for methylmercury generation in the restored areas and bioaccumulation in fish and shellfish, which could increase the potential for human exposure to mercury through fish consumption.	–[1]
	4	No impact	–
Potential changes in the potential for bird-aircraft strikes related to habitat restoration (Project-Level).	No Action	No impact	–
	1	No impact	–
	2	No impact	–
	3	No impact	–
	4	No impact	–
Potential changes in the potential for bird-aircraft strikes related to habitat restoration (Program-Level).	No Action	No impact	–
	1	Program-level habitat restoration of the type that could attract waterfowl and other birds to restored areas within 5 miles of a public-use airport could increase the potential for bird-aircraft strikes.	MM HAZ-2
	2	No impact	–
	3	Program-level habitat restoration of the type that could attract waterfowl and other birds to restored areas within 5 miles of a public-use airport could increase the potential for bird-aircraft strikes.	MM HAZ-2
	4	No impact	–

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials (Project-Level)	No Action	No impact	–
	1	No impact	–
	2	No impact	–
	3	No impact	–
	4	No impact	–
Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials (Program-Level)	No Action	No impact	–
	1	Program-level construction and/or operation and maintenance of facilities could result in the potential for hazards to the public or environment through the transport, use, accidental release, or disposal of hazardous materials, as well as through damage to existing hazardous infrastructure (e.g., natural gas pipelines).	MM HAZ-3 MM WQ-1
	2	No impact	–
	3	Program-level construction and/or operation and maintenance of facilities could result in the potential for hazards to the public or environment through the transport, use, accidental release, or disposal of hazardous materials, as well as through damage to existing hazardous infrastructure (e.g., natural gas pipelines).	MM HAZ-3 MM WQ-1
	4	Program-level construction and/or operation and maintenance of facilities could result in the potential for hazards to the public or environment through the transport, use, accidental release, or disposal of hazardous materials, as well as through damage to existing hazardous infrastructure (e.g., natural gas pipelines).	MM HAZ-3 MM WQ-1

[1] The degree to which new tidal habitat areas may be future sources of methylmercury to the aquatic environment is uncertain. The specific siting and design of the restored areas would be factors that affect the potential for methylmercury generation, transport and bioaccumulation. OEHHA standards for the consumption of fish in the study area would continue to be implemented and thus would serve to protect people against the overconsumption of fish with increased body burdens of mercury.

W.2.9 Cumulative Effects

The following impacts related to hazards and hazardous materials could, when considered with other past, present, and reasonably foreseeable future projects identified in Appendix Y, *Cumulative Methodology,* result in cumulative effects.

- Potential changes in mosquito-borne diseases related to habitat restoration;
- Potential changes in the potential for Valley fever related to agricultural land irrigation.
- Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption;
- Potential changes in the potential for bird-aircraft strikes related to habitat restoration; and
- Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials .

Potential changes in mosquito-borne diseases related to habitat restoration.

Implementation of the No Action Alternative would add approximately 8,000 acres of tidal habitat relative to existing conditions in Suisun Marsh and/or the north Delta. While it is likely that this type of habitat could provide favorable conditions for mosquito breeding and reproduction and thereby contribute to a cumulative effect, all restoration activities would be designed to minimize the potential for stagnant water and other conditions favorable to the production of mosquitoes, and that these activities would occur in consultation with applicable MCVDs. Therefore, the No Action Alternative would not contribute to an adverse cumulative effect of increasing the public's risk of exposure to mosquito-borne diseases.

Alternatives 1 and 3 would implement tidal and floodplain habitat restoration that could create conditions conducive to mosquito breeding and reproduction (e.g., increase aquatic habitat such that there may be water levels that slowly increase or recede compared to water levels that are stable or that rapidly fluctuate, substantially increase emergent vegetation, or create standing water) in the study area. Similarly, implementation of projects considered in this cumulative analysis, including, but not limited to Sites Reservoir Project, Semitropic Water Storage District Delta Wetlands, Prospect Island Tidal Habitat Restoration Project, and Suisun Marsh Habitat Management, Preservation, and Restoration Plan could also result or have resulted in an increase in habitat suitable for mosquitos. Because mosquitoes can be host to diseases that would affect public health, Alternatives 1 and 3 could contribute to cumulative effect of potentially increasing mosquito-borne diseases in the study area.

The contribution of Alternative 3 to the cumulative effect would be greater because a substantially greater number of acres would be restored under this alternative relative to Alternative 1. However, it is important to note that habitat suitable for mosquito breeding and reproduction is already present in the study area, and programs to prevent mosquitoes from breeding and multiplying are being widely implemented by MVCDs and others. In addition, implementation of Mitigation Measure HAZ-1 is expected to reduce the incremental contribution of Alternatives 1 and 3 to an adverse cumulative effect. As described for Mitigation Measure HAZ-1, Reclamation will consult/coordinate with appropriate MVCDs prior to implementing tidal and floodplain habitat restoration to develop and implement site-specific mosquito management plans to aid in mosquito management and reduce the potential for an increase in mosquito breeding habitat. Therefore, Alternatives 1 and 3, would not contribute substantially to an adverse cumulative effect related to increasing the potential for mosquito-borne diseases in the study area.

Potential changes in the potential for Valley fever related to agricultural land irrigation.

Past, present, and reasonably foreseeable projects that have or would result in the reduction or limitation of the availability of water for irrigation in the study area (e.g., the Bay-Delta Water Quality Control Plan Update, Sustainable Groundwater Management Act), particularly in the San Joaquin Valley and the Central Coast (i.e., the areas where *Coccidioides* is endemic), may create conditions suitable for *Coccidioides* growth and dispersal. Under Alternative 4 there would be an overall reduction in irrigated agricultural land in the San Joaquin River region of approximately 0.1 percent in average water years and 0.3 percent in dry/critical years. Although *Coccidioides* is endemic to the San Joaquin Valley, it is unlikely that this reduction in irrigated agricultural land would substantially contribute to the adverse cumulative effect of Valley fever risk because the irrigated acreage reduction is relatively nominal in all water year types. However, as discussed in Appendix R, Mitigation Measure AG-1 could reduce effects by encouraging water agencies to diversify their water portfolios, thus increasing the likelihood that water users would have adequate water for agricultural irrigation.

Potential changes in methylmercury production and resultant changes in bioaccumulation in fish and shellfish for human consumption.

Tidal habitat restoration under the No Action Alternative could create conditions resulting in increased methylation of mercury within the Delta, increased biotic exposure to and uptake of methylmercury, and therefore increased mercury bioaccumulation in fish and shellfish. Under existing conditions, the Delta is impaired by mercury, and there are a number of regulatory efforts being implemented to control and reduce mercury and methylmercury in the Delta, as discussed in Appendix G. Tidal habitat design and location considerations would minimize increases in the production of methylmercury and thus methylmercury bioaccumulation in fish and shellfish. Thus, the No Action Alternative would have no contribution to the cumulative production and bioaccumulation of methylmercury. .

Tidal habitat restoration under Alternative 1 and Alternative 3 could create conditions resulting in increased methylation of mercury within the Delta, which would result in increased exposure to and uptake of methylmercury by fish and shellfish, and mercury bioaccumulation fish tissues. Because more habitat would be restored in the Delta under Alternative 3 relative to Alternative 1, the magnitude of potential increased methylation of mercury would likely be substantially greater. Increased bioaccumulation of methylmercury in fish and shellfish under both Alternative 1 and Alternative 3 would contribute to the adverse cumulative effect of methylmercury in the Delta region. The degree to which newly created tidal habitat will become a new source of methylmercury in the Delta will depend on tidal habitat siting and design. OEHHA standards for the consumption of fish in the study area would continue to be implemented and thus would serve to protect people against the overconsumption of fish with increased body burdens of mercury.

Potential changes in the potential for bird-aircraft strikes related to habitat restoration.

Implementation of tidal and floodplain habitat under Alternatives 1 and 3, and tidal habitat under the No Action Alternative in the study area could potentially attract waterfowl and other birds. If these restored locations are in proximity to existing airport flight zones, there could be an increase in the potential for bird-aircraft strikes, which would contribute to the adverse cumulative effect in the study area. Because there would be substantially more habitat restoration under Alternative 3 relative to Alternative 1, depending on the location of restored sites, the potential for bird-aircraft strikes would be greater under Alternative 3. Any similar type of restoration implemented under past, present, or reasonably foreseeable projects could also create the potential for bird-aircraft strikes if located near an airport. However, because under both Alternative 1 and Alternative 3 Reclamation would comply with FAA safety guidelines on wetlands and wildlife attractants (Mitigation Measure HAZ-2) for any habitat restoration within 5 miles of a public-use airport that may attract waterfowl or other birds, neither of these alternatives would contribute incrementally to a cumulative increase in the potential for bird-aircraft strikes in the study area.

Potential changes in the potential for construction and operation and maintenance activities to result in hazards and effects related to hazardous materials .

Construction and/or operation and maintenance of facilities under the No Action Alternative, as well as under Alternatives 1, 3, and 4, could create the potential for hazards to the public or environment through the transport, use, accidental release, or disposal of hazardous materials. Construction activities under the No Action Alternative, and Alternatives 1 and 3 could damage existing hazardous infrastructure, such as natural gas pipelines. In addition, Alternative 1 would entail herbicide and algaecide application to aquatic weeds and algae at CCF on an as-needed basis. It is reasonable to assume that actions implemented as part of past, present and reasonably foreseeable future projects that involve the use, transport or storage of hazardous materials, or excavation near hazardous infrastructure (e.g., California High- Speed Rail System Merced to Fresno Section, Sites Reservoir Project, North Bay Aqueduct Alternative Intake, Los Vaqueros Reservoir Expansion Phase 2) would result in similar hazards.

Projects under the No Action Alternative have already undergone state and/or federal environmental review, it is assumed that any potential impacts related to hazards or hazardous material use, storage, or transport will be avoided or minimized through adherence to current environmental permits. Therefore, the No Action Alternative would not contribute to potential cumulative effects related to hazards and hazardous materials.

To minimize, avoid, and reduce effects related to hazards and hazardous materials, for construction activities under Alternatives 1, 3, and 4 that would disturb one or more acres, BMPs would be implemented under the Construction General Permit to control pollutant discharges. No hazardous materials would be used in reportable quantities (pursuant to CCR, Title 19, Division 2) unless approved in advance by the OES, in which case a HMMP would be prepared and implemented, as described under Mitigation Measure HAZ-3. Mitigation Measure WQ-1 would minimize the potential for, and effects from, spills of hazardous, toxic, and petroleum substances during construction and maintenance. BMPs would be implemented under the General Pesticide Permit, for herbicide and algaecide application at CCF under Alternative 1. Therefore, Alternatives 1, 3, and 4 would not substantially contribute to potential adverse cumulative effects related to hazards and hazardous materials.

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Appendix X Geology and Soils Technical Appendix

This appendix documents the geology and soils technical analysis to support the impact analysis in the EIS.

X.1 Introduction

This technical appendix describes the geology and soils resources in the study area, and potential changes that could occur as a result of implementing the action alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect geology and soils resources through potential changes in operations of the Central Valley Project (CVP) and State Water Project (SWP). The affected environment is described in Section X.2, *Affected Environment*, and evaluation of alternatives and potential impacts is discussed in Section X.3, *Evaluation of Alternatives*.

X.2 Affected Environment

This section describes the affected environment for the study area regarding the geological setting, regional seismic and soils characteristics, and subsidence potential that could be potentially affected by the implementation of the alternatives considered in this EIS. Changes in geology and soils characteristics caused by changes in CVP and SWP operations may occur in the Trinity River region; Central Valley, including affected subwatersheds in the lower reaches of the Sacramento River, Clear Creek, Feather River, American River, San Joaquin River, and Stanislaus River; Bay-Delta region; and CVP and SWP service areas. Geomorphic provinces in California are shown on Figure X.2-1.

X.2.1 Trinity River Region

The Trinity River region includes the area in Trinity County along the Trinity River from Trinity Lake to the confluence with the Klamath River, and the areas in Humboldt and Del Norte Counties along the Klamath River from the confluence with the Trinity River to the Pacific Ocean.

X.2.1.1 *Geologic Setting*

The Trinity River region is located within the southwest area of the Klamath Mountains Geomorphic Province and the northwest area of the Coast Ranges Geomorphic Province, as defined by the U.S. Geological Survey (USGS) geomorphic provinces (CGS 2002). The Klamath Mountains Geomorphic Province covers approximately 12,000 square miles of northwestern California between the Coast Range on the west and the Cascade Range on the east and is considered to be a northern extension of the Sierra Nevada (CGS 2002; Reclamation 1997).

Figure X.2-1. Geomorphic Provinces in California

The Klamath Mountains trend mostly northward. The province is primarily formed by the eastern Klamath Mountain belt, central metamorphic belt, the western Paleozoic and Triassic belts, and the western Jurassic belt. Rocks in this province include Paleozoic meta-sedimentary and meta-volcanic rocks, Mesozoic igneous rocks, Ordovician to Jurassic-aged marine deposits in the Klamath belt; Paleozoic hornblend, mica schists, and ultramafic rocks in the central metamorphic belt; and slightly metamorphosed sedimentary and volcanic rocks in the western Jurassic, Paleozoic, and Triassic belts (Reclamation 1997).

The affected environment of the Trinity River watershed is located within the Klamath Mountain Geomorphic Province. Although the Trinity River watershed includes portions of both the Coast Ranges Province and the Klamath Mountains Province, the Trinity River channel is underlain by rocks of the Klamath Mountains Province (NCRWQCB and Reclamation 2009). The Klamath Mountains Province formations generally dip toward the east and are exposed along the river channel. Downstream of Lewiston Dam to Deadwood Creek, the area is underlain by the Eastern Klamath Terrane of the Klamath Mountains Province. The rocks in this area are primarily Copley Greenstone, metamorphosed volcanic sequence with intermediate and mafic volcanic rocks, and Bragdon formation, metamorphosed sedimentary formation with gneiss and amphibolite. Along the Trinity River between Lewiston Dam and Douglas City, outcrops of the Weaverville Formation occur. The Weaverville Formation, a series of nonmarine deposits, includes weakly consolidated mudstone, sandstone, and conglomerate of clays matrix and sparse beds of tuff. Downstream of Douglas City, the Trinity River is underlain by the Northfork and Hayfork Terranes. The Northfork Terrane near Douglas City includes silicious tuff, chert, mafic volcanic rock, phyllite, and limestone sandstone and pebble conglomerate with serpentine intrusions. As the Trinity River channel extends downstream toward the Klamath River, the geologic formation extends into the Hayfork Terrane that consists of metamorphic and meta-volcanic rock. Terraces of sand and gravel from glacial erosion along the Trinity River flanks near Lewiston Dam contribute sediment into the Trinity River.

The Trinity River flows into the Klamath River near Weitchpec. Downstream of the Weitchpec, the Klamath River flows to the Pacific Ocean through the Coast Ranges Geomorphic Province. The geology along the Klamath River in the Coast Ranges Geomorphic Province is characterized by the Eastern Belt of the Franciscan Complex and portions of the Central Belt of this complex. The Franciscan Complex consists of sandstone with some shale, chert, limestone, conglomerate, serpentine, and blueschist. The Eastern Belt is composed of schist and meta-sedimentary rocks with minor amounts of shale, chert, and conglomerate. The Central Belt is primarily composed of an argillite-matrix mélange with slabs of greenstone, serpentine, graywacke, chert, high-grade metamorphics, and limestone.

X.2.1.2 *Seismicity*

The areas along the Trinity River have been categorized as regions that are distant from known, active faults and generally would experience infrequent, low levels of shaking. However, infrequent earthquakes with stronger shaking could occur (CGS 2008). The closest areas to the Trinity River with known seismic, active areas capable of producing an earthquake with a magnitude of 8.5 or greater are the northern San Andreas Fault Zone and the Cascadia Subduction Zone, which are approximately 62 and 124 miles away, respectively (NCRWQCB and Reclamation 2009).

The areas along the lower Klamath River downstream of the confluence with the Trinity River have a slightly higher potential for greater ground shaking than areas along the Trinity River (CGS 2008). The lower Klamath River is closer than the Trinity River to the offshore Cascadia Subduction Zone, which runs offshore of Humboldt and Del Norte Counties and the states of Oregon and Washington. The Klamath River is approximately 30 to 40 miles from the Trinidad Fault, which extends from the area near

Trinidad northwest to the coast near Trinidad State Beach. The Trinidad Fault is potentially capable of generating an earthquake with a moment magnitude of 7.3 (Humboldt County 2012).

The San Andreas Fault, under the Pacific Ocean in a northwestern direction from the Humboldt and Del Norte Counties, is where the Pacific Plate moves toward the northwest relative to North America (Humboldt County 2012). The Cascadia Subduction Zone, located under the Pacific Ocean offshore from Cape Mendocino in southwest Humboldt County to Vancouver Island in British Columbia, has produced earthquakes with magnitudes greater than 8. The Cascadia Subduction Zone is where the Gorda Plate and the associated Juan de Fuca Plate descend under the North American Plate.

X.2.1.3 *Volcanic Potential*

Active centers of volcanic activity occur in the vicinity of Mount Shasta, near the northeastern edge of the Trinity River region. Mount Shasta is about 45 miles north of Shasta Lake. Over the past 10,000 years, Mount Shasta erupted about once every 800 years. During the past 4,500 years, Mount Shasta erupted about once every 600 years with the most recent eruption in 1786. Lava flows, dome, and mudflows occurred during the eruptions (Reclamation 2013).

X.2.1.4 *Soil Characteristics*

Soils in the southern region of the Klamath Mountain Geomorphic Province, where the Trinity River is located, are generally composed of gravelly loam with some alluvial areas with dredge tailings, river wash, and xerofluvents (NCRWQCB and Reclamation 2009).

Soils along the lower Klamath River are generally composed of gravelly clay loam and gravelly sandy loam with sand and gravels within the alluvial deposits (USDOI and CDFG 2012). Alluvial deposits (river gravels) and dredge tailings provide important spawning habitat for Salmon and Steelhead.

X.2.1.5 *Subsidence*

Land subsidence is not a major occurrence in the Trinity River region.

X.2.2 Central Valley

The Central Valley contains the largest collective watershed in California, including six subwatersheds potentially affected by implementation of action alternatives: the Sacramento River, Clear Creek, Feather River, American River, Stanislaus River, and San Joaquin River watersheds. The Central Valley extends from above Shasta Lake in the north to the Tehachapi Mountains in the south, and includes the Sacramento Valley and San Joaquin Valley.

X.2.2.1 *Geologic Setting*

The Central Valley is located within the Great Valley Geomorphic Province, and is bounded by the Klamath Mountains, Cascade Range, Coast Ranges, and Sierra Nevada Geomorphic Provinces (CGS 2002).

The Great Valley Geomorphic Province is a vast elongated basin, approximately 430-miles-long, and 50-miles-wide, that extends from the northwest to the southeast, and bounded between the Sierra Nevada and Coast Ranges Geomorphic Provinces to the east and west, respectively. The faulted and folded sediments of the Coast Ranges extend eastward beneath most of the Central Valley. The igneous and metamorphic rocks of the Sierra Nevada extend westward beneath the eastern Central Valley (Reclamation 1997). The valley floor is an alluvial plain of sediments that have been deposited since the Jurassic age (CGS 2002). Below these deposits are Cretaceous Great Valley Sequence shales and sandstones and upper Jurassic bedrock of metamorphic and igneous rocks associated in the east with the Sierra Nevada and in the west with the Coast Ranges (DWR 2007). The trough of the Great Valley Geomorphic Province is asymmetrically filled with up to 6 vertical miles of Jurassic- to Holocene-age sediments. The trough is primarily made up of Tertiary and Quaternary continental rocks and deposits, which become separated by lacustrine, marsh, and floodplain deposits of varying thicknesses. Sediments deposited along the submarine fans within the Great Valley Geomorphic Province include mudstones, sandstones, and conglomerates from the Klamath Mountains and Sierra Nevada Geomorphic Provinces.

The valley floor in the Great Valley Geomorphic Province includes dissected uplands, low alluvial fans and plains, river floodplains and channels, and overflow lands and lake bottoms. The dissected uplands include consolidated and unconsolidated Tertiary and Quaternary continental deposits. The alluvial fans along the western boundary include poorly sorted fine sand, silt, and clay. The alluvial fans along the eastern boundary consist of well sorted gravel and sand along major tributaries, and poorly sorted materials along intermittent streams. River and floodplains primarily consist of coarse sands and fine silts. The lake bottoms primarily occur in the southern San Joaquin Valley and are composed of clay layers (Reclamation 1997).

The Sacramento Valley is in the northern portion of the Great Valley Geomorphic Province and is drained by the Sacramento River and its tributaries. Extending approximately 180-miles-long and 40- to 60-miles-wide, the Sacramento Valley lies between the Coast Ranges on the west and the Sierra Nevada on the east, and is bounded at the north end by the Cascade Geomorphic Province near Redding, and extends southeasterly to the Delta near Stockton. The surface of the Sacramento Valley consists of recent and Pleistocene-age alluvium deposited into the bottomlands by streams draining the surrounding highlands of the Klamath Mountain Geomorphic Province to the north and the Sierra Nevada and Coast Range geomorphic provinces to the east and west, respectively. These stream sediments consist of heterogeneous deposits of channel gravels, river bank sands, silt, and clay deposited on the broad floodplain that has become the Sacramento Valley (DeCourten 2008)

The San Joaquin Valley is in the southern half of the Great Valley Geomorphic Province and is drained by the San Joaquin River and its tributaries. The 250-mile-long and 50- to 60-mile-wide San Joaquin Valley lies between the Coast Ranges on the west and the Sierra Nevada on the east, and extends northwesterly to the Delta near Stockton. The continental deposits, which include the Mehrten, Kern River, Laguna, San Joaquin, Tulare, Tehama, Turlock, Riverbank, and Modesto Formations, form the San Joaquin Valley aquifer (Ferriz 2001; Reclamation and DWR 2011; Reclamation 2009).

Dissected uplands, low alluvial fans and plains, river floodplains and channels, and overflow lands and lake bottoms are the several geomorphic land types within the San Joaquin Valley. Dissected uplands consist of slightly folded and faulted, consolidated and unconsolidated, Tertiary- and Quaternary-age continental deposits. The alluvial fans and plains, which cover most of the valley floor, consist of unconsolidated continental deposits that extend from the edges of the valley toward the valley floor. In general, alluvial sediments of the western and southern parts of the San Joaquin Valley tend to have lower permeability than deposits on the eastern side. River floodplains and channels lie along the major rivers and are well defined where rivers incise their alluvial fans. Typically, these deposits are coarse and sandy in the channels and finer and silty in the floodplains (Reclamation and DWR 2011).

Lake bottoms of overflow lands in the San Joaquin Valley include historic beds of Tulare Lake, Buena Vista Lake, and Kern Lake as well as other less defined areas in the valley trough. Near the valley trough, fluvial deposits of the east and west sides grade into fine-grained deposits. The largest lake deposits in the

Central Valley are found beneath the Tulare Lake bed, where up to 3,600 feet of lacustrine and marsh deposits form the Tulare Formation. This formation is composed of widespread clay layers, the most extensive being the Cocoran Clay member, which also is found in the western and southern portions of the San Joaquin Valley. The Cocoran Clay member is a confining layer that separates the upper semi-confined to unconfined aquifer from the lower confined aquifer (Reclamation 1997).

Watersheds within the Sacramento Valley that could be affected by CVP and SWP operations include the Sacramento River, Clear Creek, Feather River, and the lower American River watersheds. Watersheds within the San Joaquin Valley that could be affected by CVP and SWP operations include the San Joaquin River and Stanislaus River watersheds. Descriptions of the geological settings of the Sacramento Valley and San Joaquin Valley watersheds follow.

X.2.2.1.1 Sacramento River

The Sacramento River flows from Shasta Lake to the Delta. The area along the Sacramento River from Shasta Lake to downstream of Red Bluff is characterized by loosely consolidated deposits of Pliocene- and/or Pleistocene-age sandstone, shale, and gravel. Downstream of Red Bluff to the Delta, the river flows through Quaternary-age alluvium, lake, playa, and terrace deposits that are unconsolidated or poorly consolidated with outcrops of resistant, cemented alluvial units such as the Modesto and Riverbank formations (CALFED 2000).

The active river channel maintains roughly constant dimensions as it migrates across the floodplain within the limits of the meander belt which is constrained only by outcrops of resistant units or artificial bank protection. Sediment loads in the tributary streams and lower reaches of the Sacramento River include the effects of past and current land use practices on the tributary streams.

X.2.2.1.2 Clear Creek

Clear Creek is a tributary to the upper Sacramento River. The reach affected by the project is the lower portion of Clear Creek from Whiskeytown Dam to its point of discharge into the Sacramento River near the southwestern edge of the Redding city limits.

Formations of Tertiary and Quaternary age occupy most of the area of the Great Valley Geomorphic Province, including lower Clear Creek. Tertiary rocks in the lower Clear Creek area are included in the Tehama Formation of Pliocene age (Helley and Harwood 1985), consisting of sandstone and siltstone with lenses of conglomerate derived from the Coast Ranges and Klamath Mountains to the west and north. The Tehama Formation grades eastward into the Tuscan Formation, which consists of volcanic and volcanoclastic rocks erupted and transported from volcanic vents in the Cascades volcanic province to the east. The Nomlaki Tuff Member of the Tehama Formation is locally exposed in bluffs along Clear Creek and gulches incised into the terrace on the north side of Clear Creek. In the vicinity of lower Clear Creek it is typically a white or pale gray, massive, non-welded pumice lapilli tuff. Its stratigraphic position is at or near the base of the Tehama Formation. The flood plain of Clear Creek, including low terraces adjacent to the active stream channel, is underlain by alluvium of Holocene age. The bulk of this alluvial material is likely gravel and sand. As a result of restricted sediment supply in the current hydrologic regime, stream erosion has locally exposed the substrate beneath the gravel, described as a hard-pan clay layer (McBain & Trush 2001) composed of weathered Nomlaki Tuff, or in some cases relatively clay-rich weathered Tehama Formation (USGS 2008).

The placer deposits of lower Clear Creek have been mined intermittently by various methods since the 1850s (Clark 1970; Averill 1933), with the result that all the alluvial gravel forming the flood plain of

Clear Creek and most of the gravel capping adjacent terraces has been disturbed. In addition, aggregate mining in recent decades has removed gravel from the lower Clear Creek alluvial system from in-stream and off-stream mining pits (USGS 2008).

X.2.2.1.3 Feather River

Portions of the Feather River watershed analyzed in this EIS extend from Antelope Lake, Lake Davis, and Frenchman Lake upstream of Lake Oroville, through Lake Oroville and the Thermalito Reservoir complex, and along the Feather River to the confluence with the Sacramento River. The Yuba and Bear Rivers are the major tributaries to the Feather River downstream of Thermalito Dam.

The Feather River watershed upstream of Thermalito Dam is located in the Cascade Range Geomorphic Province and the metamorphic belt of the Sierra Nevada Geomorphic Province. The lower watershed downstream of Thermalito Dam is located in the Great Valley Geomorphic Province.

West of Lake Oroville, scattered sedimentary and volcanic deposits cover the older bedrock, including (from oldest to youngest) the marine Chico formation from the upper Cretaceous; the auriferous gravels and mostly nonmarine Ione Formation of the Eocene Epoch; the extrusive volcanic Lovejoy basalt of the late Oligocene to early Miocene; and volcanic flows and volcanoclastic rocks of the Tuscan Formation of the late Pliocene. Late Tertiary and Quaternary units in this area include alluvial terrace and fan deposits of the Plio-Pleistocene Laguna Formation, the Riverbank and Modesto Formations of the Pleistocene, riverbed sediments of the Holocene, and historical dredge and mine tailings from twentieth century mining activities (DWR 2007).

Alluvium deposits occur in active channels of the Feather, Bear, and Yuba Rivers and tributary streams. These deposits contain clay, silt, sand, gravel, cobbles, and boulders in various layers and mixtures. Historical upstream hydraulic mining substantially increased the sediment covering the lower Feather River riverbed with a thick deposit of fine clay-rich, light yellow-brown slickens (i.e., powdery matter from a quartz mill or residue from hydraulic mining). More recent floodplain deposits cover these slickens in the banks along most of the Feather River; cobbles and coarse gravel dredge tailings constitute most of the banks, slowing the bank erosion process between the cities of Oroville and Gridley. The river is wide and shallow, with low sinuosity and a sand bed between Honcut Creek and the mouth of the Feather River.

X.2.2.1.4 American River

The Folsom Lake area is located within the Sierra Nevada and the Great Valley Geomorphic Province at the confluence of the North and South Forks of the American River. The Folsom Lake region primarily consists of rolling hills and upland plateaus between major river canyons. Three major geologic divisions within the area are a north-northwest trending belt of metamorphic rocks, granitic plutons that have intruded and obliterated some of the metamorphic belt, and deposits of volcanic ash, debris flows, and alluvial fans that are relatively flat. These deposits overlie older rocks (Reclamation et al. 2006).

Igneous, metamorphic, and sedimentary rock types are present within the Folsom Lake area. Major rock divisions are ultramafic intrusive rocks, metamorphic rocks, granodiorite intrusive rocks, and volcanic mud flows and alluvial deposits. Ultramafic rocks are most common on Flagstaff Mountain (Hill) on the Folsom Reservoir Peninsula between the North Fork American River and South Fork American River. This rock division may contain trace amounts of serpentine minerals, chromite, minor nickel, talc, and naturally occurring asbestos (Reclamation et al. 2006).

Metamorphic rocks are found in a north-northwest trending band primarily on the eastern portions of the Folsom Lake area through most of the peninsula between the North Fork American River and South Fork American River (CGS 2010). The metamorphic rocks are mainly composed of Copperhill Volcanics (metamorphosed basaltic breccia, pillow lava, and ash) and ultramafic rocks, two formations that may contain trace amounts of naturally occurring asbestos (Reclamation et al. 2006).

Granodiorite intrusive rocks occur in the Rocklin Pluton on both sides of Folsom Lake extending to Lake Natoma and in the Penryn Pluton upstream of the Rocklin Pluton. Granodiorite intrusive rocks are composed of a coarse-grained crystalline matrix with slightly more iron and magnesium-bearing minerals and less quartz than granite. Of the granodiorite, the feldspar and hornblend are less resistant than the quartz crystals and easily weather. When weathering occurs, the remaining feldspars separate from the quartz, resulting in decomposed granite (Reclamation et al. 2006).

Volcanic mud flows and alluvial deposits are present downstream of Folsom Lake in the southwest corner of two major formations: Mehrten and Laguna. The Mehrten Formation contains volcanic conglomerate, sandstone, and siltstone, all derived from andesitic sources, and portions are gravels deposited by ancestral streams. The Laguna Formation, deposited predominately as debris flow on the Mehrten Formation, is a sequence of gravel, sand, and silt derived from granitic sources (Reclamation et al. 2006).

The area along the American River downstream of Folsom Lake and Nimbus Dam is located in the Great Valley Geomorphic Province. The area includes several geomorphic land types including dissected uplands and low foothills, low alluvial fans and plains, and river floodplains and channels. The dissected uplands consist of consolidated and unconsolidated continental Tertiary and Quaternary deposits that have been slightly folded and faulted (Reclamation 2005b).

The alluvial fans and plains consist of unconsolidated continental deposits that extend from the edges of the valleys toward the valley floor (Reclamation 2005b). The alluvial plains in the American River watershed include older Quaternary deposits (Sacramento County 2010). River flood plains and channel deposits lay along the American River as well as along smaller streams that flow into the Sacramento River south of the American River. Some floodplains are well defined, where rivers are incised into their alluvial fans. These deposits tend to be coarse and sandy in the channels and finer and silty in the floodplains (Reclamation 2005b; Sacramento County 2010).

X.2.2.2 *San Joaquin River and Stanislaus River*

X.2.2.2.1 <u>San Joaquin River</u>

The San Joaquin River watershed originates in the Sierra Nevada Geomorphic Province and the lower San Joaquin River extends into the Great Valley Geomorphic Province below Millerton Lake (Friant Dam). The area is underlain by Cenozoic sedimentary rocks which dip toward the southwest and overlies the Cretaceous sedimentary rocks of the Great Valley Sequence and older metamorphic basement rocks along the edges of the Sierra Nevada. Below Lake Millerton, the lower San Joaquin River flows through the agricultural region of the northern San Joaquin Valley to the Bay-Delta area at the confluence of the Sacramento River. The lower San Joaquin River is a low-gradient, single-channel, generally sand-bedded, meandering river. Most of the banks are natural, however, there are large sections that have revetted sloping banks covered with large rocks to reduce bank erosion and river migration (USGS 2017a).

X.2.2.2.2 Stanislaus River

The Stanislaus River watershed originates in the Sierra Nevada Geomorphic Province, including the area with New Melones Reservoir, and extends into the Great Valley Geomorphic Province. New Melones Reservoir is oriented along a northwest trend that is produced by the Foothill Metamorphic Belt in the Sierra Nevada Geomorphic Province (Reclamation 2010). The area is underlain by Cenozoic sedimentary rocks which dip toward the southwest and overlies the Cretaceous sedimentary rocks of the Great Valley Sequence and older metamorphic basement rocks along the edges of the Sierra Nevada. Tertiary sedimentary formations were deposited along the Stanislaus River from an area east of Knights Ferry to Oakdale (CGS 1977). The oldest Tertiary geologic unit, the Eocene Ione Formation, primarily consists of quartz, sandstone, and interbedded kaolinitic clays with a maximum thickness of about 200 feet near Knights Ferry. The Oligocene-Miocene Valley Springs Formation of rhyolitic ash, sandy clay, and gravel deposits overlay the Ione Formation. Andestic flows, lahars, and volcanic sediments of the Mehrten Formation were deposited by volcanism, especially from Table Mountain (CGS 1977; Reclamation 2010). Three major alluvial fan deposits occurred along the Stanislaus River after deposition of the Mehrten Formation, including the Turlock Lake Formation (between Orange Blossom Road and Oakdale) composed of fine sand and silt with some clay, sand, and gravel; Riverbank Formation (between Oakdale and Riverbank) composed of silt and clay; and Modesto Formation (between Riverbank and the confluence with the San Joaquin River) composed of sand, silt, clay, and gravel.

X.2.2.3 *Seismicity*

Most of the areas in the Central Valley have been categorized as regions that are distant from known, active faults and generally would experience infrequent, low levels of shaking. However, infrequent earthquakes with stronger shaking could occur (CGS 2008). Areas within and adjacent to the Bay-Delta region and along Interstate 5) in the San Joaquin Valley have a higher potential for stronger ground shaking due to their close proximity to the San Andreas Fault Zone.

The San Andreas Fault Zone is to the west of the Central Valley along a 150-mile northwest-trending fault zone (Reclamation 2005d). The fault zone extends from the Gulf of California to Point Reyes, where the fault extends under the Pacific Ocean (CGS 2006). The fault zone is the largest active fault in California (Reclamation 2005d).

In the Sacramento Valley, the major fault zones include the Battle Creek Fault to the east of the Sacramento River, Corning Fault that extends from Red Bluff to Artois parallel to the Corning Canal, Dunnigan Hills Fault located west of I-5 near Dunnigan, Cleveland Fault located near Oroville, and Great Valley Fault system along the west side of the Sacramento Valley (Reclamation 2005a).

In the San Joaquin Valley, the eastern foothills are characterized by strike-slip faults that occur because the rock underlying the valley sediment is slowly moving downward relative to the Sierra Nevada Block to the east. An example of this type of faulting is the Kings Canyon lineament, which crosses the valley north of Chowchilla and continues nearly to Death Valley in southeastern California (Reclamation and DWR 2011). Uplift and tilting of the Sierra Nevada block toward the west and tilting of the Coast Ranges block to the east appear to be causing gradual downward movement of the valley basement rock, in addition to subsidence caused by aquifer compaction and soil compaction discussed below. The San Joaquin Valley is bounded by the Stockton Fault of the Stockton Arch on the north and the Bakersfield Arch on the south. Most of the fault zones in the San Joaquin Valley do not appear to be active. However, numerous faults may not be known until future seismic events; an example of this fault discovery is the Nunez reverse fault, which was not known until the 1983 Coalinga earthquake. In areas adjacent to the San Joaquin Valley, the dominant active fault structure is the Great Valley blind thrust associated with the

San Andreas Fault. Other active faults occur along the western boundary of the San Joaquin Valley, including the Hayward, Concord-Green Valley, Coast Ranges-Sierra Block boundary thrusts, Mount Diablo, Greenville, Ortigalita, Rinconada, and Hosgri Faults (Reclamation 2005d).

X.2.2.4 *Volcanic Potential*

Active centers of volcanic activity occur in the vicinity of Mount Shasta and Lassen Peak in the northern Central Valley. Mount Shasta is about 45 miles north of Shasta Lake. Over the past 10,000 years, Mount Shasta erupted about once every 800 years. During the past 4,500 years, Mount Shasta erupted about once every 600 years with the last eruption in 1786. Lava flows, domes, and mudflows occurred during the eruptions (Reclamation 2013).

Lassen Peak, about 50 miles southeast of Shasta Lake, is a cluster of dacitic domes and vents that have formed during eruptions over the past 250,000 years. The last eruptions were relatively small and occurred between 1914 and 1917. The most recent large eruption occurred about 1,100 years ago. Large eruptions appear to occur about once every 10,000 years (USGS 2000a).

X.2.2.5 *Soil Characteristics*

The Central Valley includes the Sacramento Valley and San Joaquin Valley. The soil characteristics are similar in many aspects in the Sacramento and San Joaquin Valleys; therefore, the descriptions are combined in the following sections.

X.2.2.5.1 Sacramento Valley and San Joaquin Valley Soil Characteristics

The Sacramento Valley and San Joaquin Valley contain terrace land and upland soils along the foothills. Alluvial, Aeolian, clayey, and saline/alkaline soils exist in various locations along the valley floors (CALFED 2000; Reclamation 1997).

Foothills soils, located on well-drained, hilly-to-mountainous terrain along the east side of the Central Valley, form through in-place weathering of the underlying rock. Soils in the northern Sacramento Valley near Shasta Lake are different than soils along other foothills in the Sacramento and San Joaquin Valleys. The soils near Shasta Lake are related to the geologic formations of the Klamath Mountains, Cascade Ranges, and Sierra Nevada geomorphic provinces. These soils are formed from weathered metavolcanic and metasedimentary rocks and from intrusions of granitic rocks, serpentine, and basalt. These soils are generally shallow with numerous areas of gravels, cobbles, and stones; therefore, they do not have high water-holding capacity or support topsoil productivity for vegetation (Reclamation 2013). Soils derived from in-place weathering of granitic rock, referred to as decomposed granite, are coarse-grained, quartz-rich, and erodible.

Upland soils along other foothills in the Sacramento and San Joaquin Valleys are formed from the Sierra Nevada and Coast Ranges geomorphic provinces. Along the western boundary of the Central Valley, the soils primarily are formed from sedimentary rocks. Along the eastern boundary of the Central Valley, the soils primarily are formed from igneous and metamorphic rock. The soils include serpentine soils (which include magnesium, nickel, cobalt, chromium, iron, and asbestos); sedimentary sandstones; shales; conglomerates; and sandy loam, loam, and clay loam soils above bedrock (Reclamation 1997; Reclamation and DWR 2011; Reclamation 2013; DWR 2007). Erosion occurs in the upland soils around reservoirs and rivers especially downgradient of urban development where paving increases the peak flow, volume, and velocity of precipitation runoff (GCI 2003).

Along the western boundary of the Sacramento Valley and the southeastern boundary of the San Joaquin Valley, the terrace lands include brownish loam, silt loam, and/or clayey loam soils. The soils are generally loamy along the Sacramento Valley terraces, and more clayey along the San Joaquin Valley terraces. Along the eastern boundaries of Sacramento and San Joaquin valleys, the terraces are primarily red silica-iron cemented hardpan and clays, sometimes with calcium carbonate (also known as lime) (DWR 2007; Reclamation 1997; Reclamation 2005b; Reclamation 2012).

Surface soils of the Central Valley include alluvial and Aeolian soils. The alluvial soils include calcic brown and noncalcic brown alluvial soils on deep alluvial fans and floodplains. The calcic brown soil is primarily made of calcium carbonate and alkaline (also known as "calcareous" soils). The noncalcic brown soils do not contain calcium carbonate and are either slightly acidic or neutral in chemical properties. In the western San Joaquin Valley, light colored calcareous soils occur with less organic matter than the brown soils (Reclamation 1997).

Soils within the Yolo Bypass area, located in the southwestern portion of the Sacramento Valley, range from clays to silty clay loams and alluvial soils (CALFED 2001; CDFG 2008). The higher clay content soils occur in the western portion of the area north of I-80 and in the eastern portion of the area south of I-80. The silty clay loams and alluvial soils occur in the western portion of the Yolo Bypass area south of I-80, including soils within the Yolo Bypass Wildlife Area.

Basin soils occur in the San Joaquin Valley and portions of the Delta. These soils include organic soils, imperfectly drained soils, and saline alkali soils. The organic soils are typically dark, acidic, high in organic matter, and generally include peat. The organic soils occur in the Delta, as discussed below, and along the lower San Joaquin River adjacent to the Delta. The poorly drained soils contain dark clays and occur in areas with high groundwater in the San Joaquin Valley trough and as lake bed deposits (Reclamation and DWR 2011). One of the most substantial stratigraphic features of the San Joaquin Valley and a major aquitard is the Corcoran Clay, located in the western and central valley (Galloway and Riley 1999). The Corcoran Clay generally extends from Mendota Pool area through the center of the valley to the Tehachapi Mountains. The depth to the Corcoran Clay varies from 160 feet under the Tulare Lake bed to less than a foot near the western edge of the Central Valley. The Corcoran Clay is composed of numerous aquitards and coarser interbeds.

Selenium salts and other salts occur naturally in the western and central San Joaquin Valley soils that are derived from marine sedimentary rocks of the Coast Ranges. Salts are leached from the soils by applied pre-irrigation and irrigation water and collected by a series of drains. The drains also reduce high groundwater elevations in areas with shallow clay soils. Reclamation and other agencies are implementing programs to reduce salinity issues in the San Joaquin Valley that will convey and dispose of drainage water in a manner that would protect the surface water and groundwater resources (Reclamation and DWR 2011). As described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, areas in the western and southern San Joaquin Valley are affected by shallow, saline groundwater that accumulates because of irrigation; and the shallow groundwater is underlain by soils with poor drainage.

Soils in the eastern San Joaquin Valley come from the Sierra Nevada and contain low levels of salt and selenium. Most soils in the western and southern San Joaquin Valley are formed from Coast Range marine sediments, and contain higher concentrations of salts as well as selenium and molybdenum. Soluble selenium moves from soils into drainage water and groundwater, especially during agricultural operations to leach salts from the soils. As described in Appendix D, *Alternatives Formulation*, Reclamation and other agencies are implementing programs to reduce the discharge of selenium from the San Joaquin Valley into receiving waters (Reclamation 2005d; Reclamation and DWR 2011; Reclamation

2009). Additional information related to concerns with salinity and selenium in the San Joaquin Valley is presented in Appendix G, *Water Quality Technical Appendix*, and Appendix R, *Land Use and Agricultural Resources Technical Appendix*.

Soil wind erosion is related to soil erodibility, wind speeds, soil moisture, surface roughness, and vegetative cover. Aeolian soils are more susceptible to wind erosion than alluvial soils. Nonirrigated soils that have been disturbed by cultivation or other activities throughout the Central Valley are more susceptible to wind erosion and subsequent blowing dust than soils with more soil moisture. Dust from eroding soils can create hazards due to soil composition (such as naturally occurring asbestos), allergic reactions to dust, adverse impacts to plants due to dust, and increased risk of Valley fever (Reclamation 2005d).

X.2.2.6 *Subsidence*

Land subsidence occurs for different reasons throughout the Central Valley as described in the following sections.

X.2.2.6.1 Sacramento and San Joaquin Valley Subsidence

Land subsidence in the Sacramento and San Joaquin Valleys occurs primarily due to aquifer-system compaction as groundwater elevations decline as a result of groundwater overdraft (i.e., groundwater withdrawals at rates greater than groundwater recharge rates) typically used for irrigation. To a lesser degree, subsidence is also caused by weathering of some types of underlying bedrock, such as limestone; decomposition of organic matter; and natural compaction of soils (Reclamation 2013). Historic subsidence of the Sacramento Valley has been far less than that observed in the San Joaquin Valley. For example, the range of historic subsidence in the Sacramento Valley is generally less than 10 feet, whereas historical subsidence in the San Joaquin Valley has caused changes in land elevations ranging from as much as 28 feet (USGS 2017b) to more than 30 feet (Reclamation and DWR 2011).

In the 1970s, land subsidence exceeded 1 foot near Zamora; however, additional subsidence has not been reported since 1973 (Reclamation 2013). Subsidence of 2 feet near Davis and 3 to 4 feet has been reported over the last several decades in the areas north of Woodland and east of Davis and Woodland (Davis 2007).

San Joaquin Valley subsidence primarily occurs when groundwater elevations decline due to pumping for irrigation water supply, which reduces water pressure in the soils and results in compressed clay lenses and subsided land elevations. Secondary factors that may influence the rate of subsidence in the San Joaquin Valley is the Sierran uplift, sediment loading and compressional down-warping or thrust loading from the Coast Ranges, and near surface compaction (Reclamation and DWR 2011). Some of the first reports of land subsidence in the San Joaquin Valley occurred in 1935 in the area near Delano (Galloway and Riley 1999). By the late 1960s, San Joaquin Valley subsidence had occurred over 5,212 square miles, or almost 50% of the San Joaquin Valley (Reclamation 2005d). The rate of subsidence decreased initially following implementation of CVP and SWP water supplies in the San Joaquin Valley during the 1970s and 1980s. Subsidence for the next 20 years appeared to continue at a rate of 0.008 to 0.016 inches/year (Reclamation and DWR 2011). However, the amount of water available for irrigation from the CVP and SWP has declined more than 20% to 30% since the early 1980s due to hydrologic, regulatory, and operational concerns, as described in Chapter 2, *Purpose and Need*. Due to the reduction in the availability of CVP and SWP water supplies, many water users have increased groundwater withdrawal. A recent study by the USGS of subsidence along the CVP Delta-Mendota Canal (USGS 2013a) reported that in areas where groundwater levels fluctuated consistently on a seasonal basis but were stable on a long-term basis, the land elevations also were relatively stable. Subsidence occurred in portions of the San Joaquin Valley where groundwater elevations below the Corcoran clay and in the shallow groundwater declined on a long-term basis between 2003 and 2010. The highest subsidence rates occurred along the Delta Mendota Canal between Merced and Mendota with subsidence of 0.8 inches to 21 inches between 2003 and 2010 (USGS 2013a).

Shallow subsidence, or hydrocompaction, occurs when low density, relatively dry, fine-grained sediments soften and collapse upon wetting. Historically, hydrocompaction has been most common along the western margin of the San Joaquin Valley (Reclamation 2005c). In the southern San Joaquin Valley, extraction of oil also can result in compaction. Changes in elevation, both subsidence and uplift, occurred near Coalinga following the 1983 Coalinga earthquake with uplift up to 1.6 feet and subsidence of 2 inches.

X.2.3 Bay-Delta Region

The Bay-Delta region includes portions of Alameda, Santa Clara, San Benito, and Napa Counties that are within the CVP and SWP service areas. Portions of Napa County are within the SWP service area and use water diverted from Barker Slough in the Sacramento River watershed for portions of Solano and Napa Counties.

X.2.3.1 *Geologic Setting*

The Bay-Delta region is a northwest-trending structural basin, separating the primarily granitic rock of the Sierra Nevada from the primarily Franciscan Formation rock of the California Coast Ranges (CWDD 1981). The Bay-Delta region is a basin within the Great Valley Geomorphic Province that is filled with a 3- to 6-mile-thick layer of sediment deposited by streams originating in the Sierra Nevada, Coast Ranges, and South Cascade Range. Surficial geologic units throughout the Bay-Delta include peat and organic soils, alluvium, levee and channel deposits, dune sand deposits, older alluvium, and bedrock.

The historical delta at the confluence of the Sacramento River and San Joaquin River is referred to as the Sacramento–San Joaquin Delta, or Delta. The Delta is a flat-lying river delta that evolved at the inland margin of the San Francisco Bay Estuary as two overlapping and coalescing geomorphic units: the Sacramento River Delta to the north and the San Joaquin River Delta to the south. During large river-flood events, silts and sands were deposited adjacent to the river channel, formed as a tidal marsh with few natural levees, and was dominated by tidal flows, allowing for landward accumulation of sediment behind the bedrock barrier at the Carquinez Strait. The sediment formed marshlands, which consisted of approximately 100 islands that were surrounded by hundreds of miles of channels. Generally, mineral soils formed near the channels during flood conditions and organic soils formed on marsh island interiors, as plant residues accumulated faster than they could decompose (Weir 1949).

In the past, because the San Joaquin River Delta had less defined levees than under current conditions, sediments were deposited more uniformly across the floodplain during high water, creating an extensive tule marsh with many small, branching tributary channels. Because of the differential amounts of inorganic sediment supply, the peat of the San Joaquin River Delta grades northward into peaty mud and mud toward the natural levees and flood basins of the Sacramento River Delta (Atwater and Belknap 1980).

The Delta has experienced several cycles of deposition, nondeposition, and erosion that have resulted in the thick accumulation of poorly consolidated to unconsolidated sediments overlying the Cretaceous and Tertiary formations since late Quaternary time. Shlemon and Begg (1975) calculated that the peat and organic soils in the Delta began to form about 11,000 years ago during an episode of sea-level rise. Tule marshes established on peat and organic soils in many portions of the Delta. Additional peat and other organic soils formed from repeated inundation and accumulation of sediment of the tules and other marsh vegetation.

X.2.3.1.1 Suisun Marsh

The Suisun Marsh area is located within the Coast Ranges Geomorphic Province. The Suisun Marsh is bounded by the steep Coast Ranges on the west and by the rolling Montezuma Hills on the east. The Montezuma Hills consist of uplifted Pleistocene sedimentary layers with active Holocene-age alluvium in stream drainages that divide the uplift. Low-lying flat areas of the marshland are covered by Holocene-age Bay Mud deposits. The topographically higher central portions of Grizzly Island in the marshlands north of the Suisun Bay are formed by the Potrero Hills. These hills primarily consist of folded and faulted Eocene marine sedimentary rocks and late Pleistocene alluvial fan deposits (Reclamation et al. 2010).

X.2.3.1.2 San Francisco Bay

The San Francisco Bay area is located primarily within the Coast Ranges Geomorphic Province. Eastern Contra Costa and Alameda Counties are located in the Great Valley Geomorphic Province. The Coast Ranges and Great Valley Geomorphic Provinces were described in Section X.2.2, *Central Valley*. San Francisco Bay is a structural trough formed as a gap in the Coast Range down-dropped, allowing the Sacramento, San Joaquin, Napa, Guadalupe, and Coyote Rivers to flow into the Pacific Ocean. When the polar ice caps melted 10,000 to 25,000 years ago, the ocean filled the inland valleys of the trough and formed San Francisco Bay, San Pablo Bay, and Suisun Bay (CALFED 2000). Initially, alluvial sands, silts, and clays filled the bays to form Bay Mud along the shoreline areas. More recently, sedimentation patterns have changed over the past 170 years due to development of upstream areas of the watersheds, including hydraulic mining and formation of levees and dams.

The San Francisco Bay is formed from the Salinian block located west of the San Andreas Fault, Mesozoic Franciscan Complex between the San Andreas and Hayward Faults, and the Great Valley Sequence to the east of Hayward Fault (WTA 2003). The Salinian block generally is composed of granitic plutonic rocks probably from the Sierra Nevada Batholith that was displaced because of movement along the San Andreas Fault. The Franciscan Complex includes deep marine sandstone and shale formed from oceanic crust with chert and limestone. The Great Valley Sequence in the area primarily includes marine sedimentary rocks.

X.2.3.2 *Seismicity*

Large earthquakes have occurred in the Bay-Delta region along the San Andreas, Hayward, Calaveras, Greenville, Antioch, Concord-Green Valley, Midway, Midland, and Black Butte Fault Zones over the past 10,000 years. The San Francisco earthquake of 1906 took place as the result of movement along the San Andreas Fault, and more recently the Loma Prieta earthquake of 1989 occurred in the Santa Cruz Mountains on a somewhat remote segment of the San Andreas Fault (USGS 2001). The San Andreas Fault remains active, as does the Hayward Fault, based on evidence of slippage along both (CALFED 2000).

The Delta and Suisun Marsh are near several major fault systems, including the San Andreas, Hayward-Rodgers Creek, Calaveras, Concord-Green Valley, and Greenville Faults (DWR et al. 2013). There are also many named and unnamed regional faults in the vicinity. The majority of seismic sources underlying the Delta and Suisun Marsh are "blind" thrusts that are not expected to rupture to the ground surface during an earthquake. The known blind thrusts in the Delta and Suisun Marsh area include the Midland, Montezuma Hills, Thornton Arch, Western Tracy, Midland, and Vernalis Faults. Blind thrust faults with discernible geomorphic expression/trace located at the surface occur near the southwestern boundary of the Delta are the Black Butte and Midway Faults. Two surface crustal fault zones (e.g., areas with localized deformation of geologic features near the surface) are located within the Suisun Marsh, including the Pittsburgh-Kirby Hills fault, which occurs along an alignment between Fairfield and Pittsburg, and Concord-Green Valley fault, which crosses the western portion of the Suisun Marsh. The Cordelia fault is a surface crustal fault zone that occurs near the western boundary of the Suisun Marsh. Since 1800, no earthquakes with a magnitude greater than 5.0 have been recorded in the Delta or Suisun Marsh.

X.2.3.3 *Soil Characteristics*

The Bay-Delta region soils include basin floor/basin rim, floodplain/valley land, terrace, foothill, and mountain soils (CALFED 2000). Basin floor/basin rim soils are organic-rich saline soils and poorly drained clays, clay loams, silty clay loams, and muck along the San Francisco Bay shoreline (SCS 1977, 1981; CALFED 2000). Well-drained sands and loamy sands and poorly drained silty loams, clay loams, and clays occur on gently sloping alluvial fans of the Bay-Delta that surround the floodplain and valley lands. Drained loams, silty loams, silty clay loams, and clay loams interbedded with sedimentary rock and some igneous rock occur in the foothills. Terrace loams are located along the southeastern edge of the Bay-Delta above the valley land.

X.2.3.3.1 Delta Soil Characteristics

Soils in the Delta region include organic and/or highly organic mineral soils, deltaic soils along the Sacramento and San Joaquin Rivers, basin rim soils, floodplain and stream terrace soils, valley alluvial and low terrace soils, and upland and high terrace soils (Reclamation 1997). Basin, deltaic, and organic soils occupy the lowest elevation ranges and are often protected by levees. In many areas of the western Delta, the soils contain substantial organic matter and are classified as peat or muck.

Basin rim soils are found along the eastern edges (rims) of the Delta, and are generally moderately deep or deep mineral soils that are poorly drained to well-drained and have fine textures in surface horizons. Some areas contain soils with a hardpan layer in the subsurface (SCS 1992, 1993). Floodplain and stream terrace soils are mineral soils adjacent to the Sacramento and San Joaquin Rivers and other major tributaries. These soils are typically deep and stratified, with relatively poor drainage and fine textures. Valley fill, alluvial fan, and low terrace soils are typically very deep with variable texture and ability to transmit water, ranging from somewhat poorly drained silt loams and silty clay loams to well-drained fine sandy loams and silt loams. Upland and high terrace soils are generally well drained, ranging in texture from loams to clays and are primarily formed in material weathered from sandstone, shale, and siltstone, and can occur on dissected terraces or on mountainous uplands.

Soil erosion by rainfall or flowing water occurs when raindrops detach soil particles or when flowing water erodes and transports soil material. Sandy alluvial soils, silty lacustrine soil, and highly organic soil are erodible. Organic soil (peat) in the Delta is also susceptible to wind erosion (deflation). Clay soils are more resistant to erosion.

X.2.3.3.2 Suisun Marsh Soil Characteristics

Soil within the Suisun Bay include the Joice muck, Suisun peaty muck, and Tamba mucky clay, Reyes silty clay, and Valdez loam (SCS 1977; Reclamation et al. 2010). The Joice muck generally is poorly drained organic soils in saline water areas interspersed with fine-grain sediment. Suisun peaty muck is formed from dark colored organic soils and plant materials with high permeability. These soils are generally located in areas with shallow surface water and groundwater; therefore, surface water tends to accumulate on the surface. Tamba mucky clay also is poorly drained organic soil formed from alluvial soils and plant materials that overlays mucky clays. Reyes silty clays are poorly drained soils formed from alluvium. The upper layers of the silty clays are acidic and saline. The lower layers are alkaline that become acidic when exposed to air, especially under wetting-drying conditions in tidal areas. Valdez loam soils are poorly drained soils formed on alluvial fans.

Suisun Marsh soils have a low susceptibility to water and wind erosion (SCS 1977; Reclamation et al. 2010).

X.2.3.4 *Subsidence*

Subsidence in the Bay-Delta occurs primarily in the Santa Clara Valley of Santa Clara County. The Santa Clara Valley is underlain by a groundwater aquifer with layers of unconsolidated porous soils interspersed with clay lenses. Historically, when the groundwater aquifer was in overdraft, the water pressure in the soils declined, which resulted in compressed clay lenses and subsided land elevations. Between 1940 and 1970, soils near San Francisco Bay declined to elevations below sea level (SCVWD 2000). Under these conditions, salt water intrusion and tidal flooding occurred in the tributary streams of Guadalupe River and Coyote Creek. As of 2000, the land elevation in downtown San Jose subsided 13 feet since 1915. In 1951, water deliveries from San Francisco Water Department were initiated (Ingebritsen and Jones 1999). In 1965, SWP deliveries were initiated in Santa Clara County. CVP water deliveries were initiated in 1987. The CVP and SWP water supplies are used to reduce groundwater withdrawals when groundwater elevations are low to allow natural recharge from local surface waters. The CVP and SWP water supplies also are used to directly recharge the groundwater through spreading basins in Santa Clara Valley.

X.2.3.4.1 Delta and Suisun Marsh Subsidence

Land subsidence on the islands in the central and western Delta and Suisun Marsh may be caused by the elimination of tidal inundation that formed the islands through sediment deposition and transport, and the oxidation and decay of plant materials that would compact to form soils. Following construction of levees, subsidence initially occurred through the mechanical settling of peat as the soil dried, and then the dried peat and other soils shrank (Reclamation et al. 2010; Drexler et al. 2009). Other contributing factors include agricultural burning of peat (a practice that has been discontinued), wind erosion, oxidation, and leaching of organic material. The rate of subsidence has declined from a maximum of 1.1 to 4.6 inches/year in the 1950s to less than 0.2 to 1.2 inches/year in the western Delta (Drexler et al. 2009; Rojstaczer et al. 1991). Many of the islands in the western and central Delta have subsided to elevations that are 10 to nearly 55 feet below sea level (USGS 2000b; Deverel and Leighton 2010).

Recently, the California Department of Water Resources (DWR) has implemented several projects to reverse subsidence. The 274-acre Mayberry Farms Duck Club Subsidence Reversal Project on Sherman Island includes creation of emergent wetlands ponds and channels through excavation of peat soils, improvement of water circulation, and waterfowl habitat. The facility was constructed in 2010 and is being monitored to determine the effectiveness of subsidence reversal, methyl mercury management, and carbon sequestration (Angell et al. 2013). Prior to that, DWR and USGS implemented wetlands restoration for about 15 acres on Twitchell Island in 1997 (DWR and USGS 2013) to encourage tule and cattail growth. After the growing season, the decomposed plant material accumulates and increases the land elevation. Since 1997, elevations have increased at a rate of 1.3 to 2.2 inches/year.

X.2.4 CVP and SWP Service Areas

The CVP and SWP service areas extend south to the general area of Diamond Valley. These services areas include the Central Coast and Southern California regions.

Portions of San Luis Obispo and Santa Barbara Counties on the Central Coast are served by the SWP. Portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino Counties in Southern California are served by the SWP.

In Southern California, operations of the SWP affect the Coachella Valley in Riverside County. The Coachella Valley Water District receives water under a SWP entitlement contract; however, SWP water cannot be conveyed directly to the Coachella Valley due to lack of conveyance facilities. Therefore, Coachella Valley Water District receives water from the Colorado River through an exchange agreement with the Metropolitan Water District of Southern California, as described in Appendix C, *Facility Descriptions and Operations*. The Imperial Valley in Southern California receives irrigation water from the Colorado River through Reclamation canals, and does not use CVP or SWP water.

X.2.4.1 *Geologic Setting*

The Central Coast and Southern California regions are located in the geomorphic provinces of the Coast Ranges, Transverse Ranges, Peninsular Ranges, Colorado Desert, and Mojave Desert (CGS 2002).

Portions of San Luis Obispo and Santa Barbara Counties use SWP water supplies. These areas are located within the Coast Ranges and Transverse Ranges Geomorphic Provinces. The Coast Ranges Geomorphic Province was described in Section X.2.2, *Central Valley*. The Transverse Ranges Geomorphic Province consists of deeply folded and faulted sedimentary rocks (CGS 2002; SBCAG 2013). Bedrock along the stream channels, coastal terraces, and coastal lowlands is overlain by alluvial and terrace deposits; and, in some area, ancient sand dunes. The geomorphic province is being uplifted at the southern border along San Andreas Fault and compressed at the northern border along the Coast Ranges Geomorphic Province. Therefore, the geologic structure of the ridges and valleys are oriented along an east-west orientation, or in a *transverse* orientation, compared to the north-south orientation of the Coast Range.

Portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino Counties use SWP water supplies. These areas are located within the geomorphic provinces of the Transverse Ranges, Peninsular Ranges, Mojave Desert, and Colorado Desert. The Transverse Ranges Geomorphic Province includes Ventura County and portions of Los Angeles, San Bernardino, and Riverside Counties. The Colorado Desert Geomorphic Province is also known as the Salton Trough, where the Pacific and North American plates are separating.

The Peninsular Ranges Geomorphic Province is composed of granitic rock with metamorphic rocks (CGS 2002; SCAG 2011; San Diego County 2011). The geologic structure is similar to the geology of the Sierra Nevada Geomorphic Province. The faulting of this geomorphic province has resulted in northwest trending valleys and ridges that extend into the Pacific Ocean to form the islands of Santa Catalina, Santa Barbara, San Clemente, and San Nicolas. The Peninsular Ranges Geomorphic Province includes Orange County and portions of southern Los Angeles County, western San Diego County, northwestern San

Bernardino County, and northern Riverside County (including the northern portion of the Coachella Valley).

The Mojave Desert Geomorphic Province lies between the Garlock Fault along the southern boundary of the Sierra Nevada Geomorphic Province and the San Andreas Fault (CGS 2002; SCAG 2011; RCIP 2000). This geomorphic province includes extensive alluvial basins with nonmarine sediments from the surrounding mountains and foothills; many isolated ephemeral lakebeds (also known as playas) occur within this region with tributary streams from isolated mountain ranges. The Mojave Desert Geomorphic Province includes portions of Kern, Los Angeles, Riverside, and San Bernardino Counties.

The Colorado Desert Geomorphic Province, or Salton Trough, is characterized by a geographically depressed desert that extends northward from the Gulf of California (located at the mouth of the Colorado River) toward the Mojave Desert Geomorphic Province where the Pacific and North American plates are separating (CGS 2002; SCAG 2011; RCIP 2000; San Diego County 2011). Large portions of this geomorphic province were formed by the inundation of the ancient Lake Cahuilla and are filled with sediments several miles thick from the historical Colorado River overflows and erosion of the Peninsular Ranges uplands. The Salton Trough is separated from the Gulf of California by a large ridge of sediment. The Salton Sea is within the trough along an ancient playa. The Colorado Desert Geomorphic Province includes portions of Riverside County in the Coachella Valley, and portions of San Diego County and Imperial County that are located outside of the study area.

X.2.4.2 *Seismicity*

CVP and SWP service areas in the Central Coast and Southern California are characterized by active faults that are capable of producing major earthquakes with substantial ground displacement. The San Andreas Fault Zone extends from the Gulf of California in a northwest direction throughout the central coast and Southern California regions (CGS 2006).

Within portions of San Luis Obispo County that use SWP water supplies, the Nacimiento Fault also can result in major seismic events (CGS 2006; San Luis Obispo County 2010).

The northern portions of Santa Barbara County that use SWP water supplies include Lion’s Head Fault along the Pacific Ocean shoreline to the southwest of Santa Maria and along the northern boundary of Vandenberg Air Force Base (CGS 2006; SBCAG 2013). The Big Pine Fault may extend into the Vandenberg Air Force Base area. Areas near the mouth of the Santa Ynez River and Point Arguello could be affected by Lompoc Terrace Fault and Santa Ynez-Pacifico Fault Zone. The Santa Ynez Fault extends across this county and could affect communities near Santa Ynez. Along the southern coast of Santa Barbara County from Goleta to Carpinteria, the area includes many active faults, including More Ranch, Mission Ridge, Arroyo Parida, and Red Mountain Faults, and potentially active faults, including Goleta, Mesa-Rincon, and Carpinteria Faults.

Portions of Ventura County that use SWP water supplies are located in the southern portion of the county adjacent to Los Angeles County. Major faults in this area are: Oak Ridge Fault, which extends into the Oxnard Plain along the south side of the Santa Clara River Valley and may extend into San Fernando Valley in Los Angeles County; Bailey Fault, which extends from the Pacific Ocean to the Camarillo Fault; Simi-Santa Rosa, Camarillo, and Springville Faults in Simi and Tierra Rejada Valleys and near Camarillo; and Sycamore Canyon and Boney Mountain Faults, which extend from the Pacific Ocean toward Thousand Oaks (CGS 2006; Ventura County 2011).

Los Angeles County major fault zones are: Northridge Hills, San Gabriel, San Fernando, Verduga, Sierra Madre, Raymond, Hollywood, Santa Monica, and Malibu Coast Fault Zones; Elysian Park Fold and Thrust Belt in Los Angeles County; and Newport, Inglewood, Whittier, and Palos Verdes Fault Zones, which extend into Los Angeles and Orange Counties (CGS 2006; City of Los Angeles 2005). Recent major seismic events that have occurred in Southern California along faults in Los Angeles are the 1971 San Fernando, 1987 Whittier Narrows, 1991 Sierra Madre, and 1994 Northridge earthquakes.

Riverside and San Bernardino Counties are characterized by the San Andreas Fault Zone that extends from the eastern boundaries of these counties and crosses to the western side of San Bernardino County (CGS 2006; RCIP 2000; Riverside County 2000; SCAG 2011; DWR 2009). The San Jacinto Fault Zone also extends through the center of Riverside County and along the western side of San Bernardino County. The Elsinore Fault Zone extends along the western sides of both counties. In San Bernardino County, the Cucamonga Fault extends into Los Angeles County, where it intersects with the Sierra Madre and Raymond Faults. The Garlock and Lockhart Fault Zones extend into both San Bernardino and Kern Counties. San Bernardino County also includes several other major fault zones, including North Frontal and Helendale Faults.

Portions of San Diego County that use SWP water supplies include the Rose Canyon Fault Zone along the Pacific Ocean shoreline, extending into the city of San Diego (San Diego County 2011).

X.2.4.3 *Soil Characteristics*

In the Central Coast region, areas within San Luis Obispo and Santa Barbara Counties that use SWP water supplies are located within coastal valleys or along the Pacific Ocean shoreline. In San Luis Obispo County, Morro Bay, Pismo Beach, and Oceano along the coast have soils that range from sands and loamy sands in areas near the shoreline to shaley loams, clay loams, and clays in the terraces and foothills located along the eastern boundaries of these communities (SBCAG 2013; NRCS 2014a; NRCS 2014b). In Santa Barbara County, the Santa Maria, Vandenberg Air Force Base, Santa Ynez, Goleta, Santa Barbara, and Carpinteria areas are in alluvial plains, along stream channels with alluvium deposits, along the shoreline, or along marine terrace deposits above the Pacific Ocean. The soils range from sands, sandy loams, loams, shaley loams, and clay loams in the alluvial soils and along the shoreline. The terrace deposits include silty clays, clay loams, and clays (NRCS 2014c; NRCS 2014d; NRCS 2014e; SCS 1972; SCS 1981).

Southern California soils include gravelly loams and gravelly sands, sands, sandy loams and loamy sands, and silty loams along the Pacific Coast shorelines and on alluvial plains. The mountains and foothills of the region include silty loams, cobbly silty loam, gravelly loam, sandy clay loams, clay loams, silty clays, and clays (SCAG 2011; UCCE 2014; SCS 1978; SCS 1986; SCS 1973). The inland region in Riverside and San Bernardino Counties have sand, silty clays, cobbles, and boulders on the alluvial fans, valley floor, terraces, and mountains, and dry lake beds (CVWD 2011).

X.2.4.4 *Subsidence*

Subsidence in the Central Coast and Southern California regions occurs because of soil compaction following groundwater overdraft, oil and gas withdrawal, seismic activity, and hydroconsolidation of soils along alluvial fans (City of Los Angeles 2005). The USGS described areas with subsidence related to groundwater overdraft in the Central Coast and Southern California regions in San Luis Obispo, Santa Barbara, Los Angeles, Riverside, and Santa Bernardino Counties (USGS 1999; Ventura County 2011; City of Los Angeles 2005; RCIP 2000). Many of the areas with subsidence have alluvial unconsolidated sands and silty sands with lenses of silt and clayey silt.

A recent study by the USGS in the southern Coachella Valley portion of Riverside described land subsidence of about 0.5 feet between 1930 and 1996 (USGS 2013b). Groundwater elevations in this area had declined since the early 1920s until 1949, when water from the Colorado River was provided to the area. This area is served by Coachella Valley Water District; and as described in Appendix C, *Facility Descriptions and Operations*, surface water has not always been available to this area in recent years. The recent USGS study indicated that land subsidence of up to approximately 0.4 feet has occurred at some locations between 1996 and 2005, and possibly greater subsidence at other locations. A Coachella Valley Water District study indicated that up to 13 inches of subsidence have occurred in parts of the valley between 1996 and 2005 (CVWD 2011).

X.3 Evaluation of Alternatives

This section describes the technical background for the evaluation of environmental consequences associated with the action alternatives and the No Action Alternative.

X.3.1 Methods and Tools

Changes in CVP and SWP operations under the action alternatives compared to the No Action Alternative may result in changes to geology and soils resources. Changes in surface water deliveries may result in increased peak flow rates in rivers downstream of CVP and SWP reservoirs that could affect stream channel erosion. Changes in water deliveries and the extent of irrigated acreage has the potential for soil erosion on crop-idled lands over the long-term average condition and in dry and critically dry years. Changes in water delivery amounts may also result in increased use of groundwater resources to maintain cropping, which could affect land subsidence. Land subsidence is caused by the consolidation of certain subsurface soils when the pore pressure in those soils is reduced, usually caused by groundwater pumping that causes groundwater levels to fall below historical low levels. Changes in the water transfer program and restoration projects could also potentially affect soils.

Evaluation of changes in peak flow rates was taken from the surface water supply analysis conducted using the CalSim II model, as described in Appendix F, Model Documentation, to simulate the operational assumptions of each alternative that were described in Chapter 3, Alternatives. The CalSim II results were used to evaluate changes in peak flows under the action alternatives compared to the No Action Alternative with regards to potential effects of stream channel erosion. The No Action Alternative and action alternatives are analyzed under future conditions, so this model run also includes median climate change projections. Additionally, other resources include resource-specific models, such as groundwater and water quality modeling.

The analysis of land use changes, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, was used to identify potential changes in irrigated acreage as a result in changes to water deliveries under the alternatives compared to the No Action Alternative, to evaluate potential effects on soil erosion. The groundwater analysis, as described in Appendix I, *Groundwater Technical Appendix*, was used to describe the characterize project effects upon land subsidence.

Water transfer programs have been historically developed on an annual basis. The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfers would occur within the normal operational elevations of the affected reservoirs and at flows less than peak flows in affected conveyance reaches, and as such, soil erosion would not be a concern for the reservoirs or transfer conveyance reaches, therefore, these changes are not analyzed further in this EIS.

X.3.2 No Action Alternative

Under the No Action Alternative, current CVP and SWP operations would continue. Flows and reservoir levels would remain as under current conditions. No additional habitat restoration or fish intervention actions are proposed, and thus no new construction is proposed.

X.3.3 Alternative 1

X.3.3.1 *Project-Level Effects*

Potential changes in soil erosion.

Trinity River Region

No changes in peak flows are expected in the Trinity River below Lewiston under Alternative 1 compared to the No Action Alternative, therefore, no changes in stream channel erosion are expected.

Regarding changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, no agricultural lands in the Trinity River area are served by CVP and SWP water supplies under Alternative 1 compared to the No Action Alternative. As a result, the Trinity River region was not included in the Statewide Agricultural Production (SWAP) model used to evaluate effects of the project upon irrigated acreage. Therefore, no conversion of agricultural land or crop idling is anticipated. Soil erosion due to changes in irrigated acreage is not affected by CVP or SWP activity.

Sacramento Valley

No changes in peak flows are expected in the affected stream reaches for the Sacramento River, Clear Creek, Feather River, and American River under Alternative 1 compared to the No Action Alternative, therefore, stream channel erosion would not occur in these areas.

The Yolo Bypass carries flood flows that spill from the Sacramento River at the Fremont Weir during large winter storm events, typically January through March. Peak flows through the Yolo Bypass are expected to increase by 1% under Alternative 1 compared to the No Action Alternative, between the January peak of approximately 151,000 cubic feet per second (cfs) to the February peak of approximately 152,600 cfs. This minor increase in winter flood flows through the Yolo Bypass is negligible given the low channel gradient, large cross-sectional area for flow and low flow velocities at the margins of the bypass, and is not expected to result in a change in erosion.

As described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, compared to the No Action Alternative in the Sacramento Valley, crop acreage would decrease by approximately 1,000 acres in both the average and dry conditions under Alternative 1. Although some conversion of agricultural land to nonagricultural uses could occur in the Sacramento Valley over time, the area affected is relatively small. Also, crops are modeled to shift from water-intensive crops to less water-intensive crops, which may reduce the total acreage subjected to crop idling. As suggested in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, Mitigation Measures AG-1 and AG-2 could reduce the effects of conversion of agricultural land to nonagricultural use. As a result, erosion due to crop idling is not expected to occur.

San Joaquin Valley

No changes in peak flows are expected in the affected stream reaches for the San Joaquin River and Stanislaus River under Alternative 1 compared to the No Action Alternative; therefore, stream channel erosion would not occur in this area.

At Old and Middle Rivers within the San Joaquin River area of the Delta, flow rates on average will be less under Alternative 1, compared to the No Action Alternative. The relatively minor changes in flow will not result in notable changes to the rate of erosion. Regarding changes in irrigated acreage, as described in Appendix R *Land Use and Agricultural Resources Technical Appendix*, this region was not modeled under SWAP and flows on average would increase in this region under Alternative 1 compared to the No Action Alternative. Therefore, no conversion of agricultural land or crop idling is anticipated, and soil erosion caused by these factors would not occur.

With regards to changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, in both the average and dry conditions in the San Joaquin River region under Alternative 1 crop acreages are expected to increase, compared to the No Action Alternative. Therefore, soil erosion caused by agricultural land conversion or crop idling is not expected to occur.

Bay-Delta Region

No changes in peak flows are expected in the Bay-Delta region under Alternative 1 compared to the No Action Alternative; therefore, stream channel erosion would not occur in this area.

No changes in peak flows are expected in the Suisun Marsh or the San Francisco Bay under Alternative 1; therefore, there is no expected change to erosion rates.

Alternative 1 includes some elements in the Summer-Fall Delta Smelt Habitat action that could vary year-to-year. The action could include operations of the SMSCG in some years or a fall action to maintain the X2 position at 80 km in some above normal and wet years. Both of these actions would require water and affect CVP and SWP operations, but the frequency of these actions is not specifically defined. The modeling of Alternative 1 in in this appendix does not include these actions. Generally, the potential impacts and benefits of Alternative 1 could range between what is described in Chapter 5 and the No Action Alternative, which includes a Fall X2 action.

CVP and SWP Service Areas

There are no affected stream reaches in the CVP and SWP service areas, therefore, erosion as a result in changes to flow is not a concern in these areas.

With regards to changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, this region was not modeled under SWAP and flows would increase in this region under Alternative 1 compared to the No Action Alternative. Therefore, no conversion of agricultural land or crop idling is anticipated, and soil erosion caused by these factors would not occur.

Potential changes in rate of land subsidence due to increased use of groundwater.

Trinity River Region

As described in Appendix I, *Groundwater Technical Appendix*, the area along the Trinity River is not known to be susceptible to subsidence and groundwater pumping is not expected to increase in this region, therefore, changes in land subsidence is not a concern in this area.

Sacramento Valley

As described in Appendix I, *Groundwater Technical Appendix*, groundwater levels are generally not expected to decrease in the Sacramento Valley (containing the watersheds of the Sacramento River, Clear Creek, Feather River, and American River) under Alternative 1 compared to the No Action Alternative, therefore, it is unlikely that additional land subsidence would occur.

San Joaquin Valley

As described in Appendix I, *Groundwater Technical Appendix*, groundwater levels are generally not expected to decrease in the San Joaquin Valley (containing the watersheds of the San Joaquin River and Stanislaus River) under Alternative 1 compared to the No Action Alternative. Therefore, it is unlikely that additional land subsidence would occur.

X.3.3.2 *Program-Level Effects*

A single potential effect was identified for program-level effects for Alternative 1.

Potential temporary change in soil mobilization.

Restoration of seasonal floodplains and tidally influenced wetlands could potentially affect soils resources at the restoration locations. The following program-level projects were identified that may result in temporary soil alteration or disturbance:

- Upper Sacramento River Spawning and Rearing Habitat Restoration
- American River Spawning and Rearing Habitat Restoration
- Stanislaus River Spawning and Rearing Habitat Restoration
- Lower San Joaquin River Habitat Program
- Tidal Habitat Restoration (8,000 acres)

Although soils may be affected during construction, all necessary permits required for construction would be obtained to minimize any short-term adverse effects, whereas the long-term effects of restoration are expected to be stabilizing and beneficial to soils. Therefore, these changes are not analyzed further in this EIS.

X.3.4 Alternative 2

X.3.4.1 *Project-Level Effects*

Potential changes in soil erosion.

Trinity River Region

No changes in peak flows are expected in the Trinity River below Lewiston Dam under Alternative 2 compared to the No Action Alternative; therefore, stream channel erosion will not be a concern in this area.

Regarding changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, no agricultural lands in the Trinity River area are served by CVP and SWP water supplies under Alternative 2 compared to the No Action Alternative. As a result, the Trinity River region was not included in the Statewide Agricultural Production (SWAP) model used to evaluate effects of the project upon irrigated acreage. Therefore, no conversion of agricultural land or crop idling is anticipated. Soil erosion due to changes in irrigated acreage is not affected by CVP or SWP activity.

Sacramento Valley

No changes in peak flows are expected in the affected stream reaches for the Sacramento River, Clear Creek, Feather River, and American River under Alternative 2 compared to the No Action Alternative; therefore, stream channel erosion would not occur in these areas.

The Yolo Bypass carries flood flows that spill from the Sacramento River at the Fremont Weir during large winter storm events, typically January through March. Peak flows through the Yolo Bypass are expected to increase by 1% under Alternative 2 compared to the No Action Alternative, between the January peak of approximately 151,000 cfs to the February peak of approximately 152,600 cfs. This minor increase in winter flood flows through the Yolo Bypass is negligible given the low channel gradient, large cross-sectional area for flow and low flow velocities at the margins of the bypass, and is unlikely to result in a potential impact.

As described in Appendix R, *Land Use and Agricultural Resources Technical Appendix,* compared to the No Action Alternative in the Sacramento Valley area, crop acreage would decrease by approximately 100 acres in the average condition and increases by 250 acres in the dry condition under Alternative 2. Although some conversion of agricultural land to nonagricultural uses could occur in the Sacramento River region over time, the area affected is relatively small. Also, crops are modeled to shift from water-intensive crops to less water-intensive crops, which may reduce the total acreage subjected to crop idling. As suggested in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, Mitigation Measures AG-1 and AG-2 could reduce the effects of conversion of agricultural land to nonagricultural use. As a result, erosion due to crop idling is not expected to result in any notable impact or change.

San Joaquin Valley

No changes in peak flows are expected in the affected stream reaches for the San Joaquin River and Stanislaus River under Alternative 2 compared to the No Action Alternative; therefore, stream channel erosion would not occur in this area.

At Old and Middle Rivers within the San Joaquin River system, flow rates on average will be less under Alternative 2, compared to the No Action Alternative. The relatively minor changes in flow will not result in notable changes to the rate of erosion.

With regards to changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, in both the average and dry conditions in the San Joaquin River region under Alternative 2 crop acreages are expected to increase, compared to the No Action Alternative. Therefore, soil erosion caused by agricultural land conversion or crop idling would not occur.

Bay-Delta Region

No changes in peak flows are expected in the Bay-Delta under Alternative 2, compared to the No Action Alternative; therefore, stream channel erosion would not occur in this area. No changes in peak flows are expected in the Suisun Marsh or the San Francisco Bay under Alternative 2; therefore, there is no expected change to erosion rates.

With regards to changes in irrigated acreage, as described in Appendix R *Land Use and Agricultural Resources Technical Appendix*, this region was not modeled under SWAP and flows on average would increase in this region under Alternative 2 compared to the No Action Alternative. Therefore, no conversion of agricultural land or crop idling is anticipated, and soil erosion caused by these factors would not occur.

CVP and SWP Service Areas

There are no affected stream reaches associated with the Central Coast or Southern California regions, therefore, erosion as a result in changes to flow is not a concern in this area.

With regards to changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, this region was not modeled under SWAP and flows would increase in this region under Alternative 2 compared to the No Action Alternative. Therefore, no conversion of agricultural land or crop idling is anticipated, and soil erosion caused by these factors would not occur.

Potential changes to land subsidence.

Trinity River Region

As described in Appendix I, *Groundwater Technical Appendix*, the area along the Trinity River is not known to be susceptible to subsidence and groundwater pumping is not expected to increase in this region, therefore, subsidence is not be a concern in this area.

Sacramento Valley

As described in Appendix I, *Groundwater Technical Appendix*, groundwater levels are generally not expected to decrease in the Sacramento Valley (containing the watersheds of the Sacramento River, Clear Creek, Feather River, and American River) under Alternative 2 compared to the No Action Alternative, therefore, it is unlikely that additional land subsidence would occur.

San Joaquin Valley

As described in Appendix I, *Groundwater Technical Appendix*, groundwater levels are generally not expected to decrease in the San Joaquin Valley (containing the watersheds of the San Joaquin River and Stanislaus River) under Alternative 2 compared to the No Action Alternative. Therefore, it is unlikely that additional land subsidence would occur.

X.3.4.2 *Program-Level Effects*

Program-related potential effects to geology and soil resources were not identified for Alternative 2.

X.3.5 Alternative 3

X.3.5.1 *Project-Level Effects*

Potential change in soil erosion.

Trinity River Region

No changes in peak flows are expected in the Trinity River below Lewiston Dam under Alternative 3 compared to the No Action Alternative; therefore, stream channel erosion is not a potential impact as a result of implementing Alternative 3.

Regarding changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, no agricultural lands in the Trinity River area are served by CVP and SWP water supplies under Alternative 3 compared to the No Action Alternative. As a result, the Trinity River region was not included in the Statewide Agricultural Production (SWAP) model used to evaluate effects of the project upon irrigated acreage. Therefore, no conversion of agricultural land or crop idling is anticipated. Soil erosion due to changes in irrigated acreage is not affected by CVP or SWP activity.

Sacramento Valley

No changes in peak flows are expected in the affected stream reaches for the Sacramento River, Clear Creek, Feather River, and American River under Alternative 3, compared to the No Action Alternative; therefore, stream channel erosion would not occur in these areas.

The Yolo Bypass carries flood flows that spill from the Sacramento River at the Fremont Weir during large winter storm events, typically January through March. Peak flows through the Yolo Bypass are expected to increase by 1% under Alternative 3, compared to the No Action Alternative, between the January peak of approximately 151,000 cubic feet/second (cfs) to the February peak of approximately 152,600 cfs. This minor increase in winter flood flows through the Yolo Bypass are negligible given the low channel gradient, large cross-sectional area for flow and low flow velocities at the margins of the bypass, and is unlikely to result in a potential impact.

As described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, compared to the No Action Alternative in the Sacramento Valley area, crop acreage would decrease by approximately 200 acres in the average condition and by 3 acres in the dry condition under Alternative 3. Although some conversion of agricultural land to nonagricultural uses could occur in the Sacramento River region over time, the area affected is relatively small. Also, crops are modeled to shift from water-intensive crops to less water-intensive crops, which may reduce the total acreage subjected to crop idling. As suggested in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, Mitigation Measures AG-1 and AG-2 could reduce the effects of conversion of agricultural land to nonagricultural use. As a result, erosion due to crop idling is not expected to notably change.

San Joaquin Valley

No changes in peak flows are expected in the affected stream reaches for the San Joaquin River and Stanislaus River under Alternative 3, compared to the No Action Alternative; therefore, stream channel erosion would not occur in this area.

At Old and Middle Rivers within the San Joaquin River system, flow rates on average will be less under Alternative 3 compared to the No Action Alternative; however, peak flows during January under Alternative 3 will be increased from approximately 30,000 cfs under the No Action Alternative to almost 42,000 cfs, an increase in peak flow of almost 40% during that month.

With regards to changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, in both the average and dry conditions in the San Joaquin River region under Alternative 3, crop acreages are expected to increase, compared to the No Action Alternative. Therefore, soil erosion caused by agricultural land conversion or crop idling would not occur.

Bay-Delta Region

As mentioned above, a minor increase in flow under Alternative 3 is expected through the Delta during January; however, this increase is well below peak flows during winter flood events through the Bay-Delta, therefore, erosion is not a substantial concern in this area. The increase in flow in January would be far less than flood flows during major winter storm events, and given the low channel gradient, large cross-sectional area for flow, and low flow velocities at the margins of Suisun Marsh, this increase in peak flow under Alternative 3 will not result in notable erosion in this area.

Under Alternative 3, an increase in peak flows of approximately 4% is expected during the month of January, compared to the No Action Alternative. This minor increase in flow in January would be far less than flood flows during major winter storm events, and given the low channel gradient, large cross-sectional area for flow, and low flow velocities at the margins of the Delta, this minor increase in peak flow under Alternative 3 is not likely to result in a potential impact.

As discussed in Appendix H, *Water Supply Technical Appendix*, hydrological conditions in the Delta and Suisun Marsh are substantially affected by structures that route water through the Delta toward the major Delta water diversions in the south Delta, including the CVP Jones Pumping Plant, the SWP Banks Pumping Plant, the Delta-Mendota Canal/California Aqueduct Intertie, the CVP Contra Costa Canal Pumping Plant at Rock Slough, and the Contra Costa Water District (CCWD) intakes on Old and Middle Rivers. As a result, the Old and Middle Rivers area is located in a highly disturbed area, and the effects of 1 month of increased peak flows during the winter under Alternative 3 is not a substantial concern with respect to erosion.

With regards to changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, this region was not modeled under SWAP and flows on average would increase in this region under Alternative 3, compared to the No Action Alternative. Therefore, no conversion of agricultural land or crop idling is anticipated, and soil erosion caused by these factors would not occur.

CVP and SWP Service Areas

There are no affected stream reaches associated with the Central Coast or Southern California regions, therefore, erosion as a result of changes to flow is not a concern in this area.

With regards to changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, this region was not modeled under SWAP and flows would increase in this region under Alternative, compared to the No Action Alternative. Therefore, no conversion of agricultural land or crop idling is anticipated, and soil erosion caused by these factors would not occur.

Potential changes in rate of land subsidence due to increased use of groundwater.

Trinity River Region

As described in Appendix I, *Groundwater Technical Appendix*, the area along the Trinity River is not known to be susceptible to subsidence and groundwater pumping is not expected to increase in this region, therefore, subsidence is not be a concern in this area.

Sacramento Valley

As described in Appendix I, *Groundwater Technical Appendix*, groundwater levels are generally not expected to decrease in the Sacramento Valley (containing the watersheds of the Sacramento River, Clear Creek, Feather River, and American River) under Alternative 3 compared to the No Action Alternative, therefore, it is unlikely that additional land subsidence would occur.

San Joaquin Valley

As described in Appendix I, *Groundwater Technical Appendix*, groundwater levels are generally not expected to decrease in the San Joaquin Valley (containing the watersheds of the San Joaquin River and

Stanislaus River) under Alternative 3 compared to the No Action Alternative. Therefore, it is unlikely that additional land subsidence would occur.

X.3.5.2 *Program-Level Effects*

A single potential effect was identified for program-level effects for Alternative 3.

Potential temporary change in soil mobilization.

Restoration of seasonal floodplains and tidally influenced wetlands could potentially affect soils resources at the restoration locations. The following program-level projects were identified that may result in temporary soil alteration or disturbance:

- Upper Sacramento River Spawning and Rearing Habitat Restoration
- American River Spawning and Rearing Habitat Restoration
- Stanislaus River Spawning and Rearing Habitat Restoration
- Lower San Joaquin River Habitat Program
- Tidal Habitat Restoration (8,000 acres)
- Additional Delta Habitat Restoration (25,000 acres)

Although soils may be affected during construction, all necessary permits required for construction would be obtained to minimize any short-term adverse effects, whereas the long-term effects of restoration are expected to be stabilizing and beneficial to soils. Therefore, these changes are not analyzed further in this EIS.

X.3.6 Alternative 4

X.3.6.1 *Project-Level Effects*

Potential changes in soil erosion.

Trinity River Region

Notable changes in peak flows are not expected in the Trinity River below Lewiston under Alternative 4 compared to the No Action Alternative, therefore, no changes in stream channel erosion are expected.

Regarding changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, no agricultural lands in the Trinity River area are served by CVP and SWP water supplies under Alternative 4 compared to the No Action Alternative. As a result, the Trinity River region was not included in the Statewide Agricultural Production (SWAP) model used to evaluate effects of the project upon irrigated acreage. Therefore, no conversion of agricultural land or crop idling is anticipated. Soil erosion due to changes in irrigated acreage is not affected by CVP or SWP activity.

Sacramento Valley

Project-level action alternatives would change operations of the CVP and SWP, as described in Appendix F, Model Documentation. The changes to CVP and SWP operations would change river flows and reservoir levels. Increases in peak flows are expected in the affected stream reaches for the Sacramento River, Clear Creek, Feather River, and American River under Alternative 4 compared to the No Action

Alternative. The increases will maintain higher flows generally in the February through June period, where it is common for seasonal discharge to increase naturally. Average annual deliveries to all contract delivery types with the exception of CVP Refuge Level 2 deliveries and deliveries to the SWP Feather River Service Area would decrease. These reductions in average annual deliveries would be less than 5% and are considered similar to conditions under the No Action Alternative. Minor fluctuations of up to 5% due to model assumptions and approaches and changes 5% or less are considered “similar” to conditions under the No Action Alternative. While the generally higher releases and reduced deliveries from these rivers are notably increased, the overall peak discharge is well-within normally occurring flow and will not likely result in mobilizing sediment or increasing erosion.

As described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, compared to the No Action Alternative in the Sacramento Valley, crop acreage would decrease by approximately 2,427 acres during dry conditions and remain relatively similar to the No Action Alternative during under normal conditions under Alternative 4. Some conversion of agricultural land to nonagricultural uses could occur in the Sacramento Valley over time. Also, crops are modeled to shift from water-intensive crops to less water-intensive crops, which may reduce the total acreage subjected to crop idling. As suggested in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, Mitigation Measures AG-1 and AG-2 could reduce the effects of conversion of agricultural land to nonagricultural use. As a result, erosion due to crop idling may increase and could be offset to a degree by conversion or mitigation; however, the sizable amount of decreased acreage may still result in increased erosion.

San Joaquin Valley

No changes in peak flows are expected in the affected stream reaches for the San Joaquin River and Stanislaus River under Alternative 4 compared to the No Action Alternative; therefore, stream channel erosion would not occur in this area.

With regards to changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, in both the dry (12,333 ac reduction) and average (5,578 ac reduction) conditions in the San Joaquin River region notable reductions would occur under Alternative 4, compared to the No Action Alternative. Therefore, soil erosion caused by agricultural land conversion or crop idling may occur. As suggested in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, Mitigation Measures AG-1 and AG-2 could reduce the effects of conversion of agricultural land to nonagricultural use.

At Old and Middle Rivers within the San Joaquin River area of the Delta, flow rates on average will be somewhat similar under Alternative 4, compared to the No Action Alternative. The trend between Alternative 4 and the No Action Alternative is relatively similar with mild differences varying from increases and reduction over the year. The most notable differences occur from mid-February through early Aprils when greater flow is present under Alternative 4. Nonetheless, the differences are not sufficient to result in a notable change to the rate of erosion. Regarding changes in irrigated acreage, as described in Appendix R *Land Use and Agricultural Resources Technical Appendix*, this region was not modeled under SWAP, but flows do periodically increase in this region under Alternative 4 compared to the No Action Alternative. Regardless, no conversion of agricultural land or crop idling is anticipated, and soil erosion caused by these factors would not occur.

Bay-Delta Region

The Bay-Delta region will experienced increased outflow from February through May when compared to the No Action Alternative. Differences are highest in March, were average increased outflow can approach a 5,000 cfs or 10 percent increase. While the increase in flow is not insubstantial, the Delta is a broad and complex area that regularly sees varied flow and stage. It is unlikely that significant increases in erosion would occur.

Similarly, the increased outflow may result in higher flow through the Suisun Marsh or the San Francisco Bay under Alternative 4, but is not anticipated to increase erosion.

CVP and SWP Service Areas

There are no affected stream reaches in the CVP and SWP service areas, therefore, erosion as a result in changes to flow is not a concern in these areas.

With regards to changes in irrigated acreage, as described in Appendix R, *Land Use and Agricultural Resources Technical Appendix*, this region was not modeled under SWAP and flows would increase in this region under Alternative 4 compared to the No Action Alternative. Therefore, no conversion of agricultural land or crop idling is anticipated, and soil erosion caused by these factors would not occur.

Potential changes in rate of land subsidence due to increased use of groundwater.

Trinity River Region

As described in Appendix I, *Groundwater Technical Appendix*, the area along the Trinity River is not known to be susceptible to subsidence and groundwater pumping is not expected to increase in this region, therefore, changes in land subsidence is not a concern in this area.

Sacramento Valley

As described in Appendix I, *Groundwater Technical Appendix*, compared with the No Action Alternative, Alternative 4 is expected to result in surface water supply to the Sacramento Valley increasing and decreasing, depending on the year. An increase in supply, especially when made to meet agricultural demands, will result in a decrease in the need for groundwater pumping to meet demands. A decrease in supply may result in an increase in groundwater pumping. Most of the change is not expected to occur in the Sacramento Valley. Modeled simulation show that the change in groundwater-surface water interaction is 0.7 percent (reduced flow from groundwater to surface water) in Alternative 4 compared with the No Action Alternative. Subsidence as a result of groundwater pumping is not expected.

San Joaquin Valley

As described in Appendix I, *Groundwater Technical Appendix*, as described in Appendix I, *Groundwater Technical Appendix*, Compared with the No Action Alternative, Alternative 4 is expected to result in surface water supply to the San Joaquin Valley increasing and decreasing, depending on the year. An increase in supply, especially when made to meet agricultural demands, will result in a decrease in the need for groundwater pumping to meet demands. A decrease in supply may result in an increase in groundwater pumping. Most of the change in pumping is expected to be in the San Joaquin Valley. Modeled simulation show that the change in groundwater-surface water interaction is 0.7 percent (reduced flow from groundwater to surface water) in Alternative 4 compared with the No Action Alternative. Subsidence as a result of groundwater pumping is not expected.

X.3.6.2 *Program-Level Effects*

Program-related potential effects to geology and soil resources were not identified for Alternative 4.

X.3.7 Summary of Impacts

Table X.3-1 includes a summary of impacts, the magnitude and direction of those impacts, and potential mitigation measures for consideration.

Table X.3-1. Impact Summary

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential changes in soil erosion (Project-Level)	No Action	No Impact	–
	Alternative 1	No Impact	–
	Alternative 2	No Impact	–
	Alternative 3	Increased January Delta flow is a minor change overall, but may result in up to 40% increases in specific areas. Overall change is expected to result in negligible differences.	–
	Alternative 4	Increase in releases from Sacramento Valley tributaries will occur, but well within the standard bounds of operational peak flows. Delta outflow will also increase, but overall differences are expected to result in negligible differences in the potential for increased erosion from outflow. Reduction in crop acreage may lead to increased erosion. Construction and restoration on agricultural land could result in conversion.	MM AG-1 and MM AG-2
Potential changes in rate of land subsidence due to increased use of groundwater (Project-Level)	No Action	No Impact	–
	Alternative 1	No Impact	–
	Alternative 2	No Impact	–
	Alternative 3	Increased January Delta flow is a minor change overall, but may result in up to 40% increases in specific areas. Overall change is expected to result in negligible differences.	–
	Alternative 4	A mix of increases and decreases in groundwater pumping may occur. Differences compared to the No Action Alternative for the Sacramento and San Joaquin valleys are unlikely to lead to subsidence.	–
Potential temporary change in soil mobilization (Program-Level)	No Action	No Impact	–
	Alternative 1	Short-term effects addressed through project-specific permitting requirements. Long-term effects expected to be beneficial.	–
	Alternative 2	No Impact	–
	Alternative 3	Short-term effects addressed through project-specific permitting requirements. Long-term effects expected to be beneficial.	–
	Alternative 4	No Impact	–

X.3.8 Cumulative Effects

As described in Appendix Y, *Cumulative Methodology*, the cumulative effects analysis considers projects, programs, and policies that are not speculative and that are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

Potential change in water supply leading to subsidence or erosion.

Climate change and sea-level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce carryover storage in reservoirs and create changes in stream flow patterns. These changes could reduce the availability of water to meet current demands as well as future demands for water in the summer and fall months. Reduced CVP and SWP water deliveries could also reduce the amount of irrigated acreage, thereby potentially increasing the incidence of crop idling and associated soil erosion, and/or increasing the demand for groundwater to maintain cropping patterns, which may affect land subsidence. Climate change may also increase the frequency and magnitude of storm events that occur with a greater fraction of rainfall compared to snowfall, thereby resulting in increased runoff and peak flood flows and decreased snowpack and snowmelt, which could increase stream channel erosion during the winter and decrease water supply in the summer and fall months for irrigation. Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans.

Implementation of No Action Alternative and reasonably foreseeable actions would result in changes in stream flows and related changes in groundwater use patterns, and reduced CVP and SWP water supplies. If CVP and SWP water supply reliability decreases, demand for alternative water supplies could increase reliance on groundwater, resulting in potential land subsidence effects.

Alternative 1 would not result in notable change to water deliveries. In the case of cumulative projects anticipated to potentially generate temporary reductions in water deliveries, the Alternative 1 improvement to water supply deliveries for many water users would help to reduce the severity of any potential cumulative effect, which would maintain irrigated crops and reduce erosion and likely subsidence from less groundwater pumping. For those users who would not see improvements in water supply deliveries under this alternative, the potential changes in water supply deliveries under this alternative would not contribute to any cumulative water supply impacts because of Alternative 1's similarity to the No Action Alternative. Large amounts of restoration would occur under Alternative 1. These, in combination with restoration actions proposed under the cumulative projects, would result in temporary effect mitigated through permitting and likely result in long-term benefits.

Notable change to water deliveries would also not occur under Alternative 2. In the case of cumulative projects anticipated to potentially generate temporary reductions in water deliveries, the Alternative 2 improvement to water supply deliveries for many water users would help to reduce the severity of any potential cumulative effect, which would maintain irrigated crops and reduce erosion and likely subsidence from less groundwater pumping. For those users who would not see improvements in water supply deliveries under this alternative, the potential changes in water supply deliveries would not contribute to any cumulative water supply impacts because of Alternative 1's similarity to the No Action Alternative. Restoration actions are not proposed under Alternative 2.

Under Alternative 3, there may be changes in irrigated agriculture only through reduced flows to the Sacramento Valley region. Increased flows would be observed in the Delta during specific time periods (i.e., January). While some revision to flow quantity and delivery would occur, the differences to those flows would not result in substantial or notable change leading to contribution of cumulative impacts. Large amounts of restoration would occur under Alternative 3. This restoration, in combination with restoration actions under the cumulative projects, would result in temporary effects mitigated through permitting and would likely result in long-term benefits.

Alternative 4 would result in increased releases largely from Sacramento Valley tributaries and result in lowered deliveries for San Joaquin River and Delta water users. Total Delta deliveries would reduce overall, but the general trend of deliveries is similar to the No Action Alternative. The reductions will result in some shortages of water deliveries and increased groundwater usage. Reductions in crops will follow the reduced water deliveries and may result in increased erosion. Conversion of agricultural land and increased storage long-term may alleviate some of the potential impact.

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Appendix Y Cumulative Methodology

Cumulative impacts are defined by the Council on Environmental Quality (CEQ) regulations in 40 Code of Federal Regulations Section 1508.7 as "the impact on the environment which results from the incremental impact of the [proposed] action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time." Cumulative impacts include the direct and indirect impacts of a project together with the past, present, and reasonably foreseeable future actions of other projects. According to CEQ's cumulative impacts guidance, the cumulative impact analysis should be narrowed to focus on important issues at a national, regional, or local level. The analysis should look at other actions that have affected or could affect the same resources as the proposed action and alternatives

Table Y-1 provides a summary of the past, present, and reasonably foreseeable projects that, when combined with the No Action Alternative and Alternatives 1 through 4, serve as the foundational information for conducting the cumulative impact assessments for many of the resources addressed in the Environmental Impact Statement (EIS). The list reflects projects which have occurred or are expected to occur within the study area and are similar in scope (i.e., water supply, restoration, etc.) to the project alternatives being evaluated in the EIS. The table includes the name of the project, lead agency(s), summary description of the scope of the project, and references to where project documentation may be located.

Not all of the projects included in this list may have been considered within the cumulative assessment for each resource analyzed in the EIS. The projects were first screened to determine if they could have an impact on a resource being evaluated. Once that initial screening was complete, only the remaining projects were considered in the analysis of a particular resource. Additionally, some cumulative assessments also considered other sources of information, including county-wide general plans or other planning-level documents which provide projections of population growth and land use changes.

Project	Primary Agencies	Description
Water Supply and Water Quality Projects and Actions		
Bay-Delta Water Quality Control Plan Update	State Water Resources Control Board (SWRCB)	The SWRCB is updating the 2006 Bay-Delta Water Quality Control Plan (WQCP) in two phases (SWRCB 2018): Phase I: The first Plan amendment is focused on San Joaquin River flows and southern Sacramento-San Joaquin Delta (Delta) salinity and modifies water quality objectives (i.e., establishes minimum flows) on the Lower San Joaquin River and Stanislaus, Tuolumne, and Merced rivers to protect the beneficial use of fish and wildlife and modifies the water quality objectives in the southern Delta to protect the beneficial use of agriculture. The proposed final amendments to the Bay-Delta Plan and the Final Supplemental Environmental Document for Phase I was released in July 2018, with some additional minor changes released in August 2018. Phase II: Phase II is focused on the Sacramento River and its tributaries, Delta eastside tributaries (including the Calaveras, Cosumnes, and Mokelumne rivers), Delta outflows, and interior Delta flows.
Shasta Lake Water Resources Investigation	Bureau of Reclamation (Reclamation)	Reclamation undertook the Shasta Lake Water Resources Investigation to determine the type and extent of federal interest in a multiple purpose plan to modify Shasta Dam and Reservoir to increase survival of anadromous fish populations in the upper Sacramento River; increase water supplies and water supply reliability to agricultural, municipal and industrial users, and environmental purposes; and, to the extent possible through meeting these objectives, include features to benefit other identified ecosystem, flood damage reduction, and related water resources needs, consistent with the objectives of the CALFED Bay-Delta Program. The alternatives for expansion of Shasta Lake include, among other features, raising the dam from 6.5 to 18.5 feet above current elevation, which would result in additional storage capacity of 256,000 to 634,000 acre-feet (AF), respectively (Reclamation 2015a). The increased capacity is expected to improve water supply reliability and increase the cold-water pool, which would provide improved water temperature conditions for anadromous fish in the Sacramento River downstream of the dam. The final EIS was released in 2014, and the final feasibility study was released in 2015. No Record of Decision (ROD) has been issued. However, in March 2018, Congress appropriated $20 million for Shasta preconstruction activities. The Shasta Dam Raise Project is expected to be complete by February 2024 (Reclamation 2018a).
Sites Reservoir Project	Reclamation, Sites Project Authority	The Sites Reservoir Project involves the construction of offstream surface storage north of the Delta for enhanced water management flexibility in the Sacramento Valley, increased California water supply reliability, and storage and operational benefits for programs to enhance water supply reliability, both locally and State-wide, benefit Delta water quality, and improve ecosystems. Secondary objectives for the project are to: 1) allow for flexible hydropower generation to support integration of renewable energy sources, 2) develop additional recreation opportunities, and 3) provide incremental flood damage reduction opportunities (Sites Project Authority and Reclamation 2017). The Draft Environmental Impact Report/Environmental Impact Study (EIR/EIS) was released for public review on August 14, 2017.
Federal Energy Regulatory Commission (FERC) License Renewals	FERC	There are 22 hydroelectric generation FERC permits that will expire prior to 2030 (FERC 2015). Fifteen projects in the Sacramento River watershed include one on the Pit River (upstream of Shasta Lake), six on the Feather River, four on the Yuba River, one on the Bear River, one on the American River, and one each on Cow and Battle creeks. Projects in the San Joaquin River watershed include four on the San Joaquin River, one on the Stanislaus River, two on the Merced River, and one on the Tuolumne River. The FERC must complete analyses under the National Environmental Policy Act (NEPA) and Endangered Species Act (ESA) to consider the effects of the hydropower operations on the environment, including flow regimes, water quality, fish passage, recreation, aquatic and riparian habitat, and special status species.
State Water Project (SWP) Oroville Project	FERC, California Department of Water Resources (DWR)	The Oroville Facilities, as part of the SWP, are also operated for flood management, power generation, water quality improvement in the Delta, recreation, and fish and wildlife enhancement. The objective of the relicensing process is to continue operation and maintenance of the Oroville Facilities for electric power generation, along with implementation of any terms and conditions to be considered for inclusion in a new FERC hydroelectric license. The initial FERC license for the Oroville Facilities, issued on February 11, 1957, expired on January 31, 2007. DWR published the Final EIR in June 2008 and the Notice of Determination (NOD) in July 2008 (DWR 2008). DWR is awaiting the FERC license renewal.
Yuba River Watershed Hydroelectric Projects	FERC, Nevada Irrigation District, Pacific Gas & Electric Company (PG&E)	The Nevada Irrigation District is applying for a new license for the Yuba-Bear Project (FERC Project No. 2266), and PG&E are applying for the Drum-Spaulding Project (FERC Project No. 2310). The Yuba-Bear Project is located on the Middle and South Yuba rivers, Bear River, and Jackson and Canyon creeks (FERC 2014). Concurrently, PG&E is applying for a license renewal for the Drum-Spaulding Project which is located on the Bear and Yuba rivers. Operations of the two projects are coordinated in many factors. The FERC relicensing processes for these two projects in underway (Yuba River Watershed Information System N.d).

Project	Primary Agencies	Description
Turlock Irrigation District and Modesto Irrigation District Don Pedro Project	FERC, Turlock Irrigation District (TID), Modesto Irrigation District (MID)	The Don Pedro Project is located on the Tuolumne River in Tuolumne County. The initial license was issued for operations between 1971 and 1991 followed by requirements to evaluate fisheries water needs in the Tuolumne River. In 1987, after the Turlock Irrigation District and Modesto Irrigation District applied to amend their license to add a fourth generating unit, FERC approved an amended fish study plan with possible changes in 1998. In 1996, FERC amended the license to implement amended minimum flow criteria and require fish monitoring studies for completion in 2005. In 2002, the National Marine Fisheries Service (NMFS) requested that FERC initiate formal consultation on the effects of the Don Pedro Project on Central Valley steelhead. The FERC approved the Summary Report on fisheries in 2008. In 2009, NMFS, United State Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and several environmental interest groups filed requests for rehearing on the license. FERC denied portions of the request but required instream flow studies to be conducted and required NMFS to be included for consultation on any authorized changes to minimum flow release schedules. The FERC also directed the appointment of an administrative law judge to assist in assessing the need for and feasibility for interim measures prior to relicensing. A final report was completed in 2010. Following the completion of the report and a monitoring plan by the affected districts, FERC approved an order modifying and approving instream flow and monitoring study plans. A final license application, including an Environmental Report, was submitted to FERC in April 2014 (TID and MID 2014). An amendment to the final license application was submitted to FERC in October 2017 (TID and MID N.d). The current license expired in 2016. The objective of the relicensing process is to continue operation and maintenance of the Don Pedro Project facilities for electric power generation, along with implementation of any terms and conditions to be considered for inclusion in a new FERC hydroelectric license.
Merced Irrigation District's Merced River Hydroelectric Project	FERC, Merced Irrigation District (ID)	The Merced River Hydroelectric Project is located on the Merced River in Mariposa County and includes both Lake McClure and McSwain Reservoir, two powerhouses (New Exchequer and McSwain), and recreation facilities. The Project does not include any transmission lines, canals, or open conduits. The installed capacity of the Merced River Hydroelectric Project is 103.5 megawatts (Merced ID N.d).The initial FERC license expired on February 28, 2014. The objective of the relicensing process is to continue operation and maintenance of the Merced River Hydroelectric Project facilities for electric power generation, along with implementation of any terms and conditions to be considered for inclusion in a new FERC hydroelectric license (Merced ID 2015).
Yuba River Development Project Relicensing	FERC, Yuba County Water Agency	The Yuba County Water Agency is seeking to renew their 50-year FERC license for the Yuba River Development Project (FERC Project No. 2246). The Yuba River Development Project is located on the Yuba River, the Middle Yuba River, and Oregon Creek in Yuba County, California, and consists of one reservoir (New Bullards Bar on the North Yuba River), two diversion dams (Our House Diversion Dam on the Middle Yuba River and Log Cabin Diversion Dam on Oregon Creek), three powerhouses (New Colgate, Fish Release, and Narrows No. 2), and various recreational facilities and appurtenant facilities (Yuba County Water Agency 2016). New Bullards Bar Reservoir has a capacity of 969,600 AF. The initial FERC license expired April 30, 2016, and the Yuba County Water Agency has engaged in FERC's Integrated Licensing Process to prepare an application for a new license. The Yuba County Water Agency filed a Draft Application for a New License Major Project – Existing Dam, on December 3, 2013, and a Final Application for a New License Major Project – Existing Dam, on April 28, 2014. FERC issued the Final EIS in January 2019.
El Dorado Water and Power Authority Supplemental Water Rights Project	El Dorado Water and Power Authority	The El Dorado Water and Power Authority (EDWPA) proposes to establish permitted water rights allowing diversion of water from the American River basin to meet planned future water demands in the El Dorado Irrigation District and Georgetown Divide Public Utility District service areas and other areas located within El Dorado County that are outside of these service areas. The EDWPA filed petitions with the SWRCB for partial assignment of State Filed Applications 5644 and 5645, and accompanying applications allowing for the total withdrawal and use of 40,000 acre-feet per year, consistent with the diversion and storage locations allowed under the El Dorado-Sacramento Municipal Utility District Cooperation Agreement (EDWPA 2010). A Notice of Preparation of an Environmental Impact Report for the Project was submitted in October 2008 (EDWPA 2008).
Semitropic Water Storage District Delta Wetlands	Semitropic Water Storage District, Delta Wetlands	In 1987, Delta Wetlands, a California Corporation, proposed a project for water storage and wildlife habitat enhancement on four privately owned islands in the Delta. The four islands were Bacon Island and Bouldin Island in San Joaquin County and Holland Tract and Webb Tract in Contra Costa County, encompassing approximately 23,000 acres. The Delta Wetlands Project would store water on two Reservoir Islands (Bacon Island and Webb Tract) for subsequent release into the Delta, and habitat enhancement to compensate for wetland and wildlife effects of the water storage operations with a Habitat Management Plan on two Habitat Islands (Bouldin Island and Holland Tract). In 2007, the Delta Wetlands Project partnered with the Semitropic Water Storage District (Semitropic WSD) to: 1) provide water to Semitropic WSD to augment its water supply, and 2) bank water within the Semitropic Groundwater Storage Bank and Antelope Valley Water Bank. The designated places of use for Delta Wetlands Project water would include: Semitropic WSD; Member Agencies of the Metropolitan Water District of Southern California, the Western Municipal Water District of Riverside County, and select service areas of the Golden State Water Company. The project would include improvements of 27 miles of levees and screened diversions to divert water during high-flow periods in the winter months of December through March into Webb Tract (100,000 AF of storage) and Bacon Island (115,000 AF of storage). The water would not be diverted in a manner that would adversely affect senior legal water rights holders, including the SWP and Central Valley Project (CVP). Stored water would be discharged into False River (from Webb Tract) and Middle River (from Bacon Island) for export when excess SWP or CVP diversion capacity is available, in the summer and fall months of July through November. Any water that could not be exported from the Delta in a given year would be available to increase Delta outflow in the fall months of September through November. Semitropic WSD issued a Draft EIR in 2010,a Final EIR in August 2011, and an addendum to the Final EIR on September 2011 (Semitropic WSD 2011).

Project	Primary Agencies	Description
North Bay Aqueduct Alternative Intake	DWR, Solano County Water Agency, Napa County Flood Control and Water Conservation District	DWR is evaluating the implementation of an alternative intake on the Sacramento River upstream of the Sacramento Regional Wastewater Treatment Plant, and conveyance facility to connect the intake with the existing North Bay Aqueduct. The proposed alternative intake would be operated in conjunction with the existing North Bay Aqueduct intake at Barker Slough. The proposed project would be designed to improve water quality and to provide reliable deliveries of SWP supplies to its contractors, the Solano County Water Agency and the Napa County Flood Control and Water Conservation District (DWR 2011). The proposed project would include construction and operation of a 240 cubic feet per second (cfs) capacity intake with state-of-the-art positive barrier fish screens, pumping plant, sediment basins, and ancillary support facilities located on the west side of the Sacramento River near south Sacramento. The conveyance facility would include an approximately 30 mile long, 72 to 84-inch diameter underground steel and/or concrete pipeline to convey the water from the alternate intake to the existing North Bay Aqueduct. Two options are proposed for the location of the alternate intake facility. Alternate intake site 1 is located on the outside edge of Garcia Bend of the Sacramento River (on the west bank), approximately 500 feet south of the boundary of the City of West Sacramento. Alternate intake site 2 is located immediately south of the outside edge of Garcia Bend of the Sacramento River (on the west bank), approximately 2,500 feet south of the boundary of the City of West Sacramento. The intake and pumping plant facility would be constructed on the water side of the Sacramento River levee and the remaining components would be constructed on the land side of the levee. The intake would extend about 100 feet from the top of the levee into the river. The exact amount of this extension would depend on the site option selected. A fish screen would be installed on the face of the intake structure to prevent fish from swimming or being drawn into the intake and it would be designed to meet CDFW, NMFS, and USFWS criteria. The dimensions of the fish screen would be based on an anticipated approach velocity of 0.2 feet per second at the fish screen. Flow-control louvers behind the screen would control flow rates through the screen to assure uniform water velocity across the screen. Normal operation would keep the top of the screen below low water elevation. A reduction in pumping would occur any time the screens are not submerged or the water velocities increased. Above the screen would be concrete panels which extend to the 200 year flood elevation. A log boom would be installed in front of the fish screen to block large debris from blocking or damaging the intake. The intake would be equipped with an automatic fish screen cleaning system. Environmental analysis, planning, and design for Project was completed in March 2018 (California Natural Resources Agency [CNRA] 2018a).
Los Vaqueros Reservoir Expansion Phase 2	Reclamation, Contra Costa Water District (CCWD), DWR	Los Vaqueros Reservoir is an off-stream reservoir in the Kellogg Creek watershed to the west of the Delta. The Los Vaqueros Reservoir initial construction was completed in 1997 as a 100,000 AF off-stream storage reservoir owned and operated by CCWD to improve delivered water quality and emergency storage reliability to their customers. In 2012, the Los Vaqueros Reservoir was expanded to a total storage capacity of 160,000 AF (Phase 1) to provide additional water quality and supply reliability benefits, and to adjust the timing of its Delta water diversions to accommodate the life cycles of Delta aquatic species, thus reducing species impact and providing a net benefit to the Delta environment. As part of the Storage Investigation Program described in the CALFED Bay Delta Program ROD, additional expansion up to 275,000 AF (Phase 2) is being evaluated by CCWD, DWR, and Reclamation. The alternatives considered in the evaluation also consider methods to convey water from Los Vaqueros Reservoir to the South Bay Aqueduct to provide water to Zone 7 Water Agency, Alameda County Water District, and Santa Clara Valley Water District. The Final EIS/R was released by Reclamation and CCWD on March 15, 2010. Construction is planned to begin as early as 2021, with a 6-year construction period (Reclamation 2018b).
Upper San Joaquin River Basin Storage Investigation	Reclamation, DWR	The Upper San Joaquin River Basin Storage Investigation is being conducted by Reclamation and DWR to evaluate alternative plans to increase Upper San Joaquin River Storage to enhance the San Joaquin River restoration efforts and improve water supply reliability for agricultural, municipal and industrial, and environmental uses in the Friant Division, the San Joaquin Valley, and other regions of the state. The investigation is evaluating integration of conjunctive management and water transfer concepts into plan formulations. Additional storage is also expected to provide incidental flood damage reduction benefits (Reclamation 2014a). Reclamation is analyzing alternatives for a new dam and a 1,260,000 AF reservoir along the San Joaquin upstream of Millerton Lake in an area known as Temperance Flat. Primary planning objectives are to: 1) increase water supply reliability, and 2) enhance flow and temperature conditions to support the San Joaquin River Restoration Program. Operation variables include reservoir carryover, new or shifting water supply beneficiaries, and alternative conveyance routes. Reclamation released a Draft Feasibility Report in February 2014 and a Draft EIS in September 2014 (Reclamation 2017).
Central Valley Regional Water Quality Control Board (RWQCB) Irrigated Lands Regulatory Program	Central Valley RWQCB	The Irrigated Lands Regulatory Program regulates discharges from irrigated agricultural lands. Its purpose is to prevent agricultural discharges from impairing the waters that receive the discharges. The California Water Code authorizes the SWRCB and RWQCBs to conditionally waive waste discharge requirements if this is in the public interest. On this basis, the Los Angeles, Central Coast, Central Valley, and San Diego regional water quality control boards have issued conditional waivers of waste discharge requirements to growers that contain conditions requiring water quality monitoring of receiving waters. In 2010, the Central Valley RWQCB proposed to expand the requirements to groundwater especially for regulation of discharges with higher concentrations of nutrients (Central Valley RWQCB 2011). Participation in the waiver program is voluntary; however, non-participant dischargers must file a permit application as an individual discharger, stop discharging, or apply for coverage by joining an established coalition group. The waivers must include corrective actions when impairments are found.
San Luis Reservoir Low Point Improvement Project	Reclamation	The San Luis Reservoir Low Point Improvement Project is proposed by Reclamation and the Santa Clara Valley Water District. As part of this project, Reclamation is investigating four alternatives to avoid supply interruptions and increase the reliability and quantity of yearly allocations to South-of-Delta contractors. The alternatives being considered are to 1) construct a new, lower San Felipe Intake, 2) technology retrofits at Santa Clara Valley Water District's Santa Teresa Water Treatment Plant, 3) increasing San Luis Reservoir storage capacity, or 4) expansion of Pacheco Reservoir. If Pacheco Reservoir were to be enlarged, the reservoir would be filled with Delta water; thus, additional impacts on Delta aquatic species (e.g., juvenile salmonids and Delta Smelt) could result from an increase in Delta exports. The draft EIS/EIR and feasibility report are currently being developed.

Project	Primary Agencies	Description
Westlands v. United States Settlement	Westlands Water District	In August 2015, Westlands Water District and the United States agreed upon a settlement involving several litigations, as described below. The settlement is contingent upon Congressional authorization of enabling legislation (Reclamation 2015b). The following information provides a summary from the Reclamation news release in October 2015. In 2000, the court in Firebaugh Canal Co v. United States, issued an Order requiring the Secretary of the Interior to provide drainage service to lands served by the San Luis Unit of the Central Valley Project. In 2007 Reclamation signed a ROD selecting a drainage plan and finding that the cost of providing drainage for lands served by the San Luis Unit. Reclamation began implementing the selected drainage plan in a portion of Westlands Water District in 2010 on a court-ordered schedule. In 2011, individual landowners within Westlands Water District filed a takings claim against the United States alleging that failure to provide drainage service has caused a physical taking of their lands without just compensation in violation of the Fifth Amendment (Etchegoinberry v. United States). The Court of Federal Claims denied the government's motion to dismiss the complaint. In January 2012, Westlands filed a breach of contract case alleging that the government's failure to provide drainage service to the Westlands Water District service area constituted a breach of Westlands Water District 1963 Water Service and 1965 Repayment contracts (including the interim renewal of those contracts). The case is currently pending. Under the proposed terms of the Settlement, Westlands Water District will: • Permanently retire not less than 100,000 acres of land from production. Westlands Water District will agree to permanently retire a total of not less than 100,000 acres of lands within its boundaries utilizing those lands only for the following purposes: – Management of drain water, including irrigation of reuse areas; – Renewable energy projects; – Upland habitat restoration projects; or – Other uses subject to the consent of the United States. • Cap contract deliveries at 75 percent of its CVP contact amount (from 1.193 million AF to 895 thousand AF). Any water above this 75 percent cap, that would have been delivered to Westlands Water District, would instead be available to the United States for other public purposes under the CVP. • Assume all responsibility for drainage in accordance with all legal requirements under state and federal law. Westlands Water District would become legally responsible for the management of drainage water within its boundaries, in accordance with federal and California law. • Indemnify the United States for any damages and pay compensation for claims arising out of the Etchegoinberry litigation. Under the Settlement Westlands Water District will indemnify the United States for any claims (past, present and future) arising out of a failure to provide drainage service with Westlands Water District. Westlands Water District would also intervene in the Etchigoinberry case for Settlement purposes and would pay compensation to individual landowners. • Continue to wheel water to Lemoore Naval Air Station. As part of the overall Settlement, CVP water will be made available to Lemoore Naval Air Station and Westlands Water District would agree to wheel all CVP water made available to Lemoore under the same terms and conditions as Westlands Water District wheels water to other Westlands Water District's contractors. • Be relieved from potential drainage repayment. If the United States were to expend significant funds to provide a drainage solution, Reclamation would seek repayment from Westlands Water District (over 50 years, with no interest, commencing after completion of each separable element). By taking responsibility for drainage, Westlands Water District would also eliminate responsibility for repayment. Under the Terms of the Settlement, the United States will: • Be relieved of all statutory obligations to provide drainage. The Settlement Agreement would relieve the Department of the Interior from all drainage obligations imposed by the San Luis Act, including implementation of the 2007 ROD, which is estimated to cost approximately $3.5 billion ($513 million authorized). Westlands Water District will agree to dismiss with prejudice the Westlands v. U.S. breach of contract litigation and will join the U.S. in petitioning for vacatur of the 2000 Order Modifying Partial Judgment in the Firebaugh case directing implementation of drainage service and control schedules. • Receive a waiver of claims for potential damages due to a failure to provide drainage service. Westlands Water District will agree to provide for the release, waiver and abandonment of all past, present and future claims arising from the government's failure to provide drainage service under the San Luis Act, including those by individual landowners within Westlands Water District's service area, and would further agree to indemnify the United States for any and all claims relating to the provision of drainage service or lack thereof within the Westlands service area. • Relieve Westlands Water District repayment obligation for CVP construction charges to date (approximately $375 million). Westlands Water District will be relieved of its current, unpaid capitalized construction costs for the CVP, the present value of which is currently estimated to be $375 million. Under the Settlement, Westlands Water District will still be responsible for Operation and Maintenance, the payment of restoration fund charges pursuant to the CVPIA, and for future CVP construction charges. • Convert Westlands Water District water service contract into a repayment contract. The Secretary will convert Westlands Water District's current 9(e) water service contract to a 9(d) repayment contract consistent with existing key terms and conditions. As a "paid out" contractor, the benefit of this conversion is permanent right to a stated share of CVP water. However, the terms and conditions of the contract—including the so called "shortage clause" – will otherwise be the same as in the current 9(e) contract.

Project	Primary Agencies	Description
		• Retain the right to cease water deliveries if Westlands Water District fails to meet its drainage obligation. Language in the Settlement makes the United States' obligation to provide water to Westlands under the 9(d) Repayment Contract conditional upon Westlands Water District's fulfillment of its obligations to manage drainage water within its service area. • Issue a water service contract to Lemoore Naval Air Station. As part of the overall Settlement, the United States is authorized to enter into a water service contract with Lemoore Naval Air Station to provide a guaranteed quantity of CVP water to meet the needs of the Naval Air Station associated with air operations and Westlands Water District will agree to wheel all CVP water made available to Lemoore.
Contra Loma Reservoir and Recreation Resource Management Plan	East Bay Regional Park District, Reclamation	The Contra Loma Recreation Resource Management Plan is a long-term plan to guide management of the resources on the federal lands within the 80-acre Contra Loma Reservoir and surrounding 661 acres of recreation areas in Contra Loma Regional Park and Antioch Community Park (Reclamation 2014b). The East Bay Regional Park District manages the federal lands and public recreation facilities under an agreement with Reclamation. The proposed plan is to expand recreational use and facilities to increase recreational demands, including establishment of an additional all-weather sports field, fishermen's shelter, playground structure, a disc golf course, and expanded swim lagoon and trails. A ROD for the Management Plan was signed in 2015 (Reclamation 2015c).
San Luis Reservoir State Recreation Area Resource Management Plan/General Plan	Reclamation, California Department of Parks and Recreation (CDPR)	The Resource Management Plan addressed recreational plans for the San Luis Reservoir State Recreation Area and adjacent lands in Merced County that are owned by Reclamation and managed by CDPR, DWR, and CDFW (Reclamation and CDPR 2013). The Final Resource Management Plan/General Plan and Final EIS/EIR was released in June 2013. The plan focused on boating management, cultural resources management, vegetation management, enhanced trails management, expanded visitor experiences and education opportunities, and road and utility upgrades.
Future Water Supply Projects		
Future groundwater storage and recovery projects		1. City of Roseville (City of Roseville 2019) 2. Mokelumne River Water & Power Authority (Mokelumne River Water & Power Authority 2015) 3. Northeastern San Joaquin County Groundwater Banking Authority (NSJCGBA) (NSJCGBA 2011) 4. Stockton East Water District (Stockton East Water District 2012) 5. Madera Irrigation District (Reclamation 2011) 6. Kings River Conservation District (Kings River Conservation District 2012) 7. City of Los Angeles (City of Los Angeles 2013) 8. Los Angeles County (Los Angeles County 2013) 9. City of San Diego (City of San Diego 2009a, 2009b) 10. Rancho California Water District (Rancho California Water District 2011, 2012) 11. Eastern Municipal Water District [EMWD] (EMWD 2014a) 12. Jurupa Community Services District (Jurupa Community Services District et al. 2010)
Major conveyance projects		13. Bay Area Regional Water Supply Reliability (CCWD 2014, East Bay Municipal Utility District [EBMUD] 2014a) 14. Friant-Kern Canal and Madera Canal Capacity Restoration Projects (San Joaquin River Restoration Program [SJRRP] 2011, 2015) 15. Los Banos Creek Water Resources Management Plan (San Joaquin River Exchange Contractors Water Agency 2012)
Major recycled water projects (more than 10,000 AF/year)		Reasonably foreseeable recycled water projects: • City of San Diego Phase 1 Pure Water Facility- Proposed Pure Water Facility would produce 30 million gallon per day of potable water for City of San Diego residents starting 2023 (City of San Diego, 2018) Existing recycled water projects: • City of Fresno (City of Fresno 2011) • City of Los Angeles (City of Los Angeles 2005) • Central Basin Municipal Water District (Central Basin Municipal Water District 2011) • Foothill Municipal Water District (Metropolitan Water District of Southern California 2010) • Upper San Gabriel Valley Municipal Water District (Upper San Gabriel Valley Municipal Water District 2013) • West Basin Municipal Water District (West Basin Municipal Water District 2011, 2019) • Olivenhain Municipal Water District (Olivenhain Municipal Water District 2015) • EMWD (EMWD 2014b) • Inland Empire Utilities Agency (Inland Empire Utilities Agency 2014) • Palmdale Water District (Palmdale Water District 2010) • East Valley Water Reclamation Authority (Antelope Valley 2013)

Project	Primary Agencies	Description
Major future coastal desalination water projects		Reasonably foreseeable desalination projects: 1. Monterey Peninsula Water Supply Project- Proposed project would produce approximately 10,750 AF per year of desalinated water for the Monterey Bay Region. (California American Water 2018) 2. West Basin Municipal Water District Ocean Water Desalination Project- Proposed Project would produce approximately 21,500 AF of desalinated water to increase water supply reliability for large portions of Southern California communities. (West Basin 2018) 3. Huntington Beach Desalination Facility- Proposed seawater desalination facility would produce 50 million gallons per day (mgd) of water to Orange County residents. (Poseidon Water 2005) 4. Doheny Ocean Desalination Project- Proposed projects initial capacity would be approximately 5 mgd and could be scaled up to 15 mgd. Project would improve water reliability in South Coast Water District. (South Coast Water District 2018) Existing desalination projects: 1. Carlsbad Desalination Project- Plant delivers approximately 56,000 AF per year of desalinated water to San Diego County residents. The project originated in 1998 and was launched 2015. (San Diego County Water Authority 2015) 2. Charles Meyer Desalination Plant- Plant produces 3,125 AF of water annually and serves the City of Santa Barbara. Plant was built in 1991. (City of Santa Barbara, 2019) 3. Pebbly Beach Desalination Plant- Plant produces approximately 0.2 mgd and serves the City of Avalon. The desalinated plant has operated as a supplement to groundwater since 1990's. (City of Avalon 2016) 4. Morro Bay Desalination Plant, Morro Bay Power Plant and Diablo Canyon Nuclear Power Plant- All three facilities are located in san Luis Obispo County. Capacities of the plants vary from 0-10 mgd. (SWRCB 2017a) 5. Moss Landing Power Plant, Marina Coast Water District Desalination Plant, Sand City Desalination Plant and Monterey Bay Aquarium- All four facilities are located in Monterey County. Capacities of the plants vary from 0-10 mgd. (SWRCB 2017)
Long-term and short-term water transfers	Reclamation, San Luis & Delta-Mendota Water Authority (SLDMWA), Biggs-West Gridley Water District	These projects provide water to municipal, agricultural, and ecosystem water users, including wildlife refuges including programs that transfer water from northern California to the San Joaquin Valley and southern California across the Delta (Reclamation and SLDMWA 2015; Biggs-West Gridley Water District 2015).
Water Supply Contract Extension Program	DWR	The State of California entered into long-term water supply contracts (Contracts) with water agencies in the 1960s. Under terms of the contracts, DWR provides a water service to these agencies, known as SWP Contractors, from the SWP in exchange for payments that will recoup all costs associated with providing this water service over the life of the SWP. The majority of the capital costs associated with the development and maintenance of the SWP is financed using revenue bonds. These bonds have historically been sold with 30 year terms that extend to the year 2035, the year in which most of the Contracts expire. The program mission is to extend the term and amend the SWP contracts by conducting negotiations between DWR and the SWP Contractors which will occur in a public forum to ensure continued water supply affordability while complying with obligations under the California Environmental Quality Act (CEQA), and the Monterey Settlement Agreement. In December 2018, DWR approved the Water Supply Contract Extension Project and subsequently filed an NOD (DWR 2018a).
System Reoperation Program	DWR	DWR is conducting a system reoperation study (SRS) to identify potential reoperation strategies for the statewide flood protection and water supply systems. The SRS includes four phases. Phase 1, Plan of Study, was completed in 2011. Phase 2, Strategy Formulation and Refinements, was completed in 2014. Phase 3, Preliminary Assessments of Strategies, was completed in August 2017. Phase 4, Reconnaissance Level Assessments of Strategies, is currently under development (DWR 2019a).
Contra Costa Canal Replacement Project	CCWD	CCWD's Canal Replacement Project will replace the canal with a pipeline along a portion of the 48-mile Contra Costa Canal near Oakley to reduce salinity and water quality impacts of groundwater seepage from adjacent agricultural areas, as well as to increase public safety and flood protection. Segment 1 of the Canal Replacement Project was completed in 2009, which installed 1,900 feet of pipeline from Pumping Plant 1 to Marsh Creek. In 2015, Segment 2 was completed and installed 6,00 feet of pipeline from Marsh Creek past Sellers Avenue. (CCWD 2017). In 2019, CCWD is constructing Segments 3 and 4 and will be initiating plans for the remaining Segment 5.
Alternative Intake Project	CCWD, Reclamation, and DWR	The Alternative Intake Project was completed in 2010. The project located a new drinking water intake at Victoria Canal, about 2.5 miles east of CCWD's existing intake on the Old River, which allows CCWD to divert higher quality water when it is available. The new screened intake includes a 2.5-mile pipeline extension and a new pumping plant that ties into CCWD's existing conveyance system. The new intake has the same capacity and similar design as the existing Old River intake (250 cfs).

Project	Primary Agencies	Description
Davis-Woodland Water Supply Project	Davis, Woodland, and University of California, Davis	The Davis-Woodland Water Supply Project up to 45,000 AF per year of surface water from the Sacramento River and convey it for treatment and subsequent use in Davis and Woodland and on the University of California, Davis campus. The purposes of the project are to provide a reliable water supply to meet existing and future needs, improve water quality for drinking supply purposes, and improve treated wastewater effluent quality through 2040. The Project facilities were completed in July 2016 (Woodland-Davis Clean Water Agency N.d). Project activities included construction and operation of a water intake/diversion, conveyance, and water treatment facilities. Surface water supplies would be acquired through new water rights and water rights transfers from senior water rights holders. The Project is located in the east-central portion of Yolo County, between and within the cities of Woodland and Davis, the University of California, Davis campus, and west of the Sacramento River. The new water diversion facility is constructed on the Sacramento River near the Interstate 5 crossing at the location of the existing Reclamation District 2035 diversion. The water treatment plant to treat the surface water diverted from the Sacramento River would have an ultimate capacity of up to 106 mgd. Water diversions under the project was made in compliance with Standard Water Right Permit Term 91, which prohibits surface water diversions when water is being released from CVP or SWP storage reservoirs to meet in-basin entitlements, including water quality and environmental standards for protection of the Delta. Water supply needs during periods applicable to Term 91 would be satisfied by entering into water supply transfer agreements with senior water rights holders within the Sacramento River watershed.
EBMUD Camanche Permit Extension	EBMUD	The proposed project would extend the term of the existing Camanche water right Permit 10478 through the year 2040. Extending the Camanche Permit would allow EBMUD additional time to apply the water provided under Permit 10478 to municipal and industrial use within EBMUD's designated service area. Additionally, EBMUD contends that the full entitlement of Permit 10478 through 2040 is needed to maintain operational flexibility to meet future projected water demand and address system vulnerabilities associated with several factors, including emergencies and potential effects of climate change. The final EIR was completed in September 2014 (EBMUD 2014b).
Water Supply Management Program (WSMP) 2040	EBMUD	EBMUD's current WSMP (WSMP 2020), adopted in 1993, serves as the basis for water conservation and recycling programs and for development of supplemental supply initiatives such as the Freeport Regional Water Project. The WSMP 2040 updates the current plan and extends the planning horizon another 20 years. It identifies and recommends a Preferred Portfolio of solutions to meet dry-year water needs through 2040, including desalination, enlargement of Mokelumne River reservoirs. The primary objectives of the WSMP 2040 are to maintain and improve EBMUD's water supply reliability to its customers and help meet the need for water in the future. WSMP 2040 will also adapt the EBMUD's water planning approach to circumstances that have changed since WSMP 2020 was adopted, such as competing and changing demands for water, the availability of Freeport water after 2009, and long-term climate change. The final WSMP 2040 was completed in April 2012 (EBMUD 2012).
Freeport Regional Water Project	Freeport Regional Water Authority and Reclamation	Freeport Regional Water Authority, a Joint Powers Authority created by exercise of a joint powers agreement between the Sacramento County Water Agency (SCWA) and EBMUD, constructed a new water intake facility/pumping plant and 17-mile underground water pipeline within Sacramento County. The new water intake facility and pumping plant is located on the Sacramento River at the Freeport Bend, just upstream of Freeport and 10 miles south of Sacramento. The pumping plant diverts up to 185 mgd from the river and pump it through new pipelines to EBMUD and SCWA project facilities. Components of the facility include an in-river intake fish screen, sheet-piled in-river transition structure, electrical substation, surge control facility, compressed air system, sediment collection and settling basin system, and utilities. Construction of the intake was completed in 2010; the Vineyard Surface Water Treatment Plant was completed in 2012 (Freeport Regional Water Project 2019).
Eastern San Joaquin Integrated Conjunctive Use Program	NSJCGBA	The Integrated Conjunctive Use Program is to develop approximately 140,000 to 160,000 AF per year of new surface water supply for the basin that will be used to directly and indirectly to support conjunctive use by the NSJCBGA member agencies. This amount of water would support groundwater recharge at a level consistent with the GBA's objectives for conjunctive use and the underlying groundwater basin. Within this framework, the program would implement the following categories of conjunctive use projects and actions: water conservation measures; water recycling; groundwater banking; water transfers; development of surface storage facilities; groundwater recharge; river withdrawals; and construction of pipelines and other facilities. To enable and facilitate sustainable and reliable management of San Joaquin County's water resources, NSJCGBA developed a series of Basin Management Objectives to support conjunctive use and address a variety of water resources issues, including groundwater overdraft, saline groundwater intrusion, degradation of groundwater quality, environmental quality, land subsidence, supply reliability, water demand, urban growth, recreation, agriculture, flood protection, and other issues. The purpose of the Basin Management Objectives is to ensure the long-term sustainability of water resources in the San Joaquin Region. A Final EIR for the program was released in February 2011 (NSJCGBA 2011).
Emergency Storage Project	San Diego County Water Authority	The San Diego County Water Authority Emergency Storage Project increases storage of water imported from the Delta or Colorado River to be used if the imported water supplies are disrupted by a drought or catastrophe. The Emergency Storage Project includes construction of the new Olivenhain Reservoir, expansion of San Vincente Reservoir and Reservoir, pipelines to connect Olivenhain and San Vincente reservoirs to the Second Aqueduct. The water facilities for the Emergency Storage Project were under construction from 2000 to late 2014 (San Diego County Water Authority 2019).
Financial Assistance Programs for Wastewater and Water Facilities for Small Communities	SWRCB and Department of Public Health	SWRCB Resolution No. 200800048 includes the Small Community Wastewater Strategy to assist small and/or disadvantaged communities with wastewater needs for training and funding. The Small Community Wastewater Grant Program and Clean Water State Revolving Fund Program provide grants, low-interest loans and bonds for construction of wastewater facilities. The Department of Public Health Drinking Water State Revolving Fund provides grants and low- interest loans for disadvantaged and small communities. On February 19, 2013 the SWRCB approved a streamlined process.

Project	Primary Agencies	Description
Groundwater Ambient Monitoring and Assessment Program	SWRCB, Central Valley RWQCB, and Department of Public Health	The SWRCB and/or Central Valley RWQCB have an ongoing program to establish water quality objectives to protect beneficial uses of surface water and groundwater. Existing programs have focused on hazardous substances from landfills, waste disposal sites, fuel storage, and industrial facilities. The Groundwater Ambient Monitoring and Assessment program has been implemented to identify emerging pollutants and other constituents that affect drinking water quality. Currently, there is only one subbasin in the Central Valley that is under study as priority basin (western San Joaquin Valley near Tracy). This program is being coordinated with the Department of Public Health California Drinking Water Source Assessment and Protection program that provides information to water users. Information from these programs is used by these agencies to establish cleanup programs to protect groundwater quality.
Delta Water Supply Project	City of Stockton	The Delta Water Supply Project would develop a new supplemental water supply for the Stockton Metropolitan Area by diverting water from the Delta and conveying it through a pipeline to a surface water treatment plant, where it would be treated to the highest drinking water standards and distributed. Initially, the project would have the capacity to treat and deliver up to 30 mgd or 33,600 AF per year, meeting approximately one third of Stockton's water needs. Construction of the intake and pump station facility along with the water treatment plant and associated pipelines were completed in 2013 (CNRA 2015a).
Folsom Dam Safety and Flood Damage Reduction Joint Federal Project	Reclamation, U.S. Army Corps of Engineers (USACE), Sacramento Area Flood Control Agency, and Central Valley Flood Protection Board	The project represents a coordinated effort among Reclamation and USACE to address dam safety and enhanced flood control at Folsom Dam. The project includes the Joint Federal Project Auxiliary Spillway, seismic improvements to the Main Concrete Dam and Mormon Island Auxiliary Dam, static improvements to earthen structures, security upgrades, replacement of the Main Concrete Dam spillway gates, and a 3.5-foot raise to all Folsom Facility structures. Construction on the auxiliary spillway began in 2008 and was completed in 2017 (Reclamation 2019). The modifications to the dam allow for the release of water sooner than was possible, with the potential for higher releases should the downstream levees be improved to accommodate the increased flows. These larger, earlier releases from Folsom Reservoir create and conserve flood storage space based on projected reservoir inflows resulting from a major storm impacting the upper American River watershed. However, the modifications are operated using existing criteria until the completion of a revised Folsom Water Control manual and supporting supplemental environmental compliance documentation. The manual would be completed one year prior to completion of proposed structural modifications at Folsom Dam and Reservoir, at which time the full potential benefits of the proposed modifications would be realized.
Delta-Mendota Canal/California Aqueduct Intertie	Reclamation	The Delta-Mendota Canal/California Aqueduct Intertie consists of constructing and operating a pumping plant and pipeline connection between the Delta Mendota Canal (DMC) and the California Aqueduct. The Intertie, which is now operational, is used to achieve multiple benefits, including meeting current water supply demands, allowing for the maintenance and repair of the CVP Delta export and conveyance facilities, and providing operational flexibility to respond to emergencies related to both the CVP and the State Water Project. The Intertie includes a 450-cfs pumping plant at the DMC that allows up to 400 cfs to be pumped from the DMC to the California Aqueduct via an underground pipeline. The additional 400 cfs allows the Jones Pumping Plant to pump to its authorized amount of 4,600 cfs. Because the California Aqueduct is located approximately 50 feet higher in elevation than the DMC, up to 900 cfs flow can be conveyed from the California Aqueduct to the DMC using gravity flow. The Intertie is owned by the federal government and operated by the SLDMWA. An agreement among Reclamation, DWR, and SLDMWA identifies the responsibilities and procedures for operating the Intertie.
Riverside-Corona Feeder Conjunctive Use Project	Western Municipal Water District and Reclamation	The Riverside-Corona Feeder Conjunctive Use Project will deliver water from the San Bernardino Groundwater Basin Areas to communities throughout western Riverside and San Bernardino counties and the cities of San Bernardino, Colton, Rialto, Grand Terrace, and Riverside during drought and emergency periods. The project will connect local groundwater basins to allow regional management and distribution of groundwater and connect the Chino Desalter Phase 3 project (described below) into the regional system. This project was initially evaluated in 2005. A Final Supplemental EIR/EIS for the Riverside-Corona Feeder Pipeline was completed in February 2012. The project includes the Bunker Hill groundwater extraction facility and the feeder pipeline. The Supplemental EIR/EIS evaluated the No Action Alternative/No Project Alternative and four alternative pipeline alignments to deliver up to 40,000 AF/year. The alignment alternatives include connections to Jurupa Community Services District and to the existing San Bernardino Valley Municipal Water District inland and central feeders to provide flexibility and facilitate connections to provide regional water management.
South Bay Aqueduct Improvement and Enlargement Project	Zone 7 Water Agency and DWR	The South Bay Aqueduct Improvement and Enlargement Project improved and expanded the existing South Bay Aqueduct. The project increased the existing capacity of the water conveyance system up to its design capacity of 300 cfs and expand capacity in a portion of the project to add 130 cfs (total of 430 cfs). These improvements assist Zone 7 in meeting its future conveyance capacity needs and allow DWR to reduce State Water Project peak power consumption by providing for variation in pumping and delivery schedule. The enlargement project supply Zone 7's future Altamont Water Treatment Plant with additional SWP water. The enlarged South Bay Aqueduct carries an additional 130 cfs through Reach 1, and 80 cfs through reaches 2 and 4.Construction of the enlargement project was completed in 2014.
Senate Bill X7-7: Water Conservation Act of 2009	California State Administration	The administration will expand existing programs to provide technical assistance, shared data and information, and incentives to urban and agricultural local and regional water agencies, as well as local governmental agencies, to promote agricultural and urban water conservation in excess of the amounts envisioned by SBX7 7. They will work collaboratively with stakeholders to identify and remove impediments to achieving statewide conservation targets, recycling and stormwater goals; to evaluate and update targets for additional water use efficiency, including consideration of expanding the 20 percent by 2020 targets by holding total urban water consumption at 2000 levels until 2030, achieving even greater per capita reductions in water use. The administration will also work with local and regional entities to develop performance measures to evaluate agricultural water management.
Various Water Conservation Programs	California local agencies	Local agencies are increasingly conserving water by prohibiting certain types of wasteful water use. Examples include: prohibiting watering hard surfaces such as sidewalks, walkways, driveways or parking areas; prohibiting outdoor watering during periods of rain; and not serving water to customers in restaurants unless specifically requested. Local agencies are also pioneering incentive programs, for example, converting lawns to drought tolerant landscapes—and programs to capture rainwater.

Project	Primary Agencies	Description
Ecosystem Improvement Projects and Actions		
Yolo County Habitat/Natural Community Conservation Plan and Yolo Local Conservation Plan	Yolo Habitat Conservancy	The Yolo Habitat Conservation Plan (HCP)/Natural Communities Conservation Plan (NCCP) and Yolo Local Conservation Plan were formerly known as the Yolo Natural Heritage Program. The Yolo HCP/NCCP covers 12 endangered and threatened species and 15 natural communities, enabling agencies to construct projects and implement activities that affect the habitat of the covered species, and establishes a framework to protect, enhance, and restore natural resources within Yolo County. The Yolo Local Conservation Plan expands on the Yolo HCP/NCCP to cover species and natural communities of local concern not included in the Yolo HCP/NCCP (Yolo Habitat Conservancy 2016). Covered activities include ongoing operation and maintenance of existing flood control facilities and implementation of habitat enhancement, restoration, and creation actions included in the Yolo HCP/NCCP Conservation Strategy. The Final Yolo HCP/NCCP and Final EIS/EIR were completed in April 2018.
California EcoRestore	CNRA	California EcoRestore is an initiative by CNRA to coordinate and advance habitat restoration for at least 30,000 acres by 2019 (CNRA 2015b, 2015c). This acreage includes 25,000 acres of habitat restoration identified in the 2008 USFWS BO and 2009 NMFS BO, and 5,000 acres of habitat enhancements. Some of these programs would be funded by federal and state water agencies that are required to mitigate impacts of the CVP and SWP. Other programs would be sponsored by a combination of funds from state bonds (Proposition 1 and 1E), Assembly Bill 32 Greenhouse Gas Reduction Fund, federal agencies, local agencies, and private investments. The California Delta Conservancy will lead implementation of identified restoration projects in collaboration with local governments and with a priority on using public lands in the Delta. Many of the programs to be implemented under California EcoRestore in Suisun Marsh, Yolo Bypass, and Cache Slough are discussed separately under the No Action Alternative and cumulative effects in this EIS.
North Delta Flood Control and Ecosystem Restoration Project	DWR	The North Delta Flood Control and Ecosystem Restoration Project is proposed near the confluence of the Cosumnes and Mokelumne rivers by the DWR and encompasses approximately 197 square miles. Consistent with objectives contained in the CALFED ROD, the project is intended to improve flood management and provide ecosystem benefits in the North Delta area through actions such as construction of setback levees and configuration of flood bypass areas to create quality habitat for species of concern. These actions are focused on McCormack-Williamson Tract and Staten Island. The project would implement flood control improvements in a manner that benefits aquatic and terrestrial habitats, species, and ecological processes. Flood control improvements are needed to reduce damage to land uses, infrastructure, and the Bay-Delta ecosystem resulting from overflows caused by insufficient channel capacities and catastrophic levee failures in the 197 square-mile project study area. The proposed project as described in the Final EIR (DWR 2010a) included: portions of the levee system degraded to allow controlled flow across McCormack-Williamson Tract; levee modification to mitigate hydraulic impacts; channel dredging to increase flood conveyance capacity; an off-channel detention basin on Staten Island; ecosystem restoration where floodplain forests and marshes would be developed at McCormack-Williamson Tract and the Grizzly Slough property; setback levee on Staten Island to expand the floodway conveyance; and opening up the southern portion of McCormack-Williamson Tract to boating; improving Delta Meadows property; providing access and interpretive kiosks for wildlife viewing; and providing restroom, circulation, parking, and signage infrastructure to support such uses.
Franks Tract Project	Reclamation, DWR	CDFW and partners are proposing to restore about 1,000 acres of Franks Tract to tidal marsh. The proposed restoration could shrink waterweeds, grow fish food, create habitat for Delta smelt and other declining pelagic species, and prevent salinity intrusion into the south Delta. If approved for further development, the Franks Tract restoration proposal would enter a detailed phase of planning, design, and environmental review with a target end date of December 2020 (CDFW 2018a).
East Alameda County Conservation Strategy	Alameda County	The East Alameda County Conservation Strategy (EACCS) is intended to preserve endangered species with a plan for long term habitat protection. The EACCS assesses the conservation value of East Alameda County to establish biological principles for conservation in that area. The EACCS provides a framework for regional conservation of biological species, streamline the environmental permitting process, provides guidance to project proponents, and facilitate ongoing conservation programs. The EACCS identifies land suitable for voluntary mitigation or conservation, mitigation ratios, standards for habitat restorations, best management and maintenance practices for conservation sites, monitoring standards, and guidelines for adaptive management. The Final East Alameda County Conservation Strategy was completed in October 2010 (East Alameda County Conservation Strategy Steering Committee 2010).
Egeria Densa Control Program	California Department of Boating and Waterways	The Egeria Densa Control Program (EDCP) is part of the Department of Boating and Waterway's (DBW) Aquatic Pest Control Program. Cal Boating has operated the EDCP in the Delta, and its tributaries, since program inception in 2001. The program was developed in order to respond to 1997 State legislation (Rainey, Assembly Bill 2193), authorizing the program. A Final EIR was published for the program in 2001. A second addendum to the 2001 EIR was published in January 2006, with 5-year program review and future operations plan. In June 2007, NMFS analyzed the potential effects of continued implementation of the EDCP on listed salmonids and green sturgeon and issued a Biological Opinion continuation of the program for 5 years (2007 through 2011). DBW received the Section 7, Biological Opinion from USFWS along with a letter of concurrence from NMFS in May 2013. Both documents were valid until 2017 (CDPR 2014). The program includes treatment with herbicides, environmental monitoring, regulatory compliance, and surveillance.
Arundo Control and Restoration Program	DWR	The Arundo Control and Restoration Program is part of the larger Delta Ecosystem Enhancement Program operated by DWR. *Arundo donax* is an invasive species that is devastating the Delta riparian habitat. The Arundo Control and Restoration Program aims to develop expertise in Arundo control, effective restoration techniques in the controlled areas, resources requirements, and landowner contacts to solicit their cooperation (DWR 2019b). As of 2019, the project is currently active.

Project	Primary Agencies	Description
Solano County Habitat Restoration Partnership	DWR, Solano Resource Conservation District (RCD), Dixon RCD, Reclamation District 2068, 2098, and 501F	The Solano County Habitat Restoration Partnership is part of the larger Delta Ecosystem Enhancement Program. The program has eradicated or heavily controlled non-native invasive plants Arundo and red sesbania in over 60 miles of levees and canals. In addition, the program has improved water quality, soil structure, and habitat in Hastings Cut by installing a cattle exclusion fence that prevents grazing cattle from entering. As of 2019, DWR is continuing their efforts to grade and plant native grasses in order to further utilize drainage canals for plant and wildlife corridors (DWR 2019c).
Decker Island Habitat Development	DWR	The Decker Island Habitat Development Project has two goals: excavate 600,000 cubic yards of material to use for levee improvements at Sherman and Twitchell islands and create channels from the removed material for shallow water habitat and providing water to the interior of the project site for planted trees and vegetation (DWR 2019d). Habitat management tasks also include detection and control of exotic plant species. As of 2019, the project has been completed; however, long-term maintenance and monitoring is ongoing.
Water Hyacinth Control Program	California Department of Boating and Waterways	The Water Hyacinth Control Program is part of DBW's Aquatic Pest Control Program. DBW has operated the Water Hyacinth Control Program in the Delta, and its tributaries, since program inception. In 1982, state legislation made DBW the lead agency for the control of water hyacinth in the Delta, its tributaries and the Suisun Marsh. The initial control plan used both short- and- long term methods that involved chemical, mechanical, and biological control measures. The primary and most successful control measure is chemical spraying. Permits for the program were obtained in 2001. DWB published a Final Programmatic Environmental Impact Report in 2009. The selected alternative is continuation of the program.
Private Lands Incentive Programs	CDFW	DFW manages the California Waterfowl Habitat Program (Presley Program), a multi-faceted wetland incentive program designed to improve habitat for waterfowl on private lands. Consistent with its primary waterfowl habitat objectives, the program also endeavors to enhance habitat for shorebirds, wading birds, and other wetland-dependent species. The program pays private landowners $20/acre ($30/acre in the Tulare Basin) annually for a 10-year duration to implement habitat practices in accordance with a detailed management plan. In cooperation with Wildlife Conservation Board's Inland Wetland Conservation Program, DFW also administers the Permanent Wetland Easement Program that pays willing landowners approximately 50-70% of their property's fair market value to purchase the farming and development rights in perpetuity. Landowner retains many rights including: trespass rights, the right to hunt and/or operate a hunting club, and the ability to pursue other types of undeveloped recreation (fishing, hiking, etc.). Easement landowners are required to follow a cooperatively developed wetland management plan. DFW also administers the Landowner Incentive Program funded by USFWS to annual incentive payments to landowners to enhance and manage their lands to protect wetlands, native grasslands, and riparian habitat. The Lands Incentive Program now has two phases. Phase 1 promotes management of California's newly restored wetland, riparian, and native grassland habitats on private lands. Phase 2 actively restores and manages riparian buffers on working agricultural lands (CDFW 2015).
Grizzly Island Wildlife Area Land Management Plan	CDFW	The Grizzly Island Wildlife Area Land Management Plan was released in January 1989. The plans purpose was to guide efforts over 1988 – 1993 to guide the Department of Fish and Wildlife budget preparation and operation of the area.
Invasive Species Program	CDFW	The Invasive Species Program participates on efforts to prevent the introduction of non-native invasive species in California, detect and respond to introductions when they occur, and prevent the spread of non-native invasive species that have become established. Program activities include development of the California Aquatic Invasive Species Management Plan, the Marine Invasive Species Monitoring Program, and informational and education activities for quagga/zebra mussels, New Zealand mudsnails, northern pike (in Lake Davis), and dwarf eelgrass.
California Aquatic Invasive Species Management Plan	CDFW	The California Aquatic Invasive Species Management Plan (CAISMP) was released in January 2008. The plan's overall goal is to identify the steps that need to be taken to minimize the harmful ecological, economic, and human health impacts of aquatic invasive species in California. This plan provides the state's first comprehensive, coordinated effort to prevent new invasions, minimize impacts from established aquatic invasive species and establish priorities for action statewide. In addition, it proposes a process for annual plan evaluation and improvement so that aquatic invasive species can continue to be managed in the most efficient manner in the future. Eight major objectives and 163 actions were identified in the CAISMP.
Aquatic Invasive Species Draft California Rapid Response Plan	CDFW	The CAISMP (described above) proposes an Aquatic Invasive Species Rapid Response Plan for the State of California. The Rapid Response Plan establishes a draft general procedure for rapid response following detection of new aquatic invasive species infestation. It provides a framework for developing and implementing a rapid response plan. It is preliminary in that it describes types of information, resources and decisions necessary to finalize the plan. In order to finalize, fund, and implement the draft Rapid Response Plan, CDFW expects that cooperating agencies will assign staff to participate. CDFW Invasive Species Program staff will provide coordination for the interagency activities called for in the agreement(s).
Zebra Mussel Rapid Watch Program and Response Plan for California	CDFW, DWR, and California State Lands Commission	As part of the Zebra Mussel Early-Detection Monitoring and Outreach Program and the California Zebra Mussel Watch Program, this rapid response plan was developed to outline necessary actions and resources needed to respond to confirmed introductions of zebra mussels into the state. The plan outlines available options for eradication and/or control of zebra mussels (and quagga mussels) and provides guidance for resource managers and agency personnel. The plan includes a list of potential zebra mussel infestation scenarios with possible treatment and post-treatment monitoring techniques. The Zebra Mussel Rapid Response Plan for California is a working document that requires additional information (which will be incorporated as it becomes available) regarding funding sources, permitting requirements, specific roles of agency personnel, legal information, and infestation site specific information. The draft plan will serve as the template for a statewide plan that staff from DWR will continue to develop.

Project	Primary Agencies	Description
Fish Screen and Passage Program	CDFW	Under the Fish Screen and Fish Passage Program, CDFW conducts inventories of all screened and unscreened diversions and fish passage problems via site visits and gathers information on the size and number of diversions at each site and presence of existing fish protective facilities. CDFW performs the following activities: 1) inventory of water diversion and fish passage problems; 2) evaluation and prioritization of fish screening and fish passage problems; 3) implementation and coordination of fish protection activities; 4) evaluation of existing and proposed fish protective installations; and 5) review of fish screening and fish passage literature. In addition, it maintains a database that is fairly comprehensive for the Central Valley streams (Sacramento and San Joaquin Rivers systems).
Fish Passage Improvement Program	DWR	Since 1999, DWR's Fish Passage Improvement Program has worked to re-open streams and rivers to migratory fishes. The program summarizes, describes, and identifies anadromous fish passage impediments and possible solutions by addressing the problem of fish passage barriers. Through the program's individual projects, and collaboration with others, DWR improves fish passage at these structures by modifying or removing them (DWR 2019e).
Delta-Bay Enhanced Enforcement Program	CDFW	The Delta-Bay Enhanced Enforcement was initiated in 1991 through the Four Pumps Agreement between CDFW and DWR (funded by the State Water Project Contractors). In 1994, Reclamation began funding additional warden positions. The program provides increased enforcement to reduce illegal harvest of species in the San Francisco Bay and Delta, upstream into the Sacramento and San Joaquin basins. In 2008, the program had 10 wardens that focused enforcement efforts to protect steelhead and salmon, as well as other anadromous species of concern. Funds support the addition of 17 field wardens and 5 supervisory and support staff. In the Sacramento Basin, the program targets enforcement during the spring-run Chinook salmon migration and summer holding period.
Ecosystem Restoration Program Conservation Strategy	CDFW	The Ecosystem Restoration Program (ERP) is a multi-agency effort aimed at improving and increasing aquatic and terrestrial habitats and ecological function in the Delta and its tributaries. The ERP Focus Area includes the Delta, Suisun Bay, the Sacramento River below Shasta Dam, the San Joaquin River below the confluence with the Merced River, and their major tributary watersheds directly connected to the Bay-Delta system below major dams and reservoirs. Principal participants overseeing the ERP are CDFW, USFWS, and NMFS, collectively known as the ERP Implementing Agencies. The ERP implements restoration projects through grants administered by the ERP Grants Program. The vast majority of these projects focus on fish passage issues, species assessment, ecological processes, environmental water quality, or habitat restoration. The ERP is guided by the following six strategic goals: • Recover endangered and other at-risk species and native biotic communities; • Rehabilitate ecological processes; • Maintain or enhance harvested species populations; • Protect and restore habitats; • Prevent the establishment of and reduce impacts from non- native invasive species; and Improve or maintain water and sediment quality.
Fremont Landing Conservation Bank	CDFW	The project is the restoration, enhancement, and preservation of 100 acres of habitat for the federally and state listed Chinook salmon and Central Valley steelhead at Fremont Landing Conservation Bank site. Construction of the Fremont Landing Conservation Bank was completed and the Banks successfully met performance standards for the final year of monitoring in 2018 (Wildlands 2018). The project preserves and enhances 40 acres of existing riparian and wetland habitat and restores/creates 60 acres of riparian woodland and wetland sloughs within the floodplain of the Sacramento River. Three borrow pits are connected to the Sacramento River in order to reduce/eliminate fish stranding. The project also includes preservation and restoration of shaded riverine aquatic habitat and placement of large woody debris along the Sacramento River.
Fish Screen Project at Sherman and Twitchell Islands	CDFW and DWR	The project proposes to place five self-cleaning, retractable fish screens at intake siphons located on Sherman Island and Twitchell Island in order to reduce potential entrainment of Delta Smelt and other fish species by agricultural diversions. The Mitigated Negative Declaration (MND) was released in March 2016 (DWR 2016).
Lower Sherman Island Wildlife Area (LSIWA) Land Management Plan (LMP)	CDFW	The Lower Sherman Island Wildlife Area occupies roughly 3,100 acres, primarily marsh and open water, at the confluence of the Sacramento and San Joaquin Rivers in the western Delta. This extensive tract of natural vegetation and Delta waters provides diverse and valuable wildlife habitats and related recreational opportunities and is integral to the functioning and human use of the Delta. The mission of CDFW is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. The LMP is consistent with that mission. The purpose of the LMP is to: (1) guide management of habitats, species, and programs described in the LMP to achieve CDFW's mission to protect and enhance wildlife values; (2) serve as a guide for appropriate public uses of the LSIWA; (3) serve as descriptive inventory of fish, wildlife, and native plant habitats that occur on or use the LSIWA; (4) provide an overview of the property's operation and maintenance and of the personnel requirements associated with implementing management goals (this LMP also serves as a budget planning aid for annual regional budget preparation); and (5) present the environmental documentation necessary for compliance with state and federal statutes and regulations, provide a description of potential and actual environmental impacts that may occur during plan management, and identify mitigation measures to avoid or lessen these impacts. The final Land Management Plan was released in April 2007 (CDFG 2007).

Project	Primary Agencies	Description
Yolo Bypass Wildlife Area Land Management Plan	CDFW	The Yolo Bypass Wildlife Area comprises approximately 16,770 acres of managed wildlife habitat and agricultural land within the Yolo Bypass. The bypass conveys seasonal high flows from the Sacramento River to help control river stage and protect the cities of Sacramento, West Sacramento, and Davis and other local communities, farms, and lands from flooding. Substantial environmental, social and economic benefits are provided by the Yolo Bypass, benefiting the people of the State of California. The stated purposes of the Yolo Bypass Wildlife Area Land Management Plan are to: (1) guide the management of habitats, species, appropriate public use, and programs to achieve CDFW's mission; (2) direct an ecosystem approach to managing the Yolo Bypass Wildlife Area in coordination with the objectives of the CALFED ERP; (3) identify and guide appropriate, compatible public-use opportunities within the Yolo Bypass Wildlife Area; (4) direct the management of the Yolo Bypass Wildlife Area in a manner that promotes cooperative relationships with adjoining private-property owners; (5) establish a descriptive inventory of the sites and the wildlife and plant resources that occur in the Yolo Bypass Wildlife Area; (6) provide an overview of the Yolo Bypass Wildlife Area's operation, maintenance, and personnel requirements to implement management goals, and serve as a planning aid for preparation of the annual budget for the Bay-Delta Region (Region 3); and (7) present the environmental documentation necessary for compliance with state and federal statutes and regulations, provide a description of potential and actual environmental impacts that may occur during plan management, and identify mitigation measures to avoid or lessen these impact. The final Land Management Plan was released in June 2008 (CDFG 2008).
Staten Island Wildlife-Friendly Farming Demonstration	CDFW	Acquisition and restoration of Staten Island (9,269 acres) to protect critical agricultural wetlands used by waterfowl and Sandhill cranes. Phase II of this project is to improve wildlife- friendly agriculture to foster recovery of at-risk species and to investigate effects of agriculture on water quality. This project acts as a demonstration for wildlife friendly agriculture practices and will increase habitat availability by allowing 2,500- 5,000 acres of corn to be flooded for a longer duration than is presently possible. Also, the project helps to determine the effect of winter flooding strategies on target bird species, namely greater sandhill crane and northern pintail (Delta EMZ).
Population Biology, Life History, Distribution, and Environmental Optima of Green Sturgeon	CDFW	This project is conducting telemetric, physiological, reproductive, and genetic studies to provide state and federal agencies such as NMFS and CDFW with information on the size of the population and its critical habitat within the Sacramento-San Joaquin watershed to inform the development of a recovery plan for the species. The distribution of spawning adults and juveniles will be continuously monitored using automated listening stations situated throughout the Sacramento River, Delta, and San Francisco Bay Estuary. The project will also characterize the environment where adult green sturgeon are found to spawn (Ecosystem Restoration Program N.d.).
Operations as for Listing of Longfin Smelt under CESA	California Fish and Wildlife Commission	Despite the fact that OAL has not "finalized" its proposed changes in regulations in code, CDFW operates in accordance with the longfin being listed as threatened. In fact, CDFW has issued DWR a 2081 permit authorizing take of this threatened species (CDFW 2018b).
Hatchery and Stocking Program	CDFW and USFWS	CDFW operates a statewide system of fish hatchery facilities that rear and subsequently release millions of trout, salmon, and steelhead of various age and size classes into state waters. These fish are reared and released for recreational and commercial fishing, for conservation and restoration of fish species that are native to California waters, for mitigation of habitat losses caused by construction of dams on the state's major rivers, and for mitigation of fish lost at state-operated pumping facilities in the Delta. CDFW's Hatchery Program includes: • operation of 14 trout hatchery facilities owned by CDFW and the related stocking of fish, • operation of eight salmon and steelhead hatchery facilities owned by others and the related stocking of fish, • operation of two salmon and steelhead hatchery facilities owned by CDFW and the related stocking of fish, • providing education staff and fish for stocking under the Fishing in the City program, • issuing authorizations and providing fish eggs for the Classroom Aquarium Education Project (CAEP) • issuing permits for stocking public and private waters with fish reared at private aquaculture facilities, • implementing the fish production and native trout conservation requirements contained in California Fish and Game Code Section 13007. The fundamental objectives of CDFW's Hatchery Program are to continue the rearing and stocking of fish from its existing hatchery facilities for the recreational use of anglers, for mitigation of habitat loss due to dam construction and blocked access to upstream spawning areas, for mitigation of fish losses caused by operation of the state-operated Delta pumps, and for conservation and species restoration.
Hatchery and Stocking Program Proposed Changes	CDFW and USFWS	CDFW has been rearing and stocking fish in the inland waters of California since the late 1800s. CDFW currently stocks trout in high mountain lakes, low elevation reservoirs, and various streams and creeks throughout California. Salmon have been planted mostly in rivers and direct tributaries to the Pacific Ocean, with the exception of inland kokanee, coho, and Chinook salmon populations that have been planted in reservoirs for recreational fishing. In 2006, a lawsuit was filed against CDFW claiming that CDFW's fish stocking operation did not comply with CEQA. In July 2007, CDFW was ordered by the Sacramento Superior Court to comply with CEQA regarding its fish stocking operations. CDFW completed a Final EIR to comply with the court order in July 2010 (CDFG and USFWS 2010). The USFWS served as the co-lead for the joint EIR/EIS.

Project	Primary Agencies	Description
Watercraft Inspection Programs	CDFW, California Department of Food and Agriculture, California State Parks	Several local boat and watercraft inspection programs have been initiated to prevent the spread of invasive species such as quagga mussels. Since early 2007, more than 150,000 watercraft have been inspected at CDFA's Border Protection Stations. Pests have been detected on nearly 200 occasions. Another 14,000 watercraft were cleaned and/or drained of all water that could harbor the mussels. The inspections are ongoing. After quagga mussels were detected in 2007 in the Colorado River, funding was granted to enable the California Department of Food and Agriculture (CDFA) to inspect watercraft at six border stations along the Nevada and Arizona borders: Truckee, Needles, Winterhaven, Blythe, Yermo and Vidal. When exotic mussels are detected by CDFA inspectors, the watercraft are cleaned and the owners issued a quarantine notice prohibiting the craft from entering California waters until a final inspection is conducted by CDFW. CDFW conducts boat inspection training and activities around the state and has initiated inspections at several water bodies.
Suisun Marsh Habitat Management, Preservation, and Restoration Plan	CDFW, USFWS, Reclamation, and Suisun Marsh Charter Group	The Suisun Marsh Charter Group, a collaboration of federal, state, and local agencies with primary responsibility in Suisun Marsh, completed the Suisun Marsh Habitat Management, Preservation, and Restoration Plan in 2014. The plan balances implementation of the CALFED Program, the Suisun Marsh Preservation Agreement, and other management and restoration programs within the Suisun Marsh in a manner that is based upon voluntary participation by private landowners and that responds to the concerns of stakeholders. Charter agencies include Reclamation, DWR, USFWS, Suisun Resource Conservation District, and other agencies. The Charter Group developed a regional plan that outlines the actions needed in Suisun Marsh to preserve and enhance managed seasonal wetlands, restore tidal marsh habitat, implement a comprehensive levee protection/improvement program, and protect ecosystem and drinking water quality. The proposed plan is consistent with the goals and objectives of the Bay-Delta Program and balances those goals and objectives with the Suisun Marsh Preservation Agreement and federal and state endangered species programs within the Suisun Marsh. The Suisun Marsh Plan also provides for simultaneous protections and enhancement of: 1) existing wildlife values in managed wetlands, 2) endangered species, 3) tidal marshes and other ecosystems, and 4) water quality, including, but not limited to, the maintenance and improvement of levees (CDFW 2018b).
Central Valley Vision	California State Parks	In 2003, California State Parks began work on a long-term Central Valley Vision to develop a strategic plan for State Parks expansion in the Central Valley. In 2009, California State Parks completed the Central Valley Vision Implementation Plan (California State Parks 2009). The plan provides a 20-year road map for State Park actions to focus on increasing service to Valley residents and visitors. Within the Great Central Valley (San Joaquin Valley, Sacramento Valley and the Delta region), California State Parks operates and maintains 32 state park units representing 7% of the total state park system acreage. Plans include: Delta Meadows River Park, Brannon Island SRA, Franks Track SRA, Locke Boarding House, and San Joaquin and Sacramento Rivers.
Central Valley Flood Management Planning (CVFMP) Program	DWR	DWR launched the CVFMP program in 2008 to improve integrated flood management in California's Central Valley. The CVFMP program efforts include the preparation of the Central Valley Flood Protection Plan (CVFPP) to fulfill the requirements of the Central Valley Flood Protection Act of 2008. A guidance document was adopted in 2012, and subsequently updated in August 2017 (DWR 2017). The document is scheduled to be updated every five years. The Lower Elkhorn Basin Levee Setback Project is the first phase of implementation of recommendations from the 2012 CVFPP. The Final EIR was certified in June 2019.
Clifton Court Forebay Fishing Facility	DWR	The Clifton Court Forebay Fishing Facility consists of installing a fishing pier into Clifton Court Forebay, a staging area, concrete pad and retaining wall, security fencing, and gates, Americans with Disabilities Act (ADA)-compliant public restroom, bicycle rack, equipment shed, ADA compliant boat dock and road section on West Canal, two ADA compliant parking spaces next to the public entrance gate, and lighting and signage. The Initial Study and Mitigated Negative Declaration (IS/MND) was circulated for public review in June 2013 (Reclamation 2013).
Delta Levees Flood Protection Program	DWR	The Bay-Delta Levees Branch of DWR administers the Delta Levees Flood Protection Program as authorized by the California Water Code, Sections 12300 thru 12318 and 12980 thru 12995. This is a grants program that works with more than 60 reclamation districts in the Delta and Suisun Marsh to maintain and improve the flood control system and provide protection to public and private investments in the Delta including water supply, habitat, and wildlife. The program, through its two major components (Delta Levees Maintenance Subventions Program and Delta Levees Special Flood Control Projects), works with the local agencies to maintain, plan, and complete levee rehabilitation projects. The Delta Levees Maintenance Subventions Program provides financial assistance to local levee maintaining agencies for the maintenance and rehabilitation of non-project levees in the Delta. It has been in effect since passage of the Way Bill in 1973, which has been modified periodically by legislation. The program is under the authority of the Central Valley Flood Protection Board (Board) and is managed by DWR. Water Code Section 12987 calls on DWR to prioritize the islands for receipt of grant funds through the program and recommend the prioritization to the Board. The Board reviews and approves the Department's recommendation and enters into an agreement with reclamation districts to reimburse eligible costs. The Delta Levees Special Flood Control Projects provides financial assistance to local levee maintaining agencies for rehabilitation of levees in the Delta. The program was established by the California Legislature under SB 34, SB 1065, and AB 360. Since the inception of the program, more than $100 million have been provided to local agencies in the Delta for flood control and related habitat projects. The program presently focuses on flood control projects and related habitat projects for eight western Delta Islands (Bethel, Bradford, Holland, Hotchkiss, Jersey, Sherman, Twitchell and Webb Islands) and for the towns of Thornton and Walnut Grove.

Project	Primary Agencies	Description
Delta Risk Management Strategy	DWR	The 2000 CALFED ROD presented a Preferred Program Alternative that described actions, studies, and conditional decisions to help the Delta. The Preferred Program Alternative for Stage 1 implementation included the completion of a Delta Risk Management Strategy (DRMS) that would examine the sustainability of the Delta, and would assess major risks to Delta resources for projections ranging from 50 to 200 years. The first phase of DRMS analyzed the risks and consequences of levee failure in the Delta region. The analysis considered current and future risks of levee failures from earthquakes, high water conditions (storms and tides), climate change, subsidence, dry-weather events, and a combination of these factors. The analysis also estimated the consequences of levee failures to the local and state economy, public health and safety and the environment. The DRMS Phase 1 2009 report found that "under business-as-usual practices, the Delta region as it exists today is unsustainable". These findings will be used to help develop a set of strategies to manage levee failure risks in the Delta and to improve the management of state funding that supports levee maintenance and improvement. Phase developed risk reduction strategies to manage levee failure risks. Phase 2 data can now be used to pinpoint major irks and advise on related mitigation measures (Water Education Foundation N.d).
FloodSAFE California	DWR	In 2006, DWR initiated FloodSAFE California, which is a multi- faceted program to improve public safety through integrated flood management. Under the FloodSAFE Program, DWR provides leadership and works with local, regional, state, tribal and federal officials to improve flood management and emergency response systems throughout California, primarily by investing funds provided by Propositions 1E and 84. Although DWR is leading FloodSAFE, successful implementation of the program depends on active participation from many key partners and substantial federal and local cost participation. The FloodSAFE vision is a sustainable integrated flood management and emergency response system throughout California that improves public safety, protects and enhances environmental and cultural resources, and supports economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and lowering the damages caused by flooding. The FloodSAFE Program is designed to help improve integrated flood management statewide with a significant emphasis on the Central Valley and Delta where communities and resources face high risk of catastrophic damage. Integrated Flood Management includes recognition of: the interconnection of flood management actions within broader water resources management and land use planning, the value of coordinating across geographic and agency boundaries, the need to evaluate opportunities and potential impacts from a system perspective, and the importance of environmental stewardship and sustainability. FloodSAFE will guide the development of regional flood management plans that encourage regional cooperation in identifying and addressing flood hazards. The plans will emphasize multiple objectives, system resiliency, and compatibility with state goals and Integrated Regional Water Management Plans.
Levee Repair- Levee Evaluation Program	DWR	On February 24, 2006, Governor Arnold Schwarzenegger declared a State of Emergency for California's levee system, commissioning up to $500 million of state funds to repair and evaluate state/federal project levees. Following the emergency declaration, the Governor directed DWR to secure the necessary means to fast-track repairs of critical erosion sites. Hundreds of levee sites have been identified for immediate repair throughout the Central Valley. These repairs are necessary to maintain the functionality of flood control systems that have deteriorated over time and/or do not meet current design standards. While many of the most urgent repairs have been completed or are near completion, other sites of lower priority are still in progress, and still more are in the process of being identified, planned, and prioritized. In general, repairs to state/federal project levees are being conducted under three main programs: the Critical Erosion Repairs Program, the Sacramento River Bank Protection Project, and the PL84-99 Rehabilitation Program. A fourth program to repair critically damaged levees on the San Joaquin Flood Control System is under development by DWR. DWR is conducting geotechnical exploration, testing, and analysis of state and federal levees that protect the highly populated urban areas of greater Sacramento, Stockton/Lathrop, and Marysville/Yuba City. This program is being implemented simultaneously with the various urgent levee repairs. To expedite efforts to protect these communities, levee evaluations are being conducted in a fast-track manner over a two- to three-year period. During this time, technical specialists are reviewing existing levee historical data; mapping near-surface geology; conducting field explorations; performing engineering, stability and seepage analyses; and preparing preliminary design and construction estimates for repairing and upgrading the levees, where needed.
Lower Yolo Restoration Project	State and Federal Contractors Water Agency, DWR, and MOA Partners	The project is located in the lower Yolo Bypass and is a tidal and seasonal salmon habitat project restoring tidal flux to about 1,100 acres of existing pasture land. The project site includes the Yolo Ranch, also known as McCormack Ranch, which was purchased in 2007 by the Wetlands Water District (WWD). The goal of this project is to provide important new sources of food and shelter for a variety of native fish species at the appropriate scale in strategic locations in addition to ensuring continued or enhanced flood protection. The Lower Yolo wetlands restoration project is part of an adaptive management approach in the Delta to learn the relative benefits of different fish habitats, quantify the production and transport of food and understand how fish species take advantage of new habitat,
Meins Landing Restoration	DWR, Suisun Marsh Preservation Agreement	The 666-acre property is currently a mosaic of managed wetlands and upland habitats. The area long used as a managed wetlands for a duck club will be restored to tidal marsh and to provide meet wetlands restoration goals of other projects, including levee improvements on Van Sickle Island.

Project	Primary Agencies	Description
Interagency Ecological Program (IEP)	DWR, CDFW, SWRCB, USFWS, Reclamation, Geological Survey, USACE, NMFS, and Environmental Protection Agency	The mission of the IEP is to provide information on the factors that affect ecological resources in the Sacramento-San Joaquin Estuary as a means to support more efficient management of the estuary. The program consists of 10 member agencies, three state (DWR, CDFW, and SWRCB), six federals (USFWS, Reclamation, Geological Survey, USACE, NMFS, and Environmental Protection Agency), and one non-government organization (the San Francisco Estuarine Institute). Program partners work together to develop a better understanding of the estuary's ecology and the effects of the SWP and CVP operations on the physical, chemical, and biological conditions of the San Francisco Bay-Delta estuary. Activities include data collection and analysis, evaluation of the impacts of human activities on fish and wildlife, interpretation of information and development of measures to avoid or offset impacts of water project operation and other human activities on the estuary, and assistance with planning, coordination and integration of estuarine studies by other agencies. The IEP Science Advisory Group also conducts independent scientific reviews of modeling activities and study programs in the Delta when requested. Current efforts focus on evaluation of the decline of pelagic species in the upper San Francisco Estuary. These efforts emphasize modeling and integration of results, and respond to management interests by including temperature modeling, wastewater impacts, contaminants, salvage efficiency, 3- dimensional particle tracking and individual based modeling for striped bass and longfin smelt. The ammonia work includes source, fate, and transport modeling, field studies, and a review and syntheses of data and studies on the effects of ammonia on aquatic species. The temperature work is closely coordinated with the CALFED-funded Computational Assessments of Scenarios of Change for the Delta Ecosystem (CASCaDE) project and will analyze the trends of water temperature stress zones and refugia in the Delta. The Interagency Ecological Program 2019 Annual Work Plan was released in December 2018 (Interagency Ecological Program 2018).
Mayberry Farms Subsidence Reversal and Carbon Sequestration Project	DWR	The Mayberry Farms Subsidence Reversal and Carbon Sequestration Project would create permanently flooded wetlands on a 307-acre parcel on Sherman Island that is owned by DWR. The project would restore approximately 192 acres of emergent wetlands and enhance approximately 115 acres of seasonally flooded wetlands. The Mayberry Farms project was conceived as a demonstration project that would provide subsidence reversal benefits and develop knowledge that could be used by operators of private wetlands (including duck clubs) that manage lands for waterfowl-based recreation. By maintaining permanent water, the growth and subsequent decomposition of emergent vegetation is expected to control and reverse subsidence. The project is also anticipated to provide climate benefits by sequestering atmospheric CO_2. The project is expected to provide year-round wetland habitat for waterfowl and other wildlife. Construction was completed in 2010, however several projects at the site are currently ongoing and are performed routinely by DWR (CNRA N.d.a).
South Delta Temporary Barriers Project	DWR	The South Delta Temporary Barriers Project, initiated as a test project in 1991, was developed partially in response to a 1982 lawsuit filed by the South Delta Water Agency. The South Delta Temporary Barriers Project consists of four rock barriers across South Delta channels. The objectives of the project are to increase water levels, improve water circulation patterns and water quality in the southern Delta for local agricultural diversions, and improve operational flexibility of the State Water Project to help reduce fishery impacts and improve fishery conditions. Of the four rock barriers, the barrier at the head of Old River serves as a fish barrier (intended to primarily benefit migrating San Joaquin River Chinook salmon) and is installed and operated in April- May and again in September-November. The remaining three barriers (Old River at Tracy, Grant Line Canal, Middle River) serve as agricultural barriers (intended to primarily benefit agricultural water users in the south Delta) and are installed and operated between April 15 and November 30 of each season. In 2008, a court order designed to protect delta smelt prohibited the installation of the spring Head of Old River barrier pending fishery agency actions or further order of the court. The remaining three barriers serve as agricultural barriers and are installed between April 15 and September 30 of each season. An experimental underwater, non-physical barrier was installed in 2009. The channel will be open to navigation.
Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen Project	DWR	The Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen Project is a multiple-year study of the effectiveness of elevating dissolved oxygen (DO) concentrations in the channel. DO concentrations drop as low as 2 to 3 milligrams per liter (mg/L) during warmer and lower water flow periods in the San Joaquin River. The low DO levels can adversely affect aquatic life including the health and migration behavior of anadromous fish (e.g., salmon). The objective of the study is to maintain DO levels above the minimum recommended levels specified in the State of California WQCP for the Sacramento River and San Joaquin River basins. The Basin Plan water quality objectives for DO are 6.0 mg/l in the San Joaquin River (between Turner Cut and Stockton, 1 September through 30 November) and 5.0 mg/l the remainder of the year. The project's full-scale aeration system includes two 200-foot- deep u-tube aeration tubes; two vertical turbine pumps capable of pumping over 11,000 gallons of water each; a liquid-to-gas oxygen supply system; and numerous pieces of ancillary equipment and control systems. The system has been sized to deliver approximately 10,000 pounds of oxygen per day into the Deep Water Ship Channel. The aeration system is anticipated to be operated only when channel DO levels are below the Basin Plan DO water quality objectives (approximately 100 days per year). The project study includes an ongoing assessment of DO levels in the channel and vicinity and a study of potential adverse effects of low DO on salmon. The final report was released in December 2010. (DWR 2010b).
Zebra Mussel Watch Program	DWR	The Zebra Mussel Watch Program is composed of several elements: a risk assessment, an early detection monitoring program, a centralized reporting system "How to Report a Zebra Mussel Sighting," a rapid response plan, and public outreach and education. The risk assessment involves identifying water bodies in California that have a high probability of zebra mussel establishment. High risk areas have suitable zebra mussel habitat (based on substrate type, pH, and mineral availability), appropriate water temperatures for spawning, adequate food supplies, and high levels of boating activity. Early detection monitoring is conducted at high risk rivers and reservoirs in the Central Valley watershed. Sampling consists of suspending artificial substrates in the water column to provide attachment sites for zebra mussels. The artificial substrates checked for the presence of zebra mussels every month. The monitoring is conducted by private citizens, marina staff, DWR staff, and staff from other agencies. Information is managed in a centralized system created for reporting zebra mussel sightings. In 2013, California Water Boards released a report analyzing long-term mussel trends with recommendations for future monitoring (SWAMP 2013).

Project	Primary Agencies	Description
Cache Slough Area Restoration	DWR and CDFW	The Cache Slough Complex is located in the northern Delta where Cache Slough and the southern Yolo Bypass meet. It currently includes Liberty Island, Little Holland Tract, Prospect Island, Little Egbert Tract and the surrounding waterways. Levee height on these tracts is restricted and designed to allow overtopping in large flow events to convey water from the upper Yolo Bypass. Since 1983 and 1998 respectively, Little Holland Tract and Liberty Island have remained breached. Restoration is occurring naturally on the islands. Restoration in the Cache Slough Complex was identified as an Interim Delta Action by Governor Schwarzenegger in July 2007 and is being evaluated through the Bay Delta Conservation Plan process. Other planning processes such as Delta Vision and the Delta Risk Management Strategy have also identified the Cache Slough Area as a potential priority restoration site. The Cache Slough Complex has potential for restoration success because of its relatively high tidal range, historic dendritic channel network, minimal subsidence, and remnant riparian and vernal pool habitat. Restoration efforts would support native species, including delta smelt, longfin smelt, Sacramento splittail, and Chinook salmon, by creating or enhancing natural habitats and improving the food web fish require. Surrounding lands that are at elevations that would function as floodplain or marsh if not separated by levees could also be included in the Cache Slough Area. This broader area includes roughly 45,000 acres of existing and potential open water, marsh, floodplain and riparian habitat. The goals of restoration in the Cache Slough Complex are to: 1) re-establish natural ecological processes and habitats to benefit native species, 2) contribute to scientific understanding of restoration ecology, and 3) maintain or improve flood safety. Three restoration actions are currently contemplated in the Cache Slough Complex, including restoration actions at Calhoun Cut, Little Holland Tract, and Prospect Island. These are briefly described in the following. **Calhoun Cut** Calhoun Cut is a manmade, excavated, east-west running channel that was originally created to improve navigation in the area. The channel initiates at the confluence of Lindsey and Barker sloughs and runs west in a straight line until it intersects the terminal portion of Lindsey Slough. Calhoun Cut adversely influences tidal action in the historic arms of Lindsey Slough. Restoration of tidal action would entail removal of features that restrict flow through the slough, excavating starter channels to initiate channel evolution and promote tidal flow, and potentially blocking Calhoun Cut to restore the tidal channel system in Lindsey Slough. **Little Holland Tract** Little Holland Tract encompasses about 1,640 acres within the Cache Slough Complex. Similar to Prospect Island, Little Holland Tract was acquired by the federal government (USACE) in anticipation of transferring ownership to the U.S. Fish and Wildlife Service as a component of a North Delta National Wildlife Refuge. The tract has been subject to tidal influence since 1983, when levees separating Little Holland Tract and the Toe Drain failed. Since that time, the site has naturally returned to a mixture of tidally influenced emergent wetlands, mudflats, and riparian habitat. Restoration actions would complement what has occurred naturally by increasing wetland values at the site.
Delta Fish Agreement (Four Pumps Project)	DWR and CDFW	The 1986 Delta Pumping Plant Fish Protection (Delta Fish) Agreement between DWR and CDFW provides a mechanism for offsetting adverse fishery impacts caused by the diversion of water at the Harvey O. Banks Delta Pumping Plant, a part of the State Water Project located at the head of the California Aqueduct. Direct losses of Chinook salmon, steelhead, and striped bass are offset or mitigated through the funding and implementation of fish mitigation projects. DWR and CDFW work closely with the Fish Advisory Committee to implement the agreement and projects funded under the agreement. The Fish Advisory Committee is made up of representatives of the State Water Contractors, sport and commercial fishing groups, and environmental groups. The agreement was signed by the Directors of DWR and CDFW on December 30, 1986 and has been amended twice since that time. The Delta Fish Agreement is also commonly known as the Four Pumps Agreement because it was subsequently identified as mitigation for the enlargement of the Banks Pumping Plant, including four additional pumps.
Dutch Slough Tidal Marsh Restoration Project	DWR and California State Coastal Conservancy	The Dutch Slough Tidal Marsh Restoration Project, located near Oakley in Eastern Contra Costa County, would restore wetland and uplands, and provide public access to the 1,166- acre Dutch Slough property owned by DWR. The property is composed of three parcels separated by narrow man-made sloughs. The project would provide ecosystem benefits, including habitat for sensitive aquatic species. It also would be designed and implemented to maximize opportunities to assess the development of those habitats and measure ecosystem responses so that future Delta restoration projects will be more successful. Construction on two of the parcels began in May 2018 and is expected to be complete in 2019, followed by revegetation planting. Restoration of the third parcel, Burroughs, is beginning in 2020 (DWR 2018b). Two neighboring projects proposed by other agencies that are related to the Dutch Slough Restoration Project collectively contribute to meeting project objectives. These include the City of Oakley's proposed Community Park and Public Access Conceptual Master Plan for 55 acres adjacent to the wetland restoration project and four miles of levee trails on the perimeter of the DWR lands. The City Community Park will provide parking and trailheads for the public access components of the Dutch Slough Restoration Project. The Ironhouse Sanitary District is proposing the West Marsh Creek Delta Restoration Project, a restoration of a portion of the Marsh Creek delta on an adjacent 100-acre parcel it owns west of Marsh Creek. The Ironhouse Project could provide fill material for, and be linked to, the Dutch Slough Restoration lands.

Project	Primary Agencies	Description
Lower Yuba River Accord	DWR and Yuba County Water Agency	The Lower Yuba River Accord is a collaborative effort among environmental interests, fisheries agencies, and water agencies intended to resolve instream flow issues associated with operation of the Yuba Project in a way that would protect and enhance lower Yuba River fisheries and local water supply reliability. It also provides revenues for local flood control and water supply projects, improves statewide water supply reliability and provides water for protection and restoration purposes in the Delta. Local water supply reliability is achieved through implementation of a conjunctive use program. The Lower Yuba River Accord includes three separate but interrelated agreements intended to meet program objectives. The Fisheries Agreement would modify the instream flow requirements contained in SWRCB Revised Decision 1644 to provide increased flows in most months of most water years. These changes would primarily serve to improve habitat conditions for salmonids by reducing water temperatures during sensitive lifestage periods. Implementation of the Yuba Accord requires appropriate SWRCB amendments of Yuba County Water Agency’s (YCWA) water-right permits and RD-1644. To assure that local water supply reliability would not be reduced by the higher minimum instream flows, YCWA and its participating local water districts would implement agreements that would establish a comprehensive conjunctive use program that would integrate the surface water and groundwater supplies of the local irrigation districts and mutual water companies that YCWA serves in Yuba County. Integration of surface water and groundwater would allow YCWA to increase the efficiency of its water management. Under the Water Purchase Agreement, the California Department of Water Resources would enter into an agreement with YCWA to purchase water from YCWA for use in the Environmental Water Account (EWA) Program or an equivalent program as long as operational and hydrological conditions allow. Additional water purchased by DWR would be available for the SWP in drier years. The EWA Program would take delivery of water in every year; the SWP would receive additional water in the drier years. The final EIS/EIR was released in October 2007 (DWR, Yuba County Water Agency, and Reclamation 2007).
Upper Yuba River Studies Program	DWR, CALFED, and NMFS	In 2002, CALFED formed a stakeholder work group and initiated investigations of the feasibility of providing anadromous fish passage at Englebright Dam on the Yuba River, a dam that blocks all upstream passage of fish. A comprehensive study program, developed with the assistance of the work group, included studies to examine the availability of upstream fish habitat and the effects of a potential fish passage project on sediment storage and transport, water quality, flood risk, water supply and hydropower, and socio- economics. Initial studies focused on sediment transport and storage in the upper watershed and Englebright Lake, and habitat quality in the Middle and South Yuba rivers, particularly for spring-run Chinook salmon and steelhead. The analyses included temperature modeling and mapping of holding pools, instream barriers, and potential spawning and rearing areas. The results of the preliminary investigations suggested that anadromous salmonids could be supported in the river upstream of Englebright Dam. In 2008, NMFS began a watershed-based habitat suitability assessment and the development of conceptual plans for engineered fish passage design alternatives to accommodate safe and timely movement of anadromous fish through or around Englebright Dam.
Riparian Habitat Joint Venture Project	California Partners In Flight	The Riparian Habitat Joint Venture (RHJV) project was initiated by California Partners in Flight in 1994. To date, 18 federal, state and private organizations have signed the Cooperative Agreement to protect and enhance habitats for native land birds throughout California. These organizations include the California Department of Fish and Wildlife, California Department of Water Resources, California State Lands Commission, Ducks Unlimited, National Audubon Society, National Fish and Wildlife Foundation, The Nature Conservancy, The Trust for Public Land, The Resources Agency State of California, Reclamation, USFWS, U.S. Geological Survey, and Wildlife Conservation Board. The RHJV, modeled after the successful Joint Venture projects of the North American Waterfowl Management Plan, reinforces other collaborative efforts currently underway that protect biodiversity and enhance natural resources as well as the human element they support. The vision of the RHJV is to restore, enhance, and protect a network of functioning riparian habitat across California to support the long-term viability of land birds and other species. A wide variety of other species of plants and animals will benefit through the protection of forests along rivers, streams and lakes. The RHJV mission is to provide leadership and guidance to promote the effective conservation and restoration of riparian habitats in California through the following goals: (1) Identify and develop technical information based on sound science for a strategic approach to conserving and restoring riparian areas in California; (2) Promote and support riparian conservation on the ground by providing guidance, technical assistance and a forum for collaboration; and (3) Develop and influence riparian policies through outreach and education. In 2004, Partners In Flight prepared The Riparian Bird Conservation Plan, a guidance document that outline a strategy for conserving riparian birds, including birds using the Delta. In 2009, a California Riparian Habitat Restoration Handbook was released and demonstrates how to approach riparian restoration design from an ecological perspective and describes the existing ecological conditions (RHJV 2009).
Delta Vision	CNRA	Delta Vision was created by Executive Order of Gov. Arnold Schwarzenegger in 2006 to find a durable vision for sustainable management of the Delta, so it could continue to support environmental and economic functions critical to the people of California. Although it builds upon work done through the CALFED Bay-Delta Program, Delta Vision broadened the focus of past Delta efforts to recommend actions that address the full array of natural resource, infrastructure, land use, and governance issues necessary to achieve a sustainable Delta. In February 2007, the Governor appointed the independent Delta Vision “Blue Ribbon” Task Force chaired by Phil Isenberg. The Task Force issued its first report, Our Vision for the California Delta, in December 2007, which identified its vision for the Delta. The Task Force issued its second report, a Strategic Plan, identified and evaluated alternative implementing measures and management practices that would be necessary to implement Delta Vision recommendations. These implementation recommendations involved considering changes in the use of land and water resources, services to be provided within the Delta, governance, funding mechanisms, and ecosystem management practices. The final Strategic Plan was submitted to the public and the Delta Vision Committee on December 31, 2008 (Delta Vision 2008).

Project	Primary Agencies	Description
Marine Invasive Species Program	California State Lands Commission	The California Marine Invasive Species Program is charged with preventing or minimizing the introduction of nonindigenous species to California Waters from commercial vessels. The program began in 1999 with the passage of California's Ballast Water Management for Control of Nonindigenous Species Act, which addressed the threat of species introductions through ships' ballast water during a time when federal regulations were not mandatory. In 2003, the Marine Invasive Species Act (MISA) was passed, reauthorizing and expanding the 1999 Act. Subsequent amendments to MISA and additional legislation have further expanded the scope of the program. The law charged the California State Lands Commission with oversight of the state's program to prevent or minimize the introduction of nonindigenous species from commercial vessels. To advance this goal, the Commission uses a comprehensive approach that includes: ballast water and vessel fouling management tracking, compliance, and enforcement; sound policy development in consultation with a wide array of experts and stakeholders; applied research that advances the strategies for nonindigenous species prevention; and outreach and education to coordinate information exchange among scientists, legislators, and stakeholders. The Coastal Ecosystems Protection Act of 2006 directed the Commission to adopt performance standards for the discharge of ballast water by January 1, 2008, and prepare a report assessing the availability of treatment technologies to meet those standards. The Commission completed the rulemaking process and adopted the standards in October 2007; the technology assessment report was completed in December 2007. In February 2019, the Commission released the 2019 Biennial Report on the Marine Invasive Species Program which summarizes and analyzes the ballast water management practices and recommendations to improve the program (California State Lands Commission 2019).
Central Valley Joint Venture Program	Central Valley Joint Venture	The Central Valley Joint Venture (CVJV) is a self-directed coalition consisting of 22 state and federal agencies and private conservation organizations. The partnership directs their efforts toward the common goal of providing for the habitat needs of migrating and resident birds in the Central Valley of California. The CVJV was established in 1988 as a regional partnership focused on the conservation of waterfowl and wetlands under the North American Waterfowl Management Plan. It has since broadened its focus to the conservation of habitats for other birds, consistent with major national and international bird conservation plans and the North American Bird Conservation Initiative. The CVJV provides guidance and facilitates grant funding to accomplish its habitat goals and objectives. Integrated bird conservation objectives for wetland habitats in the Central Valley identified in the 2006 Implementation Plan include restoration of 19,170 acres of seasonal wetland, enhancement of 2,118 acres of seasonal wetland annually, restoration of 1,208 acres of semi-permanent wetland, and restoration of 1,500 acres of riparian habitat. The Implementation Plan is currently being updated and will add additional chapters, including conservation strategies (Central Valley Joint Venture N.d).
Cache Creek, Bear Creek, Sulfur Creek, Harley Gulch Mercury TMDL	Central Valley RWQCB	Historic mining activities in the Cache Creek watershed have discharged and continue to discharge large volumes of inorganic mercury to creeks in the watershed. Much of the mercury discharged from the mines is now distributed in the creek channels and floodplain downstream from the mines. Natural erosion processes are expected to slowly move the mercury downstream out of the watershed over the next several hundred years. However, current and proposed activities in and around the creek channel can enhance mobilization of this mercury. To reduce mercury loads in these streams, which ultimately connect to the northern Delta, the Central Valley RWQCB is implementing mercury TMDLs for Cache Creek and its tributaries, as well as Sulfur Creek. The implementation plans require a reduction in mercury loads through a combination of actions to clean up mines, sediments, and wetlands; identify engineering options; control erosion reduction actions and perform studies and monitoring. In 2009, Central Valley RWQCB released the mercury inventory report for Cache Creek Canyon which evaluated the distribution of mercury in sediment in Cache Creek and identifies tributary sources of mercury to the creek (Central Valley RWQCB 2008).
Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury	Central Valley RWQCB	The Central Valley RWQCB has identified the Delta as impaired because of elevated levels of methylmercury in Delta fish that pose a risk for human and wildlife consumers. As a result, it has initiated the development of a water quality attainment strategy to resolve the mercury impairment. The strategy has two components: the methylmercury total maximum daily load (TMDL) for the Delta and the amendment of the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (the Basin Plan) to implement the TMDL program. The final Basin Plan amendment requires methylmercury load and waste load allocations for dischargers in the Delta and Yolo Bypass to be met as soon as possible, but no later than 2030. The regulatory mechanism to implement the Delta Mercury Control Program for point sources is through National Pollutant Discharge Elimination (NPDES) permits. Nonpoint sources are regulated in conformance with the State Water Resources Control Board's Nonpoint Source Implementation and Enforcement Policy. Both point and nonpoint source dischargers are required to conduct mercury and methylmercury control studies to develop and evaluate management practices to control mercury and methylmercury discharges. The RWQCB uses the study results and other information to amend relevant portions of the Delta Mercury Control Program during the Delta Mercury Control Program Review. The final Basin Plan amendment also requires proponents of new wetland and wetland restoration projects scheduled for construction after 2011 to either participate in a comprehensive study plan or implement a site-specific study plan, evaluate practices to minimize methylmercury discharges, and implement newly developed management practices as feasible. Projects would be required to include monitoring to demonstrate effectiveness of management practices. In 2017, an update to the Delta Mercury Control Program and TMDL was released (Central Valley RWQCB 2017). Activities, including changes to

Project	Primary Agencies	Description
East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan	Contra Costa County and East Contra Costa County Habitat Conservancy	The East Contra Costa County Habitat Conservation Plan / Natural Community Conservation Plan (Plan) was adopted in 2006 and provides regional conservation and development guidelines to protect natural resources while improving and streamlining the permit process for endangered species and wetland regulations. The Plan was developed by a team of scientists and planners with input from independent panels of science reviewers and stakeholders. Within the 174,018-acre inventory area, the Plan provides permits for between 8,670 and 11,853 acres of development and will permit impacts on an additional 1,126 acres from rural infrastructure projects. The Plan will result in the acquisition of a preserve system that will encompass 23,800 to 30,300 acres of land that will be managed for the benefit of 28 species as well as the natural communities that they depend upon. The East Contra Costa County Habitat Conservancy is a joint exercise of powers authority formed by Contra Costa County and the cities of Brentwood, Clayton, Oakley and Pittsburg to implement the Plan. It allows Contra Costa County, the Contra Costa County Flood Control and Water Conservation District, the East Bay Regional Park District and the cities of Brentwood, Clayton, Oakley, and Pittsburg (collectively, the Permittees) to control permitting for activities and projects they perform or approve in the region that have the potential to adversely affect state- and federally listed species. The Plan also provides for comprehensive species, wetlands, and ecosystem conservation and contributes to the recovery of endangered species in northern California. The Plan avoids project-by-project permitting that often results in uncoordinated and biologically ineffective mitigation. The Conservancy released a 2018 Work Plan which outlines the Habitat Conservancy's proposed activities for 2018 (East Contra Costa County Habitat Conservancy 2018).
Contra Costa Canal Fish Screen Project	CCWD	CCWD diversion of water from the Delta at Rock Slough serves as a major component of its water supply. Between 120,000 and 130,000 acre-feet of water per year is diverted by the canal for irrigation and municipal and industrial uses. The diversion at Rock Slough is one of the largest unscreened Delta sites. Project construction was completed in 2012 and installed fish screens at the Rock Slough diversion to minimize the entrainment losses of sensitive fish species (Reclamation 2012). It includes flow control and transition structures necessary to reduce tidal influences and maintain flow rates. This helps the screen perform properly and allow fish to pass by it easily. Improvements at the diversion site also reduces potential predation on target species, fulfills legal requirements of USFWS's 2008 Biological Opinion for the threatened Delta smelt, completes the mitigation for the Los Vaqueros Biological Opinion, and completes CVPIA requirements in Section 3406(b)(5) (Reclamation N.d).
Delta Protection Commission Land Use and Resource Management Plan Update	Delta Protection Commission	The Delta Protection Commission (Commission), created with passage of the Delta Protection Act, was formed to adaptively protect, maintain, and where possible, enhance and restore the overall quality of the Delta environment consistent with the Delta Protection Act and the Land Use and Resource Management Plan for the Primary Zone. The Commission updated its Land Use and Resource Management Plan (Management Plan) in 2010, which was originally adopted in 1995. The Management Plan outlines the long-term land use requirements for the Sacramento-San Joaquin Delta and sets out findings, policies, and recommendations in the areas of environment, utilities and infrastructure, land use, agriculture, water, recreation and access, levees, and marine patrol/boater education/safety programs. The updated Management Plan placed increased emphasis on the requirement for local government general plans to provide for consistency with the provisions of the Management Plan. The Commission develops priorities and timelines for tasks to be implemented each year and provides annual progress reports to the Legislature. One of the tasks identified by the Commission is to monitor the Delta Vision, Bay Delta Conservation Plan, and Delta Risk Management Strategy processes and provide input as deemed appropriate. The Commission has initiated an update of the Management Plan and a draft was released February 2019 (Delta Protection Commission 2019).
Delta Plan	Delta Stewardship Council	In November 2009, the California Legislature enacted SBX7 1, which took effect on February 3, 2010. One portion of this legislation is known as the Sacramento–San Joaquin Delta Reform Act of 2009 (the Delta Reform Act). The Delta Reform Act requires the development of a legally enforceable, comprehensive, long-term management plan for the Delta, which is referred to as the Delta Plan. The Delta Reform Act also created the Delta Stewardship Council (Council), which is an independent State agency. One of the Council's primary responsibilities is to adopt the Delta Plan. The Delta Reform Act requires the Council to adopt a Delta Plan that achieves the State's coequal goals. The Delta Reform Act also specifies the following: (i) eight objectives that are "inherent" in the coequal goals (see Water Code section 85020), (ii) a related statewide policy to reduce reliance on the Delta in meeting the State's future water supply needs through improved regional water self-reliance (Water Code section 85021); and (iii) certain specific subjects and strategies that must be included in the Delta Plan (see generally Water Code sections 85301–85309). The Delta Plan must include BDCP if the BDCP is completed and approved by DFW as a Natural Communities Conservation Plan and by federal agencies as a Habitat Conservation Plan. In September 2013, the Delta Plan was adopted by the Council and subsequently amended in 2016 and 2018 (Delta Stewardship Council 2018).
Recreation Proposal for the Sacramento-San Joaquin Delta and Suisun Marsh	CDPR	In 2011, California State Parks developed a Recreation Proposal for the Delta and Suisun Marsh in response to the requirements in SBX7 1. The proposal recommends that communities on the edge of the Delta or Suisun Marsh with access to major transportation routes be developed as "gateways" to provide supplies and information to visitors about recreation opportunities available in an area. Recommendations also include collaboration with other agencies and other partners to expand wildlife viewing, angling, and hunting opportunities; and expansion of the State Park system in the Delta. The Proposal was considered during the preparation of the Delta Plan.

Project	Primary Agencies	Description
Lower Mokelumne River Spawning Habitat Improvement Project	EBMUD	The Mokelumne River is tributary to the Delta and supports five species of anadromous fish. The proposed project would initially place 4,000 to 5,000 cubic yards of suitably sized salmonid spawning gravel annually for a 3-year period at two specific sites, and then provide annual supplementation of 600 to 1,000 cubic yards thereafter. Work will be conducted each year over one week within the months of August and September. Fall-run Chinook salmon and steelhead are the primary management focus in the river. Availability of spawning gravel in this section of the Mokelumne River has been determined to be deficient because historic gold and aggregate mining operations removed gravel annually and upstream dams have reduced gravel transport to the area. This area was chosen because it is known to have supported fall-run Chinook salmon and steelhead spawning in the past and because the substrate is suitable for habitat improvement. A final IS/MND was released in August 2014 (EBMUD 2014c).
Folsom Lake Temperature Control Device	El Dorado Irrigation District (EID) and Reclamation	El Dorado Irrigation District, in collaboration with Reclamation, constructed facilities on the bank of Folsom Lake to withdraw water from the warm upper reaches of the lake while preserving the cold water pool at the bottom of the lake to protect downstream aquatic species. The facilities include a large diameter concrete lined vertical shaft and five lined horizontal adits extending from the shaft. This structure, known as a Temperature Control Device (TCD) replaces the District's five existing raw pump casings that extracted water from Folsom Lake at a rate of 19.5 mgd. The new facility is sized to accommodate a maximum extraction rate of 74 mgd over an 18-hr period, which is equivalent to 52 mgd. The temperature control device began operation in spring 2003 (Reclamation, USFWS, and Water Forum 2007).
Public Draft Recovery Plan for Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon and Central Valley Steelhead	NMFS	The Draft Recovery Plan provides a roadmap that describes the steps, strategy, and actions that should be taken to return winter-run Chinook salmon, spring-run Chinook salmon, and steelhead to viable status in the Central Valley, California thereby ensuring their long-term persistence and evolutionary potential. The general near-term strategic approach to recovery includes methods to: secure all extant populations, monitor for O. mykiss in habitats accessible to anadromous fish, and minimize straying from hatcheries to natural spawning areas. Conduct critical research on fish passage and reintroductions with climate change and develop recovery plan for sustainable populations that have minimal susceptibility to catastrophic events. Recovery plan for Sacramento River Winter-Run Chinook salmon, Central Valley Spring-Run Chinook salmon, and Central Valley Steelhead was released in July 2014.
American River Pump Station and Restoration Project	PCWA and Reclamation	The American River Pump Station and Restoration Project, completed in 2008, included a permanent pump station to replace a temporary pumping facility on the American River that was installed in anticipation of construction of Auburn Dam. The project also returned the river to its natural channel. The constructed project includes several features associated with rewarding the project site, constructing the new pump station and screened intake, and creating public access to the reopened river. These features were constructed in two phases, and included the following: • Closure of the half-mile-long diversion tunnel • Removal of over 1 million yards of sediment left from Auburn Dam construction • Installation of over 60,000 yards of rocks and boulders • Construction of a whitewater course of chutes and pools alongside a portage path • Installation of a screened intake on a river chute that is safely passable by boat • Installation of a dividing ridge between the whitewater channel and the intake channel • Construction of a pumping well in the canyon wall beneath the pump station • Construction of the pump station and pipelines Addition of a State Parks entrance facility, parking lots, 2 miles of access roads, and 4,000 feet of hiking trails
Liberty Island Conservation Bank	Reclamation District 2093	This project received permits and approvals in 2009 to create a conservation bank on the northern tip of Liberty Island that would preserve, create, restore, and enhance habitat for native Delta fish species, including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, delta smelt, and Central Valley fall- and late fall-run Chinook salmon. The project consists of creating tidal channels, perennial marsh, riparian habitat, and occasionally flooded uplands on the site. The project also includes the breaching of the northernmost east- west levee, and preservation and restoration of shaded riverine aquatic habitat along the levee shorelines of the tidal sloughs. The island's private levees failed in the 1997 flood and were not recovered, leaving all but the upper 1,000 acres and the adjacent levees permanently flooded. These upper acres encompass the proposed bank. The lower nearly 4,000 acres will remain, at least for the near future, predominantly open water and subtidal because tidal elevations are too great for marsh or riparian habitat.
Flood Management Program	Sacramento Area Flood Control Agency, Central Valley Flood Protection Board, and USACE	The Sacramento Area Flood Control Agency (SAFCA) Flood Management Program includes studies, designs, and construction of flood control improvements. In the South Sacramento area, SAFCA projects include the South Sacramento Streams Project and the Sacramento River Bank Protection Project. The South Sacramento Streams Project consists of levee, floodwall, and channel improvements starting south of the town of Freeport along the Sacramento River to protect the City of Sacramento from flooding associated with Morrison, Florin, Elder, and Union house creeks. The Sacramento River Bank Protection Project, which is implemented and funded primarily through USACE, addresses long-term erosion protection along the Sacramento River and its tributaries. Bank protection measures typically consist of large angular rock placed to protect the bank, with a layer of soil/rock material to allow bank re-vegetation. SAFCA contributes to funding the local share for bank protection activities within its jurisdiction.

Project	Primary Agencies	Description
South Sacramento Habitat Conservation Plan	Sacramento County and USFWS	The final South Sacramento HCP was released in February 2018 and is a regional plan to address issues related to species conservation, agricultural protection, and urban development in south Sacramento County. The HCP covers 40 different species of plants and wildlife including 10 that are state or federally listed as threatened or endangered, and allow land owners to engage in the “incidental take” of listed species (i.e., to destroy or degrade habitat) in return for conservation commitments from local jurisdictions. The conservation measures outlined in the HCP minimize and mitigate the impact of incidental take and provide for the conservation of covered species that may occur in the plan area. The geographic location of the HCP includes a combined 341,000 acres within south Sacramento County (unincorporated area) and the cities of Rancho Cordova, Elk Grove, and Galt (SSHCP 2018).
Sacramento Stormwater Quality Partnership	Sacramento County, Sacramento, Citrus Heights, Elk Grove, Folsom, Galt, and Rancho Cordova	The Sacramento Stormwater Quality Partnership (SSQP) is a collaboration of public agencies that protects and improves water quality in local waterways for the benefit of the community and the environment. The partnership's main charge is to oversee compliance with the Sacramento Area- wide Municipal Stormwater Permit, which is designed to comply with state and federal clean water regulations (NPDES Stormwater Permit No. CAS082597). The goals of the partnership are to: educate and inform the public about urban runoff pollution; encourage public participation in community and clean-up events; work with industries and businesses to encourage pollution prevention; require construction activities to reduce erosion and pollution; and require developing projects to include pollution controls that will continue to operate after construction is complete. Program elements include monitoring, target pollutant reduction, special studies (such as evaluating the effectiveness of BMPs), and public outreach (Sacramento Stormwater Quality Partnership 2016).
Sacramento Regional Wastewater Treatment Plant Facility Upgrade Project (EchoWater)	Sacramento Regional County Sanitation District (Regional San)	RegionalSan is upgrading its existing facilities at the Sacramento Regional Wastewater Plant to meet new NPDES permit requirements. Project implementation would not result in an increase in permitted wastewater treatment capacity; however, would result in improved treated effluent water quality. The project will upgrade existing secondary treatment facilities to advanced unit processes including improved nitrification/denitrification and filtration. The upgrade involves 20 separate construction projects, with construction currently underway through 2023 (RegionalSan N.d). The completed projects include: • Heavy Equipment Maintenance Building • Bufferlands Building • Fiber Optic Replacement Project • Site Preparation Project • Miscellaneous Site Buildings • Main Electrical Substation Expansion • Disinfection Chemical Storage Project Current Projects include: • Bradshaw Equalization Structure • Channel Aeration Blower • Chemical Handling Decommissioning • Tertiary Treatment Facility • Biological Nutrient Removal Project • Flow Equalization Project • Nitrifying Sidestream Treatment Project • Return Activated Sludge Pumping Plant • Effluent Valve Replacement
San Francisco Bay Plan Amendment and Special Programs	San Francisco Bay Conservation and Development Commission	The San Francisco Bay Conservation and Development Commission (BCDC) is a 27-member commission created by the California Legislature in 1965 dedicated to the protection and enhancement of San Francisco Bay and to the encouragement of the Bay's responsible use. The commissioners are appointees from local governments and state/federal agencies. The BCDC has jurisdiction over the open water, marshes and mudflats of greater San Francisco Bay, including Suisun, San Pablo, Honker, Richardson, San Rafael, San Leandro and Grizzly Bays and the Carquinez Strait, and some inland areas. It regulates all filling and dredging in San Francisco Bay (which includes San Pablo and Suisun Bays, sloughs and certain creeks and tributaries that are part of the Bay system, salt ponds and certain other areas that have been diked-off from the Bay), protects Suisun Marsh, regulates new development within the first 100 feet inland from the Bay, pursues an active planning program to study Bay issues, and engages in the region-wide state and federal program to prepare a Long Term Management Strategy for dredging and dredge material disposal in San Francisco Bay. Among its various responsibilities, the BCDC sponsors special programs that address climate change planning; subtidal habitat research, restoration and management; and a long- term management strategy for the placement of dredged material in the San Francisco Bay region.

Project	Primary Agencies	Description
San Francisco Bay Mercury TMDL	San Francisco Bay RWQCB	San Francisco Bay is impaired because mercury contamination is adversely affecting existing beneficial uses, including sport fishing, preservation of rare and endangered species, and wildlife habitat. On February 12, 2008, the U.S. Environmental Protection Agency approved a Basin Plan amendment incorporating a TMDL for mercury in San Francisco Bay and an implementation plan to achieve the TMDL. The amendment was formerly adopted by the San Francisco RWQCB, the SWRCB, and the state Office of Administrative Law. It is now officially incorporated into the WQCP for the San Francisco Bay Basin (Basin Plan). The San Francisco Bay mercury TMDL, which includes the waters of the Delta within the San Francisco Bay region, is intended to: 1) reduce mercury loads to achieve load and wasteload allocations, 2) reduce methylmercury production and consequent risk to humans and wildlife exposed to methylmercury, 3) conduct monitoring and focused studies to track progress and improve the scientific understanding of the system, and 4) encourage actions that address multiple pollutants. The implementation plan establishes requirements for dischargers to reduce or control mercury loads and identifies actions necessary to better understand and control methylmercury production. In addition, it addresses potential mercury sources and describes actions necessary to manage risks to Bay fish consumers. Load reductions are expected via implementation of the Delta Methylmercury TMDL (river source), plus urban runoff management, Guadalupe River mine remediation, municipal and industrial wastewater source controls and pretreatment, and sediment remediation.
Alameda Watershed Habitat Conservation Plan	San Francisco Public Utilities Commission, USFWS, and NMFS.	San Francisco Public Utilities Commission (SFPUC) is in the process of developing a HCP in compliance with the federal Endangered Species Act for the purpose of conserving sensitive species that could be affected by operations and maintenance activities in the Alameda Creek watershed. The HCP proposes coverage for 17 species, including steelhead and Chinook salmon, over a period 30 years. Activities covered by the HCP include those in the Alameda Watershed Management Plan adopted in 2000 to maintain and improve source water quality and supply while preserving and enhancing the watershed's ecological resources. The SFPUC-owned Alameda Watershed consists of 36,000 acres of rolling grasslands, native woodlands, scrub and freshwater marshes within the Southern Alameda Creek Watershed. The conservation measures are expected to consist of a combination of avoidance and minimization measures, water and land management, river and stream restoration, barrier modification, and threat abatement. SFPUC released all preliminary draft chapters in May 2012 (SFPUC N.d).
San Joaquin County Multi- Species Habitat Conservation and Open Space Plan	San Joaquin Council of Governments	Permitted in 2000, the key purpose of the San Joaquin County Multi-Species Habitat Conservation and Open Space Plan (Plan) is to provide a strategy for balancing the need to conserve open space and the need to convert open space to non-open space uses. These goals are intended to be met while protecting the region's agricultural economy; preserving landowner property rights; providing for the long-term management of plant, fish and wildlife species, especially those that are currently listed, or may be listed in the future, under the ESA or the California ESA; providing and maintaining multiple-use open spaces that contribute to the quality of life of the residents of San Joaquin County; and accommodating a growing population while minimizing costs to project proponents and society at large. The conservation strategy relies on minimizing, avoiding, and mitigating impacts on the species covered by the Plan. Minimization of impacts on covered species takes a species- based approach emphasizing the implementation of measures to minimize incidental take by averting the actual killing or injury of individual covered species and minimizing impacts to habitat for such species on open space lands converted to non- open space uses. Unavoidable impacts to covered species are addressed through a habitat-based approach that emphasizes compensation for habitat losses through the establishment, enhancement and management-in-perpetuity of preserves composed of a specific vegetation types or association of vegetation types (habitats) upon which discrete groups of covered species rely. The purchase of easements from landowners willing to sell urban development rights is the primary method for acquiring preserves. The Plan identifies zones distinguished by a discrete association of soil types, water regimes (e.g., Delta lands subject to tidal influence, irrigated lands, lands receiving only natural rainfall), elevation, topography and vegetation types. In general, impacts within a particular zone are mitigated within the same zone.
San Joaquin County, Stockton, and Tracy Stormwater Management Programs	San Joaquin County (Department of Public Works), Stockton (Municipal Utilities Department), Tracy (Water Resources Department), and SWRCB	San Joaquin County has developed a Stormwater Management Program committed to protecting local rivers and the Delta by involving and educating residents in stormwater pollution prevention, regulating stormwater runoff from construction sites, investigating non-stormwater discharges, and reducing non-stormwater run-off from municipal operations. Storm drainage is conveyed via County storm drains to the Calaveras, Mokelumne, Old, and San Joaquin Rivers, where it ultimately flows into the Delta. In addition to the County program, several municipalities in San Joaquin County have developed stormwater management programs and obtained NPDES permits from SWRCB. Permits issued for medium (serving between 100,000 and 250,000 people) and large (serving 250,000 people) municipalities are typically issued to a group of co-permittees encompassing an entire metropolitan area. These permits are reissued as the permits expire. For smaller municipalities, the first 5-year term of the NPDES permits were adopted by the SWRCB in 2003 and expired on May 1, 2008. Under the General Permit, Section H.21, Continuation of Expired Permit, the General Permit continues in force and in effect until a new General Permit is issued or the SWRCB rescinds the General Permit. The goals of the City of Stockton's program are to reduce the degradation of the beneficial uses of the San Joaquin River and tributary streams and the regional groundwater aquifer caused by urban runoff in the metropolitan area of Stockton. The City of Tracy's NPDES permit requires the City to develop and implement a Storm Water Management Plan/Program with the goal of reducing the discharge of pollutants to the maximum extent practicable.

Project	Primary Agencies	Description
Solano Multispecies Habitat Conservation Plan	Solano County Water Agency	The Solano HCP is intended to support the issuance of an incidental take permit under the federal Endangered Species Act for a period of 30 years. This permit is required by the March 19, 1999 Solano Project Contract Renewal Biological Opinion between USFWS and Reclamation. The scope of the Solano HCP was expanded beyond the requirements of the Biological Opinion to include additional voluntary applicants and additional species for incidental take coverage. Thirty-seven species are proposed to be covered under the Solano HCP. The minimum geographical area to be covered is the Solano County Water Agency's contract service area that is the cities of Fairfield, Vacaville, Vallejo, Suisun City, the Solano Irrigation District and the Maine Prairie Water District. The area covered by the HCP is all of Solano County and a small portion of Yolo County. The Final Administrative Draft was completed in October 2012 (SCWA 2012). The HCP includes a Coastal Marsh Natural Community Conservation Strategy designed to maintain the water and sediment quality standards, hydrology of this natural community; contribute to the restoration of tidally influenced coastal marsh habitat; and promote habitat connectivity. Primary conservation actions include preservation (primarily through avoidance), restoration, invasive species control, and improvement of water quality. The plan area Covers 580,000 acres, which includes 12,000 acres of proposed development and 30,000 acres that will be preserved.
California Water Boards' Strategic Plan Update – 2008-2012	SWRCB	The Strategic Plan Update broadly identifies the SWRCB's vision and direction for the future. It identifies goals intended to achieve that vision, which include: implementing strategies to fully support the beneficial uses for all 2006-listed water bodies; improving and protecting groundwater quality in high- use basins; increasing sustainable local water supplies available for meeting existing and future beneficial uses and ensuring adequate flows for fish and wildlife habitat; comprehensively addressing water quality protection and restoration in consideration of the connections between water quality, water quantity, and climate change, throughout California's water planning processes; improving Water Board transparency and accountability; enhancing consistency across the Water Boards; and ensuring that the Water Boards have access to information and expertise. The plan also identifies environmental priorities that focus on strategies for achieving environmental outcomes associated with protecting the State's surface waters and groundwaters and promoting sustainable water supplies. To better address the implementation of coordinated activities in the Bay-Delta, the SWRCB adopted Resolution 2007-0079 in 2007; similar resolutions were adopted by the San Francisco Bay and Central Valley regional water boards. In those resolutions, the Water Boards committed to ensure the protection of beneficial uses of water, and to the equitable administration of water rights in the Bay-Delta and its tributaries. A strategic work plan, completed in July 2008, describes the actions the Water Boards will undertake to protect beneficial uses of water in the Bay-Delta and the timelines and resource needs for implementing those actions. Workplan activities are divided into the nine broad elements covering a range of actions that: 1) implement the Water Boards' core water quality responsibilities; 2) continue meeting prior Water Board commitments; 3) are responsive to priorities identified by the Governor and the Delta Vision Blue Ribbon Task Force; and 4) build on existing processes, such as the BDCP. The Water Boards do not have the capacity or responsibility to conduct all the planning and implementation activities needed to protect and restore fisheries, aquatic habitats, and other beneficial uses in the Bay-Delta. Accordingly, the work plan identifies activities that will need to be coordinated with other efforts (SWRCB 2019).
Battle Creek Salmon and Steelhead Restoration Project	Reclamation and SWRCB	Construction of the Battle Creek Salmon and Steelhead Restoration Project was initiated in 2009 reestablish approximately 42 miles of prime salmon and steelhead habitat on Battle Creek, plus an additional 6 miles on its tributaries. The species benefited by the project include the Central Valley spring-run Chinook salmon (state- and federally listed as threatened), the Sacramento River winter-run Chinook salmon (state- and federally listed as endangered), and the Central Valley steelhead (federally listed as threatened). Restoration of Battle Creek will be accomplished primarily through the modification of the Battle Creek Hydroelectric Project (FERC Project No. 1121) facilities and operations, including instream flow releases. Facility changes include the removal of five diversion dams and construction of fish ladders and fish screens at three diversion dams. PG&E is the owner and licensee of the Hydroelectric Project. Any changes to the Hydroelectric Project trigger the need for PG&E to seek a license amendment from FERC. The Restoration Project has been developed in collaboration with various resource agencies, including the U.S. Fish and Wildlife Service, National Marine Fisheries Service, the California Department of Fish and Wildlife, and the California Bay Delta Authority, and in conjunction with participation from the public, including the Greater Battle Creek Watershed Working Group and the Battle Creek Watershed Conservancy. The Project is currently being implemented (Reclamation 2018c).
Delta Dredged Sediment Long- Term Management Strategy (LTMS)	USACE	The Delta Dredged Sediment Long-Term Management Strategy is a cooperative planning effort to coordinate, plan, and implement beneficial reuse of sediments in the Delta. Five agencies (USACE, U.S. Environmental Protection Agency, DWR, California Bay Delta Authority, and the Central Valley RWQCB) have begun to examine Delta dredging, reuse, and disposal needs. The strategy development process will examine and coordinate dredging needs and sediment management in the Delta to assist in maintaining and improving channel function (navigation, water conveyance, flood control, and recreation), levee rehabilitation, and ecosystem restoration. Agencies and stakeholders will work cooperatively to develop a sediment management plan that is based on sound science and protective of the ecosystem, water supply, and water quality functions of the Delta. As part of this effort, the sediment management plan will consider regulatory process improvements for dredging and dredged material management so that project evaluation is coordinated, efficient, timely, and protective of Delta resources.
Lower San Joaquin Feasibility Study	USACE	The Lower San Joaquin Feasibility Study was released in January 2018 and was intended to determine if there is a federal interest in providing flood risk management and ecosystem restoration improvements along the Lower (northern) San Joaquin River. The Lower San Joaquin River study area includes the San Joaquin River from the Mariposa Bypass downstream to, and including, the city of Stockton. The study area also includes the channels of the San Joaquin River in the southernmost reaches of the Delta: Paradise Cut and Old River as far north as Tracy Boulevard and Middle River as far north as Victoria Canal. The floodplains of the lower San Joaquin River and its tributaries are also included in the study area (USACE 2018a).

Project	Primary Agencies	Description
Sacramento River Bank Protection Project	USACE	Originally authorized by Section 203 of the Flood Control Act of 1960, the Sacramento River Bank Protection Project is a long-term flood risk management project designed to enhance public safety and help protect property along the Sacramento River and its tributaries. While the original authorization approved the rehabilitation of 430,000 linear feet of levee, the 1974 Water Resources Development Act added 405,000 linear feet to the authorization and a 2007 bill authorized another 80,000 linear feet for a total of 915,000 linear feet of project. The Corps is set to release a Post Authorization Change Report, including an Environmental Impact Statement, to address the effects of the latest authorization. USACE, Sacramento District is responsible for implementation of the project in conjunction with its non-Federal partner, the California Central Valley Flood Protection Board. A Draft Post Authorization Change Report Draft Environmental Impact Statement/Environmental Impact Report was released in December 2014. The Corps released an annual erosion inventory engineering report in July 2015 (USACE N.d.a).
Sacramento River General Reevaluation Report	USACE	The Sacramento River General Reevaluation Report assesses flood risk management capabilities and ecosystem restoration opportunities within the flood conveyance system of the Sacramento Valley and Delta. Public scoping was performed in November 2015.
American River Common Features General Reevaluation Report	USACE	USACE proposed to enhance flood risk management for the city of Sacramento by improving the levees that surround the city. The Final EIS/EIR was released in December 2015.
Suisun Bay Channel Operations and Maintenance	USACE	The project is located 30 miles northeast of San Francisco and is part of the San Francisco Bay to Stockton Ship Channel. The project provides for annual maintenance dredging of the main channel, 300 feet wide and -35 feet deep at Mean Lower Low Water, from the Carquinez Strait at Martinez to Pittsburg (called Suisun Bay Channel), and maintenance dredging of New York Slough Channel farther upstream to Antioch (a distance of 17 miles). The project also provides annual maintenance dredging for a channel 250 feet wide and -20 feet deep south of Seal Islands, from the main channel at Point Edith to the main channel again at Port Chicago at mile (USACE N.d.b).
Suisun Channel (Slough) Operation and Maintenance	USACE	The Suisun Channel connects the City of Suisun near Fairfield, California to Grizzly Bay and thus to Suisun Bay 30 miles northeast of San Francisco. Project operations and maintenance provides for maintenance dredging of an entrance channel in Suisun Bay 200 feet wide and -8 feet deep, and thence a channel 100 to 125 feet wide and -8 feet deep for 13 miles to the head of navigation at City of Suisun, with a turning basin. This shallow draft channel is maintained on an infrequent basis (USACE N.d.b).
Delta Islands and Levees Feasibility Study	USACE and DWR	The final feasibility study and EIS was released in September 2018. This report addressed flood risk management, ecosystem restoration, water quality, water supply, and a variety of other issues. DWR's Delta Risk Management Strategy studies was used to define problems, opportunities, and specific planning objectives. The feasibility study provides the mechanism by which USACE can participate in a cost-shared solution to a variety of water resources needs for which it has authority. USACE and DWR share the cost of the feasibility study equally (USACE 2018b).
Grassland Bypass Project, 2010 - 2019	Reclamation and SLDMWA	The purposes and objectives of the proposed continuation of the Grassland Bypass Project, 2010–2019 are: • To extend the San Luis Drain Use Agreement in order to allow the Grassland Basin Drainers time to acquire funds and develop feasible drainwater treatment technology to meet revised Basin Plan objectives (amendment underway) and Waste Discharge Requirements by December 31, 2019; • To continue the separation of unusable agricultural drainage water discharged from the Grassland Drainage Area from wetland water supply conveyance channels for the period 2010–2019; and • To facilitate drainage management that maintains the viability of agriculture in the Project Area and promotes continuous improvement in water quality in the San Joaquin River; The project would continue the present drainwater conveyance using the Drain with discharge of a portion of the collected drainwater to Mud Slough. New features include negotiation with Reclamation and other stakeholders for a 2010 Use Agreement for the Drain, to include an updated compliance monitoring plan, revised selenium and salinity load limits, an enhanced incentive performance fee system, a new Waste Discharge Requirement from the Regional Board, and mitigation for continued discharge to Mud Slough. In-Valley treatment/drainage reuse at the San Joaquin River Water Quality Improvement Project facility would be expanded to 6,900 acres. The 2019 Grassland Bypass Project Pesticide Monitoring Plan was approved by Central Valley RWQCB in October 2018 (Central Valley RWQCB 2018).
Agricultural Drainage Selenium Management Program Plan	Reclamation and SLDMWA	Impairment of water quality in the San Joaquin River, the Delta, and San Francisco Bay has resulted in the completion of a TMDL for selenium in the lower San Joaquin River, listing of the western Delta as having impaired water quality for selenium, and initiation of a TMDL study for selenium in North San Francisco Bay. The overall goal of the Agricultural Drainage Selenium Management Program is to minimize discharges of selenium in subsurface agricultural drainage from the western San Joaquin Valley to the river and downstream areas. Actions being taken include reduction in the generation of agricultural drainage containing elevated levels of selenium (through land and irrigation management practices) and limiting where and when the drainage water can be discharged.

Project	Primary Agencies	Description
2-Gates Project	Reclamation and SLDMWA	The proposed 2-Gates Fish Protection Demonstration Project would install and operate removable gates at two key Delta locations to test the ability of the structures to manage turbidity plume dispersion towards the south Delta intakes. In a five-year pilot study, the gates would control flows in selected interior Delta channels to evaluate whether these changes reduce turbidity movement toward the south Delta intakes. Reclamation is the lead agency for the project, with DWR providing technical assistance. Scientific advice will be provided by a panel of experts facilitated by the Delta Stewardship Council (formerly CALFED Bay-Delta Program). A funding source for the project has yet to be identified. Operational costs are undetermined. The project proposed that by operating the gates, movement of adult and juvenile delta smelt into the South Delta pumping area can be controlled. Gates would be closed for short periods December through February to control adult delta smelt movement and for moderate periods March through June to control larvae/juvenile delta smelt movement. Boat ramps would be used to allow boat passage when the gates are closed. From July through November, a period of high Delta boating activity, the gates would not operate, remaining in a fully open position. The proposed central Delta locations are on Old River between Bacon Island and Holland Tract, and Connection Slough between Mandeville and Bacon Islands. A draft Environmental Assessment/ Finding of No Significant Impacts was released October 2009 (Reclamation 2009a).
Red Bluff Diversion Dam Fish Passage Improvement Project	Reclamation and Tehama Colusa Canal Authority	The project modified the Red Bluff Diversion Dam to reduce or minimize impacts on migration of anadromous fish and improve the reliability of agricultural water supply in the Tehama-Colusa and Corning Canal systems. The project included a new pumping plant and fish screen with a pumping capacity of 2,500 cubic feet per second (cfs). The initial installed pumping capacity is 2,000 cfs. There is no increase in water diversions above 2,500 cfs. The original diversion dam is currently in the decommissioning process. Construction commenced in spring 2010 and the facility began full operation in the summer of 2012 (TCCA 2013).
Anadromous Fish Screen Program	Reclamation and USFWS	The primary objective of the Anadromous Fish Screen Program (AFSP) is to protect juvenile Chinook salmon (all runs), steelhead, green and white sturgeon, striped bass and American shad from entrainment at priority diversions throughout the Central Valley. Section 3406 (b)(21) of the Central Valley Project Improvement Act (CVPIA) requires the Secretary of the Interior to assist the State of California in developing and implementing measures to avoid losses of juvenile anadromous fish resulting from unscreened or inadequately screened diversions on the Sacramento and San Joaquin rivers, their tributaries, the Delta, and the Suisun Marsh. Additionally, all AFSP projects meet Goal 3 of the CALFED Ecosystem Restoration Program's (ERP) Draft Stage 1 Implementation Plan (USFWS 2015).
American Basin Fish Screen and Habitat Improvement Project	Reclamation, CDFW, and Natomas Central Mutual Water Company	Reclamation and CDFW authorized and provided funds to the Natomas Central Mutual Water Company (Natomas Mutual) to construct and operate the American Basin Fish Screen and Habitat Improvement Project. The purpose of the project is: (1) to avoid or minimize potentially adverse effects to fish, particularly anadromous juvenile fish, due to water diversions from the Sacramento River and Natomas Cross Canal by Natomas Mutual and other small pumps operated by individual landowners for diversion of water into the Natomas Basin; (2) to ensure reliability of Natomas Mutual's water diversion and distribution facilities for beneficial uses of its water supply within its service area; and (3) to maintain important habitat within the Natomas Basin created by the operation of the Natomas Mutual's water distribution facilities. The project would result in modifications of Natomas Mutual's water diversion and distribution system adjacent to the Sacramento River and Natomas Cross Canal in Sacramento and Sutter counties, California. The modifications include the construction and operation of one or two positive-barrier fish screen diversion facilities; decommissioning and removing the Verona Diversion Dam and lift pumps; removing five pumping plants and one small private diversion; and modifying the distribution system. The project is anticipated to be implemented in three phases. A Record of Decision was signed on April 20, 2009 (Reclamation 2009b).
San Joaquin River Restoration Program (SJRRP)	Reclamation, USFWS, NMFS, DWR, and CDFW Wildlife	SJRRP is a comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of Merced River and restore a self-sustaining Chinook salmon fishery in the river while reducing or avoiding adverse water supply impacts from restoration flows. The restoration program is the product of more than 18 years of litigation, which culminated in a Stipulation of Settlement on the lawsuit known as NRDC, et al., v. Kirk Rodgers, et al. The settling parties reached agreement on the terms and conditions of the settlement, which was subsequently approved by Federal Court on October 23, 2006. The settling parties include the Natural Resources Defense Council, Friant Water Users Authority, and the U.S. Departments of the Interior and Commerce. The settlement's two primary goals are to: • Restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish, and • Reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the settlement. The settlement requires specific releases of water from Friant Dam to the confluence of the Merced River, which are designed primarily to meet the various life stage needs for spring- and fall-run Chinook salmon. The release schedule assumes continuation of the current average Friant Dam release of 116,741 acre-feet, with additional flow requirements depending on the year type. Interim flows began in October 2009, and full restoration flows would begin no later than January 2014. Salmon will be reintroduced in the upper reaches no later than December 31, 2012. There are many physical improvements within and near the San Joaquin River that will be undertaken to fully achieve the river restoration goal. The improvements will occur in two separate phases that will focus on a combination of water releases from Friant Dam, as well as structural and channel improvements. The project was authorized and funded with the passage of San Joaquin River Restoration Settlement Act, part of the Omnibus Public Land Management Act of 2009 (Public Law 111-11) (SJRRP 2019).

Project	Primary Agencies	Description
Ballast Water Management Program	U.S. Coast Guard	In July 2004, the Coast Guard established a ballast water management program for all vessels equipped with ballast water tanks that enter or operate within U.S. waters. This program requires vessels to maintain a ballast water management plan that is specific for that vessel and allows any master or appropriate official to understand and execute the ballast water management strategy for that vessel. The Coast Guard may impose a civil penalty if ships headed to the U.S. fail to submit a ballast water management reporting form. The National Invasive Species Act (NISA) required the Coast Guard to establish national voluntary ballast water management guidelines. If the guidelines were deemed inadequate, NISA directed the Coast Guard to convert them into a mandatory national program. To comply with NISA, the Coast Guard has established both regulations and guidelines to prevent the introduction of these species because the original voluntary guidelines were deemed inadequate prior to establishing the regulations.
North American Waterfowl Management Plan (NAWMP)	USFWS	The North American Waterfowl Management Plan, a collaboration of Canada, the United States, and Mexico to enhance waterfowl populations, was originally written in 1986 and envisioned as a 15-year effort to achieve landscape conditions that could sustain waterfowl populations. The plan has been modified twice since the 1986 Plan to account for biological, sociological, and economic changes that influence the status of waterfowl and the conduct of cooperative habitat conservation. The 2012 Plan fundamentally re-examined the NAWMP goals and developed renewed goals through extensive consultation with stakeholders. The 2012 Plan established three main goals: 1) Abundant and resilient waterfowl populations to support hunting and other uses without imperiling habitat; 2) wetlands and related habitats sufficient to sustain waterfowl populations at desired levels, while providing places to recreate and ecological services that benefit society; and 3) growing numbers of waterfowl hunters, other conservationists and citizens who enjoy and activity support waterfowl and wetlands conservation (USFWS 2012).
Stone Lakes National Wildlife Refuge Comprehensive Conservation Plan	USFWS	U.S. Fish and Wildlife Service published a final Comprehensive Conservation Plan (CCP) for Stone Lakes National Wildlife Refuge in January 2007 to describe the selected alternative for managing Stone Lakes National Wildlife Refuge for the next 15 years. The refuge is located about 10 miles south of Sacramento, straddling I-5 and extending south from Freeport to Lost Slough. Under the plan, the Refuge will continue its focus of providing wintering habitat for migratory birds and management to benefit endangered species. Management programs for migratory birds and other Central Valley wildlife will be expanded and improved and public use opportunities will also be expanded. The number of refuge units open to the public will increase from one to five. In addition, environmental education, interpretation, wildlife observation, wildlife photography, hunting, and fishing programs will be expanded. The plan achieves the refuge's purposes, vision, and goals; contributes to the Refuge System mission; addresses the significant issues and relevant mandates; and is consistent with principles of sound fish and wildlife management.
Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes	USFWS	The recovery plan addresses the recovery needs for eight fish species that occupy the Delta, including delta smelt, Sacramento splittail, longfin smelt, green sturgeon, Chinook salmon (spring-run, late fall-run, and San Joaquin fall-run), and Sacramento perch (believed to be extirpated). The objective of the plan is to establish self- sustaining populations of these species that will persist indefinitely. This would be accomplished by managing the estuary to provide better habitat for aquatic life in general and for the fish addressed by the plan. Recovery actions include tasks such as increasing freshwater flows; reducing entrainment losses to water diversions; reducing the effects of dredging, contaminants, and harvest; developing additional shallow-water habitat, riparian vegetation zones, and tidal marsh; reducing effects of toxic substances from urban non- point sources; reducing the effects of introduced species; and conducting research and monitoring.
Lower American River Temperature Reduction Modeling Project (Formerly the Lake Natoma Temperature Curtains Pilot Project)	USFWS, Anadromous Fish Restoration Program; Reclamation; Sacramento Water Forum	The objective of the Lower American River Temperature Reduction Modeling Project is to develop predictive tools that will: 1) Reduce uncertainties in the performance of identified temperature control actions that could be implemented to improve the management of cold water resources in the Folsom/Natoma Reservoir system and the lower American River, and 2) Be available for daily operations, planning, and salmon and steelhead habitat studies by other project operators and other stakeholders. The project adapted, calibrated, and verified existing thermodynamic and hydrologic mathematical models for application at Folsom Reservoir, Lake Natoma and the lower American River. The models were used to assess the effectiveness of the identified actions individually and in combination in order to support a recommendation as to the development and implementation of one or more actions for the purpose of reducing temperatures in the lower American River. The actions identified to improve transport of cold water through Lake Natoma and reduce the temperature of the lower American River included: a Nimbus Dam curtain, a Lake Natoma plunge zone curtain, Nimbus powerplant debris wall removal, dredging Lake Natoma, and modifying Folsom Powerplant peak loading operation.
Interim Federal Action Plan for the California Bay-Delta	USFWS, Reclamation, DWR, and CDFW	The Interim Federal Action Plan for the California Bay-Delta included an action item for a federal-State and local partnership, led by USFWS to promote the development of a permanent fish restoration facility (the Bay Delta Center for Collaborative Science and Restoration Propagation of Native Imperiled Aquatic Species) to be located at Rio Vista. This facility would be capable of maintaining genetic refugia of delta smelt and other imperiled native aquatic species and producing the numbers of fish necessary for restoration and recovery. Federal agencies expect to partner with the State and local agencies in conducting initial engineering design, site demolition and preparation activities, planning and environmental compliance consultation, and other activities. In addition to the fish restoration facility, the plan calls for developing a backup delta smelt refugium to guard against a catastrophic event and loss of genetic diversity and to provide an interim restoration propagation facility until the Rio Vista facility is operational. Federal agencies will work with the University of California, Davis and the State to upgrade and ensure safety compliance for the existing facility Delta Smelt Research and Culture Facility at Banks Pumping Plant.

Project	Primary Agencies	Description
San Francisco Bay Delta Action Plan	Environmental Protection Agency	In 2012, Environmental Protection Agency identified seven key activities to advance the protection and restoration of aquatic resources and ensure a reliable water supply in the San Francisco Bay Delta Estuary watershed. EPA's Action Plan included the following actions: (1) Strengthen estuarine habitat protection standards; (2) Advance regional water quality monitoring and assessment; (3) Accelerate water quality restoration through Total Maximum Daily Loads; (4) Strengthen selenium water quality criteria; (5) Prevent pesticide pollution; (6) Restore aquatic habitats while managing methylmercury; and (7) Support the Bay Delta Conservation Plan.
UCD Fish Conservation and Cultural Lab	University of California, Davis, DWR, CDFW, USFWS, and Reclamation	The University of California, Davis (U.C. Davis) and DWR, working with federal agencies, operates a program to spawn and rear delta smelt for scientific studies, and develops and improves cultural methods for delta and longfin smelt. The facility includes a delta smelt culture laboratory located at DWR's Fish Facility near Byron.
Delta Research Station Project	DWR and USFWS	The planned Delta Research Station is science and research station in the Delta and would consist of two facilities, the Estuarine Research Station and the Fish Technology Center. The Delta Research Station would provide improved and additional facilities and would provide accurate and useful information to support adaptive management of the Delta and conservation of Delta ecosystems. This project would include construction activities In the San Francisco Bay-Delta Region. The schedule for construction is undecided currently.
Lower American River Flow Management Standard Implementation	Water Forum and Reclamation	The Sacramento Water Forum developed a Modified Flow Management Standard (FMS) for the lower American River that was released in October 2015. The Modified FMS will significantly lower water temperatures in the lower American River during the crucial rearing season for juvenile steelhead; provide better overall habitat conditions; significantly improve water supply reliability in the American River basin by avoiding low reservoir levels; and avoid redirected impacts to Sacramento River fisheries.
West Sacramento Levee Improvements Program	West Sacramento Area Flood Control Agency (WSAFCA) and USACE	The West Sacramento Levee Improvements Program (WSLIP) would construct improvements to the levees protecting West Sacramento to meet local and federal flood protection criteria. The program area includes the entire WSAFCA boundaries which encompasses portions of the Sacramento River, the Yolo Bypass, the Sacramento Bypass, and the Sacramento Deep Water Ship Channel. The levee system associated with these waterways includes over 50 miles of levees in Reclamation District (RD) 900, RD 537, RD 811, DWR's Maintenance Area 4, and the Deep Water Ship Channel. These levees completely surround the West Sacramento. For the purposes of this program, the levees have been generally divided into the nine reaches: Sacramento River Levee North, Sacramento River Levee South, Port North Levee, Port South Levee, South Cross Levee, Deep Water Ship Channel Levee East, Deep Water Ship Channel Levee West, Yolo Bypass Levee, and Sacramento Bypass Levee. WSAFCA is preparing to start construction of the Southport Levee Improvement Project, which extends from river mile 57.2 to river mile 51.6 within the Sacramento River South Levee.
Yolo County Stormwater Management Program	Yolo County, Public Works Division	The Yolo County Stormwater Management Program (SWMP) is composed of six elements: Public Education and Outreach, Public Involvement and Participation, Illicit Discharges, Construction Activities, New Development and Redevelopment, and County Operations. The program provides education, opportunities for participation, requires permanent stormwater BMPs for major development, implements improved control measures at county facilities, and delineates responsibilities. The program was adopted by the Yolo County Board of Supervisors in 1994.
San Joaquin River Restoration Program: Salmon Conservation and Research Facility (SCARF) and Related Management Actions Project	CDFW and DWR	CDFW and DWR will lead the state's effort to achieve the goals of restoring flows to the San Joaquin River from Friant Dam to the confluence of the Merced River, and bring back a naturally-reproducing, self-sustaining Chinook salmon fishery while reducing or avoiding adverse water supply impacts. Chinook will be reintroduced pursuant to the San Joaquin River Restoration Program, and CDFW will complete construction of the conservation hatchery and research facility. DWR will perform activities that support the implementation of channel and structural improvements that result in restoring fish and flows. CDFW is currently operating a temporary, small-scale conservation facility (Interim SCARF) and is finalizing construction of the permanent SCARF. The SCARF will be constructed adjacent to the San Joaquin River, just south of the existing San Joaquin (trout) Hatchery in Friant, CA, adjacent to the current Interim SCARF. When complete, the SCARF will consist of a main hatchery building and outdoor broodstock and juvenile rearing tanks with volitional release channels. Once the SCARF is operational, it will be capable of producing up to one million smolts annually for release to the Restoration Area.
Salton Sea Species Conservation Habitat Project	CNRA, Salton Sea Authority, CDFW, DWR	CNRA, in partnership with the Salton Sea Authority, will coordinate state, local and federal restoration efforts and work with local stakeholders to develop a shared vision for the future of the Salton Sea. The Salton Sea is one of the most important migratory bird flyways in North America and is immediately threatened with reduced inflows and increasing salinity. CDFW and DWR will begin immediately to implement the first phase of this effort with the construction of 600 acres of near shore aquatic habitat to provide feeding, nesting and breeding habitat for birds. This project area encompasses approximately 3,770 acres of exposed lake bed. The project is part of the 10-year Plan for implementing projects around the Salton Sea and DWR is currently in the process of selecting a Design-Build Entity to deliver the project (DWR 2019f).
Klamath Basin Restoration	CDFW and CNRA	CDFW and CNRA will continue to work with diverse stakeholders to implement the Klamath Basin restoration and settlement agreements. Those agreements include measures to improve water quality in the Klamath River, restore anadromous fish runs, including Chinook and Coho salmon, and improve water reliability for agricultural and other uses by providing a drought planning mechanism for low water years. The administration will continue to work with tribes, irrigators, ranchers, farmers, the power company, commercial fishing communities, environmental groups, the state of Oregon, and federal agencies to restore the Klamath River, bring water stability to rural communities, resolve long-running disputes, and remove four hydroelectric dams on the Klamath River.

Project	Primary Agencies	Description
Sustainable Groundwater Management Act	SWRCB, California Department of Toxic Substances Control, DWR	DWR has developed a Strategic Plan for its Sustainable Groundwater Management (SGM) Program. DWR's SGM Program will implement the new and expanded responsibilities identified in the 2014 Sustainable Groundwater Management Act (SGMA). Some of these expanded responsibilities include: (1) developing regulations to revise groundwater basin boundaries; (2) adopting regulations for evaluating and implementing Groundwater Sustainability Plans (GSPs) and coordination agreements; (3) identifying basins subject to critical conditions of overdraft; (4) identifying water available for groundwater replenishment; and (5) publishing best management practices for the sustainable management of groundwater. More than 99 percent of the State's high- and medium-priority basins are now covered by groundwater sustainability agencies that are now tasked with submitting groundwater sustainability plans beginning in 2020 (CNRA 2019).
Delta Science Plan	Delta Stewardship Council, DWR, CDFW, SWRCB, State Agencies, Delta Stewardship Council Implementation Committee, CA State Administration	The problems affecting the Delta need to be addressed on multiple fronts, including habitat loss, export conveyance, water projects operations, pollution control, and flows. The principal state entities charged with addressing these issues are the Delta Stewardship Council, DWR, CDFW, and SWRCB. Several federal agencies exercise regulatory authority related to these issues. There are also multiple water districts, private parties, nongovernmental organizations and tribal communities with a profound stake in these issues. A coordinated approach to managing the Delta is essential to serve the needs of California's residents. State agencies will commit to using collaborative processes to achieve water supply, water quality and ecosystem goals. This approach embraces enhanced sharing of data, consistent use of peer-reviewed science, coordinated review under CEQA, improved integration of related processes, and encouragement of negotiated resolutions. The Delta Science Program is currently updating the Delta Science Plan.
Staten Island Sandhill Crane Habitat Enhancement	CDFW, The Nature Conservancy	In partnership with government and nonprofits, the Nature Conservancy manages thousands of acres of habitat, provides educational opportunities for local schools and is restoring tidal wetlands in the Delta. Investments by the Conservancy have expanded the Cosumnes River Preserve by 3,388 acres since 2002. Diverse crop management is being used to demonstrate the potential for enhanced foraging habitat for cranes and other wildlife, while improving the diversity and viability of the farming operation.
Twitchell Island Levee Habitat Restoration Project	CNRA	The Twitchell Island East End Wetland Restoration Project restored approximately 740 acres of palustrine emergent wetlands and approximately 50 acres of upland and riparian forest habitat on Twitchell Island. The project was completed in 2013. An additional 1,250 acres are planned to be restored as part of the Twitchell Island West End Wetland Restoration Project, but the project is conceptual and so timing is uncertain.
Restoration of Eastern Delta Floodplain Habitats on Grizzly Slough in the Cosumnes River Watershed	CNRA	The Grizzly Slough Floodplain Restoration Project is one of two main elements of the North Delta Flood Control and Ecosystem Restoration Project that consists of flood management and habitat improvements where the Mokelumne River, Cosumnes River, Dry Creek and Morrison Creeks converge. Flood flows and high water conditions in this area threaten levees, bridges and roadways. The North Delta project will reduce flooding and provide contiguous aquatic and floodplain habitat along the downstream portion of the Cosumnes Preserve by modifying levees on Grizzly Slough. Benefits to ecosystem processes, fish and wildlife, will be achieved by recreating floodplain seasonal wetlands and riparian habitat on the Grizzly Slough property. Construction is targeted for 2019 or later (CNRA N.d.b).
Lower Putah Creek Realignment	CNRA	This project serves as a fish passage improvement action, as well as a habitat restoration action. In combination with the Upper Reach project, the construction phase will restore approximately 430 acres of floodplain habitat, and 90 acres of tidal freshwater wetlands, create 5 miles of new channel, improve anadromous fish access to 25 miles of stream, and restore instream habitat. Construction is targeted for 2019 or later (CNRA N.d.c).
Prospect Island Tidal Habitat Restoration Project	DWR	The proposed project would restore tidal action to the interior of Prospect Island, partially fulfilling the 8,000-acre tidal habitat restoration obligations contained within the Reasonable and Prudent Alternative (RPA) 4 of the USFWS Delta Smelt Biological Opinion for long-term coordinated operations of the SWP and CVP. Because restoration of tidal habitat would provide access for salmonid rearing at Prospect Island, the project would also be consistent with RPA 1.6.1 of the 2009 NMFS Salmonid Biological Opinion for SWP/CVP. The project would result in a suite of overarching long-term ecosystem benefits, including enhancement of primary productivity and food availability for fisheries in Delta; an increase in the quantity and quality of salmonid rearing habitat and habitat for other listed species; enhancement of water quality, recreation and carbon sequestration in tidal marshes; promotion of habitat resiliency; and promotion of habitat conditions that support native species. Current design of the project includes breaching the external Miner Slough levee and removing a portion of the internal cross levee to open the site to daily tidal inundation. This project has been identified as one of the projects that will be implemented under California EcoRestore. Construction is targeted for 2019 or later (CNRA N.d.d).
Tule Red Restoration Project	State and Federal Contractors Water Agency	The Tule Red Restoration Project is a joint effort by the State and Federal Contractors Water Agency (SFCWA) and DWR to open more than 400 acres of wetlands to daily tides in the southern Suisun Marsh to benefit native fish species. Located in Solano County's Grizzly Bay region, the site was historically managed as the Tule Red Duck Club. Prior to being diked off to create freshwater habitat favored by game ducks in the early 1900s, this property was estuarine tidal habitat, providing tidal inundation and seasonal fresh water inundation during wet winter periods. This restoration project involves breaching a natural berm to allow for full daily tidal exchange through the interior of the project site and creation of a network of channels to convey water across the marsh plain. This project has been identified as one of the projects that will be implemented under California EcoRestore. Construction is currently underway (CNRA N.d.e).
Southport Early Implementation Project	West Sacramento Area Flood Control Agency	The Southport Sacramento River Setback Levee is a multi-benefit flood and ecosystem enhancement project that will be constructed as part of the USACE West Sacramento General Reevaluation Report (GRR) process through a partnership to plan and permit by the City of West Sacramento and West Sacramento Area Flood Control Agency (WSAFCA), and DWR Division of Flood Management. The setback area will be a mixed floodplain and riparian habitat to provide floodplain restoration benefits to native fish species. This project would yield up to 152 acres of mixed floodplain and riparian habitat as part of a unique opportunity to set back the levee in this rapidly urbanizing area. Setting back the levee will enhance the ability of the river to meander across the floodplain, distributing soils and nutrients that sustain riparian vegetation and aquatic species. This project has been identified as one of the projects that will be implemented under California EcoRestore. Construction is currently underway (CNRA N.d.f).

Project	Primary Agencies	Description
McCormack- Williamson Tract Flood Control and Ecosystem Restoration Project	DWR	The McCormack-Williamson Tract (MWT) island in Sacramento County offers opportunities for restoration of critical tidal freshwater marsh and floodplain habitat. Restoration of MWT is included as part of the DWR North Delta Flood Control and Ecosystem Restoration Project ("North Delta FCERP"). The North Delta FCERP will implement flood control improvements principally on and around MWT, Dead Horse Island, and Grizzly Slough in a manner that benefits aquatic and terrestrial habitats, species, and ecological processes. Flood flows and high water conditions in the area downstream of the confluence threaten levees, bridges and roadways. The MWT and Grizzly Slough properties are proposed for restoration to reduce flooding and provide aquatic and floodplain habitats along the downstream portion of the Cosumnes Preserve along the Cosumnes and Mokelumne Rivers. The project at MWT is intended to allow the passing of flood flows through the Tract, in a way that minimizes flood impacts to the system because MWT's levees are already lower than surrounding neighbor's levees and flooding has occurred on the island historically. Currently two projects are proposed for MWT: 1) The levee re-sloping and tower levee, known as "Project A," and 2) the levee breach, weir and restoration, known as "Project B." These projects combine flood surge reduction measures with the construction of habitat friendly levees and a breach on MWT to provide benefits to ecosystem processes and species by recreating tidal marsh, subtidal and floodplain/riparian habitats. This project has been identified as one of the projects that will be implemented under California EcoRestore. Construction is currently underway (CNRA N.d.g).
Hill Slough Restoration Project	CDFW	The Hill Slough Tidal Marsh Restoration Project will restore tidal marsh and enhance upland managed wildlife habitat. The restoration design consists of (1) breaching eight perimeter and two internal levees to open most of the site to tidal action from surrounding sloughs; (2) lowering some segments of existing levees to provide high marsh habitat and improving levees in other areas to provide flood protection for the surrounding area; (3) improving some water control structures; (4) raising the elevation of Grizzly Island Road through the project site to reduce flood risks; (5) adding a loop trail and parking area for improved public access; and (6) upgrading three transmission towers and lines in areas subject to tidal inundation. The project will create approximately 750 acres of restored tidal marsh and upland fish and wildlife habitat, and 200 acres of enhanced wildlife habitat. This project has been identified as one of the projects that will be implemented under California EcoRestore. Construction is currently underway (CNRA N.d.h)
Goat Island at Rush Ranch Tidal Marsh Restoration	Solano Land Trust	This project would restore unrestricted tidal flows to Goat Island Marsh, currently a diked, muted marsh with broken tide gates. Proposed actions include excavating a breach in the levee and constructing a tidal channel, lowering the remainder of the perimeter levee, closing the levee portion of the Marsh Trail, expanding marsh ponds, and revegetating the levee excavation site and marsh-terrestrial ecotone. A boardwalk would be constructed concurrently with the project to provide alternate public access (County of Solano 2015). 80 acres tidal marsh. Adjacent Suisun Hill Restoration and Lower Spring Branch Creek Restoration adds additional land and habitat values. This project has been identified as one of the projects that will be implemented under California EcoRestore. Construction is pending financing for construction.
Other Projects		
ACE*forward*	San Joaquin Regional Rail Commission (SJRRC)	ACE*forward* is a phased improvement plan proposed by the SJRRC to increase service reliability and frequency, enhance passenger facilities, reduce travel times along the existing Altamont Corridor Express (ACE) service corridor from San Jose to Stockton and to extend ACE service to Manteca, Modesto, Ceres, Turlock and Merced. This plan would provide the foundation for SJRRC's near-term and longer-term vision of intercity and commuter passenger rail services. In the near term, ACE*forward* aims to increase service to 6 daily round trips, extend to Modesto and Ceres, implement safety and grade crossings improvements, and add track in key locations. ACE*forward* is also planning longer-term improvements to increase service to at least 10 daily round trips, provide weekend service, and extend to Merced. ACE*forward* is also investigating potential connections to BART in the Tri-Valley and Union City.
California High- Speed Rail System Merced to Fresno Section	California High Speed Rail Authority and Federal Railroad Administration	The Merced to Fresno high-speed train section is 65 miles long. Following release of the Draft Project EIR/EIS for the section in August 2011 and completion of the public review process in October, the Authority Board in December 2011 selected the "Hybrid" route as the preferred alternative out of the three primary alternatives studied during the EIR/EIS process. The Hybrid Alternative alignment generally parallels the Union Pacific Railroad (UPRR) tracks and State Route 99 between Merced and Fresno. To avoid impacts to downtown Madera, the alignment travels east of Madera and generally parallels the existing Burlington Northern Santa Fe railroad corridor. Station locations are proposed in downtown Merced between Martin Luther King Jr. Way and G Street and in downtown Fresno at Mariposa Street (California High-Speed Rail Authority 2012, N.d).
Sacramento County General Plan Update	Sacramento County	The 2030 General Plan was adopted on November 9, 2011. The General Plan is periodically amended to make changes to accommodate public and private projects, to update information and policies, or to comply with State regulations. Multiple sections were amended in September 2017 as part of a Clean-Up Package. The general plan update covers the entire unincorporated portion of Sacramento County, including portions of the Delta within Sacramento County. The update also includes a Delta Protection Element that identifies goals and objectives within the primary zone of the Delta.
Sacramento International Airport Master Plan	Sacramento County	The Master Plan for Sacramento International Airport was completed in 2004 and establishes a program for the improvement of existing facilities and the development of facilities at the Airport over the next 20 years. The plan identifies the type and extent of facilities that are required to meet projections of aviation demand and the airport functions, including the airfield, terminal and related passenger services, cargo, general aviation, airport support, and access. The airport is currently preparing an update to the Master Plan and a draft summary report was released in January 2017 (Leigh Fisher 2017). The summary report identifies a long-term development plan of projects that could be completed over the next 20 years.
San Joaquin County General Plan Update	San Joaquin County	The San Joaquin County General Plan 2035 was released in December 2016. The general plan provides guidance for future growth in a manner that preserves the county's natural and rural assets. Most of the urban growth is directed to existing urban communities. The General Plan contains goals and policies for the Delta as part of the Natural and Cultural Resources Element.

Project	Primary Agencies	Description
San Francisco Bay to Stockton Deep Water Ship Channel Project	USACE, Port of Stockton, and Contra Costa County Water Agency	The project consists of deep-draft navigation channels that extend from the San Francisco Bay to the Port of Stockton through San Francisco, Marin, Contra Costa, Solano, Sacramento, and San Joaquin Counties. The Corps is assessing the feasibility of deepening the existing 35-foot channel to realize significant transportation cost savings. The channel is currently authorized to 45-feet west of Pittsburgh. Deepening east of Pittsburgh would require new authorization.
Yolo County General Plan Update	Yolo County	The Yolo County 2030 Countywide General Plan was adopted on November 10, 2009 (Yolo County 2009). The general objective of the General Plan is to guide decision-making in the unincorporated areas in the County toward the most desirable future possible. The highest and best use of land within Yolo County is one that combines minimum efficient urbanization with the preservation of productive farm resources and open space amenities.
Franklin Bulk Substation	Sacramento Municipal Utility District (SMUD)	SMUD is proposing the Franklin Electric Transmission Project to construct and operate a new bulk transmission substation (Franklin Bulk substation), construct and operate a new co-located distribution substation (Franklin Distribution substation), modify existing and construct new overhead 69 kilovolt (kV) and 230kV power lines that would link the substations to the electrical grid, and dismantle a nearby distribution substation that will be replaced by the new distribution substation. Project features would include the Franklin Bulk substation, the Franklin Distribution substation, subtransmission lines, transmission lines, and a fiber optic network connection. The proposed Project is located in southwestern Sacramento County, California.

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Appendix Z ROC on LTO Consultation and Coordination

Reclamation has coordinated with stakeholders and interested parties since consultation was reinitiated in August 2016.

- 12/15/2016 – Reclamation (Dave Mooney + Michelle Banonis) met with NGOs regarding the 5-agency ROC on LTO MOU.
- 12/19/2016 – Reclamation, DWR, NMFS, USFWS, and DFW Principal's meeting regarding the 5-agency ROC on LTO MOU. Established 3-5 year timeframe, transparent process, peer review, "fresh look", biological objectives.
- 2/14/2017 – Kickoff Meeting with water users, power customers, NGOs, agencies (including 5-agencies, EPA, USFS, WAPA, etc), to discuss ROC on LTO process, schedule and desire for extensive input from interested parties and stakeholders.
- 2/14/2017 – Reclamation and NGO and fishing organization meeting to gather initial brainstorm ideas for ROC on LTO actions
- 2/24/2017 – Reclamation and Power Customer meeting to brief power customers on ROC on LTO process, schedule, and gather initial ideas from power customers
- 2/28/2017 – First ROC on LTO 5-agency meeting. These continued every 2-3 weeks until August 8, 2018. Topics included project management plan, schedule, brainstorming ideas, brainstorming workshops, small groups to develop ideas, discussion of ESA regulation changes, conference options, listing decisions that could affect the ROC on LTO, scope of the consultation, existing consultations, interrelated and interdependent effects, etc.
- 4/6/2017 – Reclamation and Friant Water Authority and South Valley Water Association meeting to discuss to what extent Friant would be incorporated into the ROC on LTO.
- 4/17/2017 – First regular Reclamation and DWR meeting. These occurred monthly through the present.
- 4/27/2017 – Provided ROC on LTO update at the CVP Power User Meeting
- 5/10/2017 – ROC on LTO Meeting at ACWA, to discuss schedule, process, and upcoming brainstorming meetings
- 5/25/2017 – NMFS / Reclamation meeting to discuss inclusion of Friant in the ROC on LTO. At the meeting and subsequent follow-ups, NMFS agreed that the Reclamation actions needing consultation at Friant are very limited, if any exist.
- 6/7/2017 – Reclamation and NGO meeting to discuss schedule, process, and upcoming brainstorming meetings
- 7/6/2017 – 7/7/2017 – Clear Creek ROC Band – Brainstorming with 5-agencies and WAPA regarding ideas to improve all Reclamation's authorized purposes for Clear Creek, using the FAST process.

- 7/20/2017 – Reclamation and SWRCB meeting to brief SWRCB on ROC on LTO, get update on WQCP, and discuss how they might interact.
- 8/11/2017 – Clear Creek ROC Band Follow-up to continue identify advantages and disadvantages of ideas.
- 8/24/2017 -8/25/2017 – American River ROC Band with 5-agencies + WAPA to brainstorm ideas for improving Reclamation's authorized purposes on the American River.
- 9/14/2017 – American River ROC Band follow-up to continue identifying advantages and disadvantages of ideas
- 9/20/2017 – Reclamation and NGO meeting to discuss pre-NEPA brainstorming process
- 10/2/2017 – Water User MOU meeting to discuss possible 5-agency + water user MOU
- 10/12/2017 – ROC on LTO update at the CVP power customer meeting
- 10/30/2017 – ROC on LTO Water User Smallgroup – continued every month or two until Fall 2018
- 11/2/2017 – Reclamation, DWR and Water User Meeting for water users to share ideas for the ROC on LTO
- 11/3/2017 – Reclamation and SWRCB meeting to provide update on ROC and WQCP processes
- 11/13/2017 – Water User Smallgroup Call to discuss the inclusion of CWF in the ROC on LTO
- 11/20/2017 – Reclamation and EPA call to brief EPA on ROC on LTO
- 11/21/2017 – American River Brainstorming Workshop with water users, power customers, NGOs, agencies (including WAPA, EPA, USFS, etc). Obtained ideas for improving Reclamation's authorized purposes on the American River.
- 11/28/2017 – Reclamation and CVP water users call to discuss draft ROC on LTO Notice of Intent for NEPA document
- 11/29/2017 – ROC on LTO briefing at ACWA, shared new approach – shortened schedule, multiple track processes – for the ROC on LTO
- 12/12/2017 – Meetings with Yurok and Hoopa to discuss ROC on LTO, including 3-track process and whether or not Trinity is included
- 12/14/2017 – Meeting with Reclamation and Stanislaus River water user representatives to discuss Stanislaus River ideas for the ROC on LTO
- 1/4/2018 – 1/5/2018 – Trinity River ROC Band with 5-agencies, WAPA, Hoopa and Yurok to brainstorm ideas to improve Reclamation's authorized purposes on the Trinity River.
- 1/17/2018 – ROC on LTO meeting at Water Users Conference, discuss upcoming brainstorming workshops

- 1/19/2018 – Delta Brainstorming Workshop with water users, power customers, NGOs, agencies (including WAPA, EPA, USFS, etc) to brainstorm ideas for Track 1 – Initial Actions, which was to be a short 1-year process focused on water supply improvements.
- 1/23/2018 – Track 2 Scoping Meeting for the public, focused on areas of concern and alternatives to consider for Track 2 (which was to be an 18 month process considering storage projects) to "maximize water supply and optimize marketable power generation and address the status of listed species"
- 1/24/2018 - Track 2 Scoping Meeting for the public, focused on areas of concern and alternatives to consider for Track 2 to "maximize water supply and optimize marketable power generation and address the status of listed species"
- 1/25/2018 - Track 2 Scoping Meeting for the public, focused on areas of concern and alternatives to consider for Track 2 to "maximize water supply and optimize marketable power generation and address the status of listed species"
- 2/6/2018 – ROC on LTO briefing update at the CVP Water User Forum, with Reclamation and CVP water users
- 2/15/2018 – Power User Brainstorming Meeting – Agenda was: Intro to the 3-track process - Draft outreach schedules - Power User Brainstorming. The goal was to have a brief introduction to the project(s) and what opportunities for input will be, and then spend most of the time in an open discussion to hear ideas for how to optimize marketable power generation for Track 2.
- 2/22/2018 – CVP and SWP Water User, Reclamation and DWR meeting to discuss Track 1 initial ideas
- 2/28/2018 – Track 2 Brainstorming Workshop with water users, power customers, NGOs, and agencies.
- 3/2/2018 – Water User and 5-agency discussion of Track 1 initial ideas
- 3/7/2018 – South Valley Water Association and Reclamation meeting to discuss whether or not Friant is included into the various tracks
- 3/13/2018 – Reclamation and NGO meeting to discuss Track 1 initial ideas. Minimal NGO attendance.
- 3/14/2018 – Reclamation and DWR meeting with water and power customers and WAP to discuss an initial list of ideas from Contractors, Reclamation, and DWR related to Track 2 (Revisions to the coordinated LTO of the CVP and SWP).
- 3/27/2018 - Meeting with Water and Power customers, WAPA, Reclamation, and DWR to discuss an initial list of ideas from Contractors, WAPA, Reclamation, and DWR related to Track 1 (Projects to Advance Water Supply) and Track 2 (Revisions to the coordinated LTO of the CVP and SWP).
- 3/28/2018 – SOD CVP and SWP water users discuss Track 1 ideas with Reclamation and DWR
- 3/28/2018 – ROC on LTO update at Trinity Management Council

- 3/28/2018 – Reclamation meet with Yurok staff
- 3/29/2018 – Reclamation ROC on LTO briefing to USFS
- 3/29/2018 – American River ROC Band Follow-up to further screen ideas
- 4/3/2018 – SWP and CVP Water User Forum, Reclamation and DWR. ROC on LTO update provided to water users
- 4/4/2018 – SOD CVP and SWP water users discuss Track 1 ideas with Reclamation
- 4/5/2018 – 4/6/2018 – Sacramento River ROC Band, brainstorm ideas to improve Reclamation's authorized purposes on the Sacramento River for Track 3
- 4/5/2018 – Reclamation and SWRCB update meeting
- 4/10/2018 – Reclamation and NGO meeting to discuss Track 2 initial ideas list. Minimal NGO attendance.
- 4/17/2018 – SOD CVP and SWP water users discussion of Track 1 ideas with Reclamation
- 4/19/2018 – Meeting with Water and Power customers, WAPA, Reclamation, DWR, USFWS, NMFS and DFW to discuss an initial list of ideas from Contractors, WAPA, Reclamation, and DWR related to Track 2 (Revisions to the coordinated LTO of the CVP and SWP).
- 4/23/2018 – SJR I:E Ratio Technical Team to develop SJR I:E modification idea for Track 1. Included 5-agencies and water user technical representatives.
- 4/25/2018 – Rapid Genetic Protocol Technical Team meeting to develop idea for Track 1. Included 5-agencies and water user technical representatives.
- 4/26/2018 – Track 1 Workshop with water users, power customers, NGOs, 5-agencies and other agencies (EPA, USFS, SWRCB, etc) to discuss Track 1 ideas and develop alternatives.
- 4/30/2018 – Reclamation and DWR meeting to discuss SMSCG / Fall X2 modeling and solicit DWR's help
- 5/3/2018 – Fall X2 Technical Team meeting to develop idea for Track 1. Included 5-agencies and water user technical representatives.
- 5/4/2018 – Predation Technical Team meeting to develop predation reduction ideas for Track 1. Included 5-agencies and water user technical representatives.
- 5/8/2018 – OMR Technical Team meeting to develop details of WIIN Act inspired storm OMR flexibility for Track 1. Included 5-agencies and water user technical representatives.
- 5/9/2018 – Fall X2 Technical Team follow-up meeting to further develop ideas
- 5/9/2018 – ROC on LTO update at ACWA, provided schedule update for Track 1, Track 2, and ideas for Track 1
- 5/10/2018 – Smelt Monitoring Technical Team meeting to develop ideas for Track 1. Included 5-agencies and water user technical representatives.

- 5/10/2018 – Non Physical Barriers Technical Team meeting to define possible actions to include for non-physical barriers for Track 1 of the Reinitiation of Consultation. Included 5-agencies and water user technical representatives.
- 5/11/2018 – Track 2 meeting with SLDMWA and Westlands and Reclamation, discussing scope and benefits of Track 2
- 5/17/2018 – Discuss Stanislaus River ideas for various tracks with Stan water users and Reclamation
- 5/23/2018 – Sacramento River Brainstorming Workshop – Meeting with water users, power customers, NGOs, and state and federal agencies to discuss possible ideas for Track 3 of the ROC on LTO – ideas to improve Reclamations authorized purposes on the Sacramento River.
- 6/5/2018 – CVP / SWP Water User Forum with Reclamation and DWR, provided update on ROC on LTO actions for Track 1.
- 6/7/2018 - Track 2 Revisions to the LTO Alternatives Workshop - Meeting with water users, power customers, NGOs, and state and federal agencies to discuss possible alternatives for Track 2
- 6/18/2018 – Reclamation meeting with Coalition for a Sustainable Delta, received science write-ups
- 6/20/2018 – ROC on LTO update at Power Customer Meeting
- 6/21/2018 – Track 1 Near-Term Actions Workshop - Meeting with water users, power customers, NGOs, and state and federal agencies to share initial analysis results from Track 1
- 7/12/2018 – ROC update at Water User Forum
- 7/25/2018 - Initial Actions (formerly Track 1) Analysis Meeting with 5-agencies and water users to discuss Track 1 modeling and what additional analysis is needed
- 7/25/2018 – Reclamation and NMFS meeting, NMFS sharing their alternatives to the I:E ratio inspired by the existing RPA options and CWF
- 8/7/2018 – 5-agency meeting to discuss Track 1, 2 progress and share Track 3 ideas
- 8/20/2018 – Reclamation and American River Water Forum discuss possible ROC actions
- 8/21/2018 – Reclamation and SCVWD meeting on science for the ROC
- 9/5/2018 – ROC Update for the Trinity Management Council
- 9/13/2018 – ROC update at CVP Water User Forum, share new approach of no more tracks, one process, finish BA by end of January 2019
- 10/5/2018 – SOD CVP water user and Reclamation meeting on alternatives for the new ROC approach
- 10/11/2018 - Develop ROC alternatives with Reclamation, DWR, CVP and SWP water users. Provided initial alternative list

- 10/26/2018 – MWD provided comments on draft ROC alternatives to Reclamation
- 11/6/2018 through government shutdown – USFWS participating with Reclamation in drafting sessions to write the ROC on LTO BA.
- 11/16/2018 – USFWS and Reclamation meeting to walk USFWS through the ROC on LTO proposed action
- 11/20/2018 – DWR, NMFS, DFW, USFWS and Reclamation meet to discuss the draft ROC on LTO proposed action
- 11/26, 11/27, 11/28/2018 – All day meetings with DWR, NMFS, DFW, USFWS and Reclamation to discuss ROC proposed action, gather agency comments, and draft edits
- 11/30/2018 – 5-agency meeting to discuss inclusion of Trinity in ROC BA
- 11/30/2018 – 5-agency meeting to discuss OMR salvage and metrics in ROC BA
- 11/30/2018 – 5-agency meeting to discuss adaptive management in ROC BA
- 12/4/2018 – Water User Forum, Reclamtaion, DWR, CVP and SWP water users discuss progress on ROC BA
- 12/4/2018 – 5-agency meeting on Shasta Temperature in ROC proposed action
- 12/7/2018 – ROC on LTO Update Meeting – Meeting with water users, power customers, NGOs, and state and federal agencies to share new approach and schedule for the ROC on LTO
- 12/7/2018 – SLDMWA / Reclamation meeting to discuss SLDMWA comments on ROC proposed action
- 12/11/2018 – Reclamation, USFWS, and NMFS discuss environmental baseline
- 12/11/2018 – Reclamation, USFWS, NMFS, DWR and DFW continue proposed action update /edits
- 12/12/2018 – 5-agency meeting on adaptive management
- 12/12 and 12/13 – all day 5-agency meetings to continue drafting ROC BA and review draft effects analysis
- 12/14/2018 – ROC Proposed Action Delta proposed action 5-agency meeting
- Week of 12/17 – 5-agency meetings every day including Saturday to work on ROC BA
- 12/24/2018 – 5-agency meeting to discuss ROC BA
- 12/27/2018 – 5-agency meeting to discuss ROC BA
- 12/28/2018 – 5-agency meeting to review Clear Creek effects analysis for ROC BA
- 1/9/2019 – Reclamation / South Valley Water Association meeting to check in on Friant's inclusion in the ROC on LTO as well as discuss SJRRP recapture
- 1/10/2019 – ROC on LTO update at the Water User Forum with Reclamation, DWR, CVP and SWP water users

- 1/11/2019 – SLWMA / Reclamation meeting on draft ROC BA sent out for water user review 1/4/2019
- 1/11/2019 – American River water user / Reclamation meeting on comments on draft ROC BA sent out for water user review 1/4/2019
- 1/18/2019 – SWC and Westlands meeting with Reclamation and USFWS to discuss comments on draft ROC BA
- 2/5/2019 – ROC update at Water User Forum
- 2/14/2019 – NMFS / Reclamation meeting to discuss biological modeling, received initial list of models requested from NMFS
- 2/20/2019 – ROC on LTO Update Meeting – Meeting with water users, power customers, NGOs, state and federal agencies to discuss status of ROC on LTO – discussed ROC on LTO BA on the website and draft NEPA alternatives
- 2/21 and 2/22/2019 – Reclamation, USFWS, and NMFS meetings to discuss USFWS and NMFS questions / concerns on the ROC BA
- 2/25/2019 – ROC Stanislaus Questions with 5-agencies
- 2/25/2019 – Fall X2 / SMSCG Questions with 5-agencies
- 2/26/2019 – 5-agency meeting to answer Clear Creek questions
- 2/26/2019 – CCF Predation Management 5-agency meeting to answer questions on BA
- 2/26/2019 – American and Feather Q&A 5-agency meeting
- 2/27/2019 – Adaptive Management Q&A 5-agency meeting
- 2/27/2019 – SMSCG DWR / Reclamation meeting to further develop action
- 2/28/2019 – Trinity Q&A 5-agency meeting
- 2/28/2019 – Delta Q&A 5-agency meeting
- 2/28/2019 – Reclamation / NMFS Biological Modeling Meeting
- 3/1/2019 – Reclamation / WAPA meeting to discuss WAPA comments on ROC BA
- 3/4/2019 – CCF predation Q&A 5-agency meeting follow-up
- 3/5/2019 – Shasta Storage and Allocations Q&A 5-agnecy meeting
- 3/11/2019 – Reclamation / USFWS Fall X2 proposed action editing
- 3/12/2019 – Shasta temperature modeling 5-agency meeting
- 3/13/2019 – Reclamation / USFWS meeting on CVPIA B2
- 3/14/2019 –ROC update at Water User Forum
- 3/19/2019 – USFWS, DFW, DWR, SWC, Reclamation meeting on Delta Smelt Habitat action
- 3/21/2019 – USFWS, DFW, DWR, Reclamation, SWC Delta smelt Habitat meeting

- 3/21/2019 – Reclamation / USFWS meeting to go through tracking sheet of ROC BA revisions
- 3/22/2019 –Reclamation, USFWS, NMFS meeting on Appendix C revisions / adaptive management
- 3/25/2019 – 5-agency, CVP and SWP contractor meeting on Delta Smelt Habitat revised language