Impact AQUA-50: Effects of Nonphysical Fish Barriers on Chinook Salmon (Winter-Run ESU) (Environmental Commitment 16)

Under Alternative 4A, an NPB at the divergence of Georgiana Slough from the Sacramento River would be intended to guide juvenile salmonid fish such as winter-run Chinook salmon away from Georgiana Slough and the interior Delta, wherein survival is relatively low compared to the Sacramento River (Perry et al. 2010). Exploration with the DPM of the potential effects of an NPB at this location suggests that with effectiveness similar to that observed during a pilot study in 2011 (Perry et al. 2012), through-Delta survival of winter-run Chinook salmon juveniles would not differ greatly between Alternative 4A and Existing Conditions or NAA_ELT (see Table 5.C.5.3-36 in the *BDCP Effects Analysis Appendix 5.C hereby incorporated by reference*). As discussed for Alternative 1A, the physical structure of an NPB may provide habitat for piscivorous fish in the area and increase localized predation risk, but the NPB is intended to improve migratory conditions for juvenile Sacramento River salmon, limiting their overall susceptibility to predation in the Delta.

NEPA Effects: The effects of NPBs would not be adverse because it would improve migration conditions for Chinook salmon.

CEQA Conclusion: As discussed above, the NPB at the divergence of Georgiana Slough from the Sacramento River has the potential to reduce the proportion of winter-run Chinook salmon entering the low-survival interior Delta. The impacts of *Environmental Commitment 16 Nonphysical Fish Barriers* are expected to be less than significant. Consequently, no mitigation would be required.

Spring-Run Chinook Salmon

Construction and Maintenance of Water Conveyance Facilities

The discussion of potential effects to delta smelt from construction and maintenance of the water conveyance facilities under Alternative 4A is also relevant to spring-run Chinook salmon. Adult and juvenile spring-run Chinook salmon would have the potential to overlap construction and maintenance to a minor degree (Table 11-8).

Impact AQUA-55: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

The potential effects of construction of the water conveyance facilities on spring-run Chinook salmon would be the same as described for Alternative 4 (Impact AQUA-55). The potential effects of underwater noise as a result of construction of the water conveyance facilities on spring-run Chinook salmon would be the same as described above for winter-run Chinook (Impact AQUA-37), which provides additional detail on underwater noise impacts which are also applicable to Impact AQUA-55 in Alternative 4.

NEPA Effects: Potential effects of construction of the water conveyance facilities on spring-run Chinook salmon would be similar to those discussed for winter-run Chinook salmon (see Impact AQUA-37 for winter run Chinook salmon). Construction of Alternative 4A involves several elements with the potential to cause adverse effects on spring-run Chinook salmon. However, these turbidity and hazardous material spill effects will be effectively avoided and/or minimized through implementation of environmental commitments (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments*: *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment,* *and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*); environmental commitments; and through implementation of the avoidance and minimization measures included in Mitigation Measures AQUA-1a and AQUA-1b. The effects would not be adverse for spring-run Chinook salmon.

CEQA Conclusion: As described in Alternative 4, Impact AQUA-55, the impact of the construction of water conveyance facilities on spring-run Chinook salmon would not be significant except for construction noise associated with pile driving. Potential effects of construction of the water conveyance facilities on spring-run Chinook salmon would be similar to those discussed for winter-run Chinook salmon (see Impact AQUA-37 for winter run Chinook salmon). Construction of Alternative 4A involves several elements with the potential to affect spring-run Chinook salmon. However, these turbidity and hazardous material spill effects will be effectively avoided and/or minimized through implementation of environmental commitments (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments*: *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Mitigation Measure AQUA-1b: Monitor Underwater Noise and if Necessary, Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Impact AQUA-56: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

NEPA Effects: The potential effects of water conveyance facilities maintenance under Alternative 4A would be the similar to those described for Alternative 4, Impact AQUA-56. As concluded in Alternative 4, Impact AQUA-38, the impact would not be adverse for spring-run Chinook salmon.

CEQA Conclusion: As described in Alternative 4, Impact AQUA-56, the impact of the maintenance of water conveyance facilities on spring-run Chinook salmon would be less than significant and no mitigation is required.

Operations of Water Conveyance Facilities

Impact AQUA-57: Effects of Water Operations on Entrainment of Chinook Salmon (Spring-Run ESU)

Water Exports from SWP/CVP South Delta Facilities

Average entrainment of juvenile spring-run Chinook salmon at the south Delta export facilities would be reduced nearly 40% under the Scenario H3_ELT compared to NAA_ELT (Table 11-4A-25). The greatest reduction would be in wet years, when entrainment would be reduced 63% (~58,000 fish) compared to NAA_ELT. Entrainment loss under Scenario H4_ELT would further reduce south Delta entrainment relative to the Scenario H3_ELT as spring exports would be lower under H4_ELT compared to H3_ELT.

Table 11-4A-25. Juvenile Spring-Run Chinook Salmon Annual Entrainment Index[a] at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 4A (Scenario H3_ELT)

Water Year	Absolute Difference (Percent Difference)	
	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Wet	-53,805 (-61%)	-57,967 (-63%)
Above Normal	-7,403 (-28%)	-8,520 (-31%)
Below Normal	-1,357 (-21%)	-1,669 (-25%)
Dry	1,698 (10%)	74 (0%)
Critical	-2,622 (-22%)	-1,916 (-17%)
All Years	-13,318 (-35%)	-14,788 (-38%)

Note: Estimated annual number of fish lost, based on normalized data.
Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

The proportion of the annual spring-run Chinook salmon index of abundance (assumed to be 750,000 juveniles approaching the Delta) lost at the south Delta facilities averaged 5.2% across all years under the NAA_ELT, and decreased to 3.3% under Alternative 4A Scenario H3_ELT. The greatest improvement was in wet years, when the proportion lost decreased by 7.7% under Alternative 4A Scenario H3_ELT (4.6%) compared to NAA_ELT (12.4%). As noted above, entrainment under Scenario H4_ELT is expected to further reduce entrainment losses relative to NAA_ELT.

Water Exports from SWP/CVP North Delta Intake Facilities

As noted for Alternative 4, the effect of Alternative 4A on entrainment and impingement at the north Delta intakes would be the same as described for Alternative 1A (Impact AQUA-57), but the degree would be less because Alternative 4A would have fewer intakes. State-of-the-art fish screens operated with an adaptive management plan would be expected to eliminate entrainment risk for juvenile spring-run Chinook salmon.

Predation Associated with Entrainment

Entrainment-related predation loss of spring-run Chinook salmon at the south Delta facilities would be no greater and may be lower than baseline due to a reduction in entrainment loss. Entrainment-related predation losses are expected to decrease under Scenario H4_ELT compared to Scenario H3_ELT.

Predation at the north Delta would be increased at the proposed North Delta intake facilities on the Sacramento River. As noted for Alternative 4, bioenergetics modeling with a median predator density predicts a predation loss of about 8,000 juveniles, or 0.2% of the spring-run juvenile population under Alternative 4A (Table 11-4A-26). This minimal predation loss would not be adverse. Note that this estimate does not provide context to the level of predation in this reach that would occur without implementation of Alternative 4A. See additional discussion under Impact AQUA-42 for winter-run Chinook salmon.

Table 11-4A-26. Juvenile Spring-Run Chinook Salmon Predation Loss at the Proposed North Delta Diversion (NDD) Intakes for Alternative 4A (Three Intakes)

Striped Bass at NDD (Three Intakes)			Spring-Run Chinook Consumed	
Density Assumption	Bass per 1,000 feet of Intake	Total Number of Bass	Number	Percentage of Annual Production Entering the Delta[1]
Low	18	86	1,204	0.03%
Median	119	571	7,961	0.19%
High	219	1,051	14,650	0.35%

Note: Based on bioenergetics modeling of Chinook salmon consumption by striped bass (*BDCP Effects Analysis*, Appendix 5F Biological Stressors, hereby incorporated by reference).

[1] Estimated as 4.2 million juveniles. See Section 5.F.3.2.1 in *BDCP Effects Analysis*, Appendix 5F Biological Stressors, hereby incorporated by reference.

NEPA Effects: In conclusion, Alternative 4A would reduce overall entrainment and associated predation losses of juvenile spring-run Chinook salmon relative to NAA _ELT. Conditions under Scenario H4_ELT would further reduce entrainment losses compared to Scenario H3_ELT. The effect of Alternative 4A would not be adverse and may provide some benefit.

CEQA Conclusion: Entrainment losses of juvenile spring-run Chinook salmon at the south Delta facilities will be substantially reduced under the Scenario H3 operations for Alternative 4A for all water year types (35% average reduction in entrainment index) compared to Existing Conditions (Table 11-4A-25). The proportion of the annual spring-run Chinook index of abundance entrained at the south Delta facilities averaged 5.0% across all years under Existing Conditions, and would decrease to 3.3% under Alternative 4A. The greatest improvement would be in wet years, when the proportion lost would decrease by just over 7% under Scenario H3_ELT (4.6%) compared to Existing Conditions (11.8%). Under Scenario H4_ELT, entrainment losses are expected to further decrease relative to Existing Conditions. Predation loss at the north Delta intakes would have minor population level effects on spring-run Chinook salmon (<0.4% of the annual index of abundance). Overall, impacts to spring-run Chinook salmon under Alternative 4A would not be significant and would in fact be beneficial because of the reductions in entrainment losses at the south Delta facilities across all water-years compared to existing biological conditions. No mitigation would be required.

Impact AQUA-58: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Spring-Run ESU)

In general, the effects of Alternative 4A on spawning and egg incubation habitat for spring-run Chinook salmon relative to the NAA are not adverse.

H3_ELT/ESO_ELT

Sacramento River

There has been a small, inconsistent spawning population (<400 individuals) in the mainstem Sacramento River primarily upstream of Red Bluff Diversion Dam over the past decade (Azat 2012).

Flows in the Sacramento River between Keswick and upstream of Red Bluff were examined during the spring-run Chinook salmon spawning and incubation period (September through January)

(Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H3_ELT during all months except November would generally be similar to those under NAA_ELT, with minor exceptions. Flows under H3_ELT during November would be up to 23% lower than flows during NAA_ELT, depending on water year type and location.

Shasta Reservoir storage volume at the end of September influences flows downstream of the dam during the spring-run spawning and egg incubation period (September through January). Mean storage under H3_ELT would generally be similar to storage under NAA_ELT in all water year types (Table 11-4A-27), so there would be no biologically meaningful effects.

Table 11-4A-27. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Scenario H3_ELT and Two Baseline Scenarios.

Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Wet	-308 (-9%)	-11 (-0.4%)
Above Normal	-363 (-11%)	0 (0%)
Below Normal	-230 (-8%)	-63 (-2%)
Dry	-171 (-7%)	31 (1%)
Critical	-134 (-11%)	-65 (7%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the September through January spring-run Chinook salmon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between H3_ELT and NAA_ELT in any month or water year type throughout the period at either location.

The number of days when temperatures exceeded the analysis criterion (i.e., 56°F identified in Table 11-4A-13) by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September At Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period. The combination of number of days and degrees above the 56°F threshold were further assigned a “level of concern”, as defined in Table 11-4A-14. Differences between baselines and H3_ELT in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4A-15 for Bend Bridge and in Table 11-4A-28 for Red Bluff. At Bend Bridge, there would be 4 (5%) more years with a “red” level of concern under H3_ELT, which would not be biologically meaningful to spring-run Chinook salmon spawners and eggs, as 4 years constitutes a small proportion of the 82 year period examined. At Red Bluff, there would be 1 (5%) more year with a “red” level of concern under H3_ELT, which would not be biologically meaningful to spring-run Chinook salmon spawners and eggs, as 1 year is such a small proportion of the 82 year period.

Table 11-4A-28. Differences between Baseline and H3_ELT Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F are within Each Level of Concern, Sacramento River at Red Bluff, October through April

Level of Concern[a]	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Red	10 (83%)	1 (5%)
Orange	5 (83%)	-2 (-15%)
Yellow	14 (108%)	1 (4%)
None	-29 (-57%)	0 (0%)

[a] For definitions of levels of concern, see Table 11-4A-14.

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, the monthly total degree-days under H3_ELT would be 8% lower than under NAA_ELT for May and June, 9% higher for September, and would be similar for July and August (Table 11-4A-16). At Red Bluff, total degree-days under H3_ELT would be 19% higher than those under NAA_ELT for March and would be similar for the remaining months of the period (Table 11-4A-29).

Table 11-4A-29. Differences between Baseline and H3_ELT Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Red Bluff, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
October	Wet	442 (172%)	20 (3%)
	Above Normal	209 (80%)	12 (3%)
	Below Normal	246 (118%)	-12 (-3%)
	Dry	403 (82%)	29 (3%)
	Critical	357 (60%)	-58 (-6%)
	All	1,657 (91%)	-9 (0%)
November	Wet	9 (900%)	1 (11%)
	Above Normal	4 (NA)	1 (33%)
	Below Normal	2 (NA)	0 (0%)
	Dry	37 (463%)	-5 (-10%)
	Critical	20 (500%)	2 (9%)
	All	72 (554%)	-1 (-1%)
December	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
March	Wet	1 (NA)	0 (0%)
	Above Normal	1 (NA)	1 (NA)
	Below Normal	10 (111%)	9 (90%)
	Dry	21 (150%)	1 (3%)
	Critical	11 (1100%)	0 (0%)
	All	44 (183%)	11 (19%)
April	Wet	101 (88%)	4 (2%)
	Above Normal	77 (55%)	5 (2%)
	Below Normal	87 (110%)	-7 (-4%)
	Dry	109 (59%)	2 (1%)
	Critical	40 (333%)	-2 (-4%)
	All	414 (78%)	2 (0%)

NA = could not be calculated because the denominator was 0.
Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

The Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under H3_ELT would be similar to mortality under NAA_ELT in wet, dry, and critical years, but greater in above normal and below normal water years (26% to 32% greater, respectively) (Table 11-4A-30). Relative increases of 26% and 32% mortality of the spring-run population in above and below normal water years represent 4% and 7% increases, respectively, on an absolute scale and, therefore, would not cause a biologically meaningful effect to spring-run Chinook salmon due to this small magnitude. Combining all water years, there would also be no effect of H3_ELT on egg mortality (2% absolute increase; 7% relative increase).

Table 11-4A-30. Difference and Percent Difference in Percent Mortality of Spring-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Wet	4 (41%)	0.2 (1%)
Above Normal	7 (52%)	4 (26%)
Below Normal	16 (134%)	7 (32%)
Dry	22 (114%)	1 (3%)
Critical	19 (25%)	1 (1%)
All	13 (57%)	2 (7%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

SacEFT predicts that there would be a 4% relative decrease (2% on an absolute scale) in the percentage of years with good spawning availability, measured as weighted usable area, under H3_ELT relative to NAA_ELT (Table 11-4A-31). SacEFT predicts that there would be no difference in the percentage of years with good (lower) redd scour risk under H3_ELT relative to NAA_ELT. SacEFT predicts that there would be an 11% decrease on a relative scale (7% on absolute scale) in the percentage of years with good (lower) egg incubation conditions under H3_ELT relative to NAA_ELT. SacEFT predicts that there would be a 5% relative decrease (2% on an absolute scale) in the percentage of years with good (lower) redd dewatering risk under H3_ELT relative to NAA_ELT. It is unlikely that spawning habitat availability is currently limiting to spring-run Chinook salmon due to deeply suppressed escapement values over the past decade. Given this, these values may be less important to spring-run Chinook salmon spawning.

Table 11-4A-**31. Difference and Percent Difference in Percentage of Years with "Good" Conditions** for Spring-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Spawning WUA	-15 (-21%)	-2 (-4%)
Redd Scour Risk	0 (0%)	0 (0%)
Egg Incubation	-28 (-33%)	-7 (-11%)
Redd Dewatering Risk	-10 (-20%)	-2 (-5%)
Juvenile Rearing WUA	6 (27%)	3 (12%)
Juvenile Stranding Risk	1 (5%)	0 (0%)

WUA = Weighted Usable Area.

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

The results of the SacEFT model and Reclamation egg mortality model are consistent with regard to predicted conditions for spring-run salmon eggs. SacEFT predicts that egg incubation habitat would decrease (7% absolute scale decrease) and the Reclamation egg mortality model predicts that overall egg mortality would increase 7% under the H3_ELT. This level of agreement in the results of the two models is likely somewhat coincidental because the models employ different sets of data. The SacEFT uses mid-August through early March as the egg incubation period, based on Vogel and Marine (1991), and the reach between ACID Dam and Battle Creek for redd locations. The Reclamation egg mortality model uses the number of days after Julian week 33 (mid-August) that it takes to accumulate 750 temperature units to hatching and another 750 temperature units to emergence. Temperatures units are calculated by subtracting 32°F from daily river temperature and are computed on a daily basis. As a result, egg incubation duration is generally mid-August through January, but is dependent on river temperature. The Reclamation model uses the reach between ACID Dam and Jelly's Ferry (approximately 5 river miles downstream of Battle Creek), which includes 95% of Sacramento River spawning locations based on 2001–2004 redd survey data (Reclamation 2008). The SacEFT model has been peer-reviewed, and the Reclamation egg mortality model has been extensively reviewed and used in prior biological assessments and BiOps. Therefore, both results are considered valid and were considered in drawing conclusions about spring-run egg mortality in the Sacramento River.

Clear Creek

Mean flows in Clear Creek during the spring-run Chinook salmon spawning and egg incubation period (September through January) under H3_ELT would generally be similar to flows under NAA_ELT throughout the spring-run spawning and egg incubation period for all water year types (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). The potential risk of spring-run Chinook salmon redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month during the incubation period to the flow in September when spawning is assumed to occur. The greatest reduction in flows under H3_ELT would be the same as that under NAA_ELT in all water year types (Table 11-4A-32).

Water temperatures were not modeled in Clear Creek.

Table 11-4A-32. Difference and Percent Difference in Greatest Monthly Reduction (Percent Change) in Instream Flow in Clear Creek below Whiskeytown Reservoir during the September through January Spawning and Egg Incubation Period[a]

Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Wet	0 (NA)	0 (NA)
Above Normal	-41 (NA)	0 (0%)
Below Normal	53 (100%)	0 (NA)
Dry	-67 (NA)	0 (0%)
Critical	-33 (-50%)	0 (0%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

NA = could not be calculated because the denominator was 0.

[a] Redd dewatering risk not applicable for months when flows during the egg incubation period were at or greater than flows in September, when spawning is assumed to occur. A negative value indicates that the greatest monthly reduction would be of greater magnitude (worse) under the alternative than under the baseline.

Feather River

Flows were examined in the Feather River low-flow channel (upstream of Thermalito Afterbay) where spring-run Chinook salmon primarily spawn during September through January. Flows under H3_ELT would not differ from NAA_ELT because minimum Feather River flows are included in the FERC settlement agreement (California Department of Water Resources 2006) and would be met for all model scenarios (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Oroville Reservoir storage volume at the end of September influences flows downstream of the dam during the spring-run spawning and egg incubation period. Mean storage volume at the end of September under H3_ELT would be similar to storage under NAA_ELT in wet, above normal, and below normal water years and 15% and 12% greater in dry and critical water years (Table 11-4A-33).

Table 11-4A-33. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Alternative 4 (Scenario H3)

Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Wet	-676 (-23%)	46 (2%)
Above Normal	-681 (-29%)	-125 (-7%)
Below Normal	-392 (-19%)	-67 (-4%)
Dry	-65 (-5%)	173 (15%)
Critical	26 (3%)	108 (12%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month during the egg incubation period to the flow in September when spawning is assumed to occur. Minimum flows in the low-flow channel during October through January were identical between H3_ELT and NAA_ELT (Appendix 11C, *CALSIM II*

Model Results utilized in the Fish Analysis). Therefore, there would be no effect of H3_ELT on redd dewatering in the Feather River low-flow channel.

Mean water temperatures in the low-flow channel would not differ between NAA_ELT and H3_ELT (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Effects of H3_ELT on water temperature-related spawning and egg incubation conditions for spring-run Chinook salmon in the Feather River were analyzed by comparing the percent of months between September through January over the 82-year CALSIM modeling period that exceed a 56°F temperature threshold in the low-flow channel (above Thermalito Afterbay) (Table 11-4A-34). There would be no differences between NAA_ELT and H3_ELT in the percent of months exceeding the threshold in December and January, and negligible differences (<5% on an absolute scale) in November. However, for September there would be an 11% increase (absolute difference) in the percent of months exceeding the threshold by >5°F and a 6% increase in percent of months exceeding the threshold by >4°F.

Table 11-4A-34. Differences between Baseline and H3_ELT Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 56°F Threshold, September through January

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H3_ELT					
September	0 (0%)	0 (0%)	6 (7%)	11 (15%)	16 (39%)
October	22 (100%)	16 (217%)	7 (120%)	6 (250%)	4 (150%)
November	9 (350%)	7 (600%)	2 (200%)	2 (NA)	0 (NA)
December	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
NAA_ELT vs. H3_ELT					
September	0 (0%)	0 (0%)	0 (0%)	6 (8%)	11 (24%)
October	-5 (-10%)	0 (0%)	-4 (-21%)	-2 (-22%)	-2 (-29%)
November	1 (13%)	0 (0%)	-1 (-25%)	0 (0%)	-1 (-100%)
December	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).
NA = could not be calculated because the denominator was 0.

The effects of H3_ELT on water temperature-related spawning and egg incubation conditions for spring-run Chinook salmon in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 56°F NMFS threshold during the September through January spring-run Chinook salmon spawning and egg incubation period for all 82 years (Table 11-4A-35). Combining all water year types, there would be a reduction of 17 degree-months in the number of degree-months exceeding the NMFS threshold under H3_ELT relative to NAA_ELT for October, an increase of 17 degree-months for September. There would be negligible differences in degree months between NAA_ELT and H3_ELT in the other months. Results are highly variable when separating out by water year type, ranging from 9% more degree-months (absolute difference) under H3_ELT in below normal water years during September to 9% fewer degree-months under H3_ELT in dry water years during October. The absolute scale is used to compare results for these analyses because the large relative differences (percent differences) between NAA_ELT and H3_ELT in most cases are mathematical artifacts due to the small values of degree-months for NAA_ELT (i.e., dividing by a small number amplifies the relative difference), which would not translate into biologically meaningful effects on spring-run Chinook salmon.

Table 11-4A-35. Differences between Baseline and H3_ELT Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River above Thermalito Afterbay, September through January

Month	Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
September	Wet	-5 (-5%)	4 (4%)
	Above Normal	0 (0%)	3 (8%)
	Below Normal	14 (23%)	9 (14%)
	Dry	31 (45%)	2 (2%)
	Critical	10 (15%)	-1 (-1%)
	All	50 (14%)	17 (4%)
October	Wet	10 (200%)	0 (0%)
	Above Normal	8 (80%)	0 (0%)
	Below Normal	11 (157%)	-3 (-14%)
	Dry	12 (171%)	-9 (-32%)
	Critical	8 (100%)	-5 (-24%)
	All	49 (132%)	-17 (-17%)
November	Wet	0 (NA)	-1 (-100%)
	Above Normal	3 (100%)	0 (0%)
	Below Normal	2 (200%)	-2 (-40%)
	Dry	10 (NA)	3 (43%)
	Critical	2 (NA)	-1 (-33%)
	All	17 (425%)	-1 (-5%)
December	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

NA = could not be calculated because the denominator was 0.

H4_ELT /HOS_ELT

Sacramento River

Mean flows in the Sacramento River between Keswick and upstream of RBDD under H4_ELT during the September through January spring-run Chinook salmon spawning and egg incubation period would generally be similar to flows under NAA_ELT, except during November (up to 20% lower, depending on water year type and location).

Shasta Reservoir storage at the end of September under H4_ELT would be similar to storage under NAA_ELT, except in critical water years (24% higher) (Table 11-4A-36).

Table 11-4A-36. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Baseline and H4_ELT Scenarios

Water Year Type	EXISTING CONDITIONS vs. H4_ELT	NAA_ELT vs. H4_ELT
Wet	-302 (-9.1%)	-5 (-0.2%)
Above Normal	-371 (-11.6%)	-7 (-0.3%)
Below Normal	-143 (-5%)	24 (0.9%)
Dry	-144 (-5.8%)	58 (2.6%)
Critical	36 (3%)	235 (23.7%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

The number of days when temperatures exceeded the analysis criterion (i.e., 56°F identified in Table 11-4A-13) by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September at Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period. The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4A-14. Differences between baselines and H4_ELT in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4A-20 for Bend Bridge and in Table 11-4A-37 for Red Bluff. At Bend Bridge, there would be 1 (17%) more years with an "orange" level of concern under H4_ELT. This difference would not be biologically meaningful to spring-run Chinook salmon spawners and eggs. At Red Bluff, there would be 6 (27%) fewer years with any of the three "levels of concern", indicating that water temperatures would be within an acceptable range more often under H4_ELT than under NAA_ELT.

Table 11-4A-37. Differences between Baseline and H3_ELT Scenarios in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Red Bluff, October through April

Level of Concern[a]	EXISTING CONDITIONS vs. H4_ELT	NAA_ELT vs. H4_ELT
Red	9 (75%)	0 (0%)
Orange	2 (33%)	-5 (-38%)
Yellow	12 (92%)	-1 (-4%)
None	-23 (-45%)	6 (27%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).
[a] For definitions of levels of concern, see Table 11-4A-14.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, there would be reductions under H4_ELT relative to NAA_ELT in the monthly total degree-days exceeding the 56°F threshold for all of the months (Table 11-4A-21). At Red Bluff, exceedances above the threshold under H4_ELT would be 9 degree-days (16%) higher than those under NAA_ELT for March, and lower or similar for the remaining months (Table 11-4A-38). On an absolute scale, the 9 degree-day increase during March, because it is the sum of differences in degree-days for March summed over the 82-year period, would not translate into a biologically meaningful effect on spring-run Chinook salmon.

Table 11-4A-38. Differences between Baseline and H3 Scenarios in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Red Bluff, October through April

Month	Water Year Type	EXISTING CONDITIONS vs. H4_ELT	NAA_ELT vs. H4_ELT
October	Wet	406 (158%)	-16 (-2%)
	Above Normal	191 (73%)	-6 (-1%)
	Below Normal	229 (110%)	-29 (-6%)
	Dry	286 (58%)	-88 (-10%)
	Critical	201 (34%)	-214 (-21%)
	All	1,313 (72%)	-353 (-10%)
November	Wet	7 (700%)	-1 (-11%)
	Above Normal	4 (NA)	1 (33%)
	Below Normal	1 (NA)	-1 (-50%)
	Dry	31 (388%)	-11 (-22%)
	Critical	13 (325%)	-5 (-23%)
	All	56 (431%)	-17 (-20%)
December	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
February	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
March	Wet	1 (NA)	0 (0%)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	10 (111%)	9 (90%)
	Dry	20 (143%)	0 (0%)
	Critical	11 (1,100%)	0 (0%)
	All	42 (175%)	9 (16%)
April	Wet	97 (84%)	0 (0%)
	Above Normal	68 (49%)	-4 (-2%)
	Below Normal	99 (125%)	5 (3%)
	Dry	118 (63%)	11 (4%)
	Critical	49 (408%)	7 (13%)
	All	431 (81%)	19 (2%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

Clear Creek

Flows in Clear Creek during the spring-run Chinook salmon spawning and egg incubation period (September through January) under H4_ELT would generally be similar to those under NAA_ELT (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Also, flows would generally be similar between H4_ELT and H3_ELT such that results of the redd dewatering analysis would be similar between H4_ELT and H3_ELT. Therefore, no analysis of redd dewatering risk was conducted for H4_ELT in Clear Creek. Due to similar flows between H4_ELT and H3_ELT, effects of H4_ELT on spring-run Chinook salmon spawning and egg incubation habitat in Clear Creek would not be different from effects of H3_ELT. Therefore, there would be no effects of H4_ELT on spring-run Chinook salmon spawning and egg incubation in Clear Creek relative to the NAA_ELT.

Feather River

Flows in the Feather River low-flow channel during the spring-run Chinook salmon spawning and egg incubation period (September through January) would be the same between NAA_ELT and H4_ELT (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Oroville Reservoir storage volume at the end of September under H4_ELT would generally be similar to storage under NAA_ELT in wet and above normal water years, slightly (9%) lower in below normal water years, and moderately to substantially higher in dry and critical years (28% to 44% higher), respectively) (Table 11-4A-39). Higher storage in drier water year types would generally benefit spring-run Chinook salmon spawning and egg incubation habitat.

Table 11-4A-39. Difference and Percent Difference in September Water Storage Volume (thousand acre-feet) in Oroville Reservoir for H4 Scenarios

Water Year Type	EXISTING CONDITIONS vs. H4_ELT	NAA vs. H4_ELT
Wet	-664 (-22.9%)	58 (2.6%)
Above Normal	-576 (-24.3%)	-20 (-1.1%)
Below Normal	-481 (-23.8%)	-156 (-9.2%)
Dry	74 (5.4%)	311 (27.7%)
Critical	310 (31.5%)	393 (43.5%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

Mean water temperatures in the low-flow channel would not differ between NAA_ELT and H4_ELT (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Increases in the percent of months exceeding the 56°F threshold between NAA_ELT and H4_ELT would occur during October and November, with up to 10% (absolute difference) more months exceeding the threshold under H4_ELT (Table 11-4A-40).

Table 11-4A-40. Differences between Baselines and H4_ELT Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 56°F Threshold, September through January

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H4_ELT					
September	0 (0%)	-1 (-1%)	4 (4%)	5 (7%)	-1 (-3%)
October	19 (83%)	20 (267%)	16 (260%)	15 (600%)	14 (550%)
November	17 (700%)	15 (1200%)	7 (600%)	4 (NA)	1 (NA)
December	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
NAA_ELT vs. H4_ELT					
September	0 (0%)	-1 (-1%)	-2 (-3%)	0 (0%)	-6 (-14%)
October	-9 (-18%)	4 (16%)	5 (29%)	6 (56%)	7 (86%)
November	10 (100%)	7 (86%)	4 (75%)	1 (50%)	0 (0%)
December	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
January	0 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

NA = could not be calculated because the denominator was 0.

Total degree-months of exceedance above the 56°F threshold under H4_ELT would be up to 48 degree-months greater than those under NAA_ELT for September through November (all water years combined) (Table 11-4A-41). An increase of 48 degree-months would not be biologically meaningful, given the 82-year period of analysis. The total degree-months of exceedance for the other months of the period would be similar between H4_ELT and NAA_ELT. Overall, effects of H4_ELT on spring-run Chinook salmon spawning and egg incubation habitat in the Feather River would generally be negligible or beneficial compared to the NAA_ELT.

Table 11-4A-41. Differences between Baseline Scenarios and H4_ELT Scenario in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Feather River above Thermalito Afterbay, September through April

Month	Water Year Type	EXISTING CONDITIONS vs. H4_ELT	NAA_ELT vs. H4_ELT
September	Wet	7 (6%)	16 (16%)
	Above Normal	10 (23%)	13 (33%)
	Below Normal	36 (60%)	31 (48%)
	Dry	27 (39%)	-2 (-2%)
	Critical	-6 (-9%)	-17 (-22%)
	All	74 (21%)	41 (11%)
October	Wet	35 (700%)	25 (167%)
	Above Normal	14 (140%)	6 (33%)
	Below Normal	24 (343%)	10 (48%)
	Dry	38 (543%)	17 (61%)
	Critical	3 (38%)	-10 (-48%)
	All	114 (308%)	48 (47%)
November	Wet	12 (NA)	11 (1,100%)
	Above Normal	6 (200%)	3 (50%)
	Below Normal	12 (1,200%)	8 (160%)
	Dry	15 (NA)	8 (114%)
	Critical	0 (NA)	-3 (-100%)
	All	45 (1,125%)	27 (123%)
December	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)
January	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	0 (NA)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	0 (NA)
	Critical	0 (NA)	0 (NA)
	All	0 (NA)	0 (NA)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

NA = could not be calculated because the denominator was 0.

NEPA Effects: Collectively, these modeling results indicate that the effect of Alternative 4A on spring-run Chinook salmon spawning and egg incubation conditions would not be adverse because the alternative does not substantially reduce the amount of suitable spawning and egg incubation habitat or substantially interfere with winter-run Chinook salmon spawning and egg incubation. There are no substantial changes to flows, cold water pool storage, or water temperatures that would cause a biologically meaningful negative effect to spring-run Chinook salmon spawners or eggs. Biological models including the Reclamation Egg Mortality Model and SacEFT also indicate that there would be no biologically meaningful effects.

CEQA Conclusion: Collectively, the results of the Impact AQUA-58 CEQA analysis show that the difference between the CEQA baseline and Alternative 4A could be significant because, when compared to the CEQA baseline, the alternative, including climate change, would substantially reduce the quantity and quality of spawning and egg incubation habitat for spring-run Chinook salmon relative to Existing Conditions. However, as further described below in the Summary of CEQA Conclusion, the comparison to the NAA_ELT is a better approach because it isolates the effects of the alternative from those of sea level rise, climate change, and future water demand. Based on this identification of the actual increment of change attributable to the alternative, Alternative 4A would not affect the quantity and quality of spawning and egg incubation habitat for spring-run Chinook salmon relative to the CEQA conclusion.

H3_ELT /ESO_ELT

Sacramento River

Flows in the Sacramento River between Keswick and upstream of Red Bluff were examined during the spring-run Chinook salmon spawning and incubation period (September through January). Mean flows under H3_ELT during October and November would be similar to or up to 20% lower than flows under Existing Conditions, depending on water year type and location. Mean flows under H3_ELT during September would be up to 24% lower and up to 34% higher than flows under Existing Conditions depending on water year type and location. And mean flows under H3_ELT during January and December would generally be similar to flows under Existing Conditions.

Shasta Reservoir mean storage volume at the end of September would be 7% to 11% lower under H3_ELT relative to Existing Conditions depending on water year type (Table 11-4A-27).

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the September through January spring-run Chinook salmon spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At Keswick, the mean monthly (all water years combined) temperatures under H3_ELT would be 6% greater for both September and October than those under Existing Conditions, but they would not be different for other months during the period. Differences by water year type were <10% except for September of critical water years (10.3% higher). At Bend Bridge, there would be no differences (<5%) in water temperatures between H3_ELT and Existing Conditions for all months and water year types during the period.

The number of days when temperatures exceeded the analysis criterion (i.e., 56°F identified in Table 11-4A-13) by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September at Bend Bridge and October through April at Red Bluff) and year of the 82-year modeling period. The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern," as defined in Table 11-4A-14. Differences between baselines and H3_ELT in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4A-15 for Bend Bridge and in Table 11-4A-28 for Red Bluff. At Bend Bridge, there would be a 55% increase in the number of years with a "red" level of concern under H3_ELT relative to Existing Conditions. At Red Bluff, there would be 83%, increases in the number of years for both "red" and "orange" levels of concern under H3_ELT relative to Existing Conditions, and a 108% increase for the "yellow" level of concern.

Total degree-days exceeding 56°F were summed by month and water year type at Bend Bridge during May through September and at Red Bluff during October through April. At Bend Bridge, total degree-days (all water years combined) under H3_ELT would be 60% to 114% higher than that under Existing Conditions depending on month throughout the period (Table 11-4A-16). At Red Bluff, total degree-days under H3_ELT would be 78% to 554% higher than those under Existing Conditions during October, November, March, and April, and similar during December through February (Table 11-4A-29).

The Reclamation egg mortality model predicts that spring-run Chinook salmon egg mortality in the Sacramento River under H3_ELT would be 25% to 134% greater than mortality under Existing Conditions depending on water year type (Table 11-4A-30).

SacEFT predicts that there would be a 21% relative decrease in the percentage of years with good spawning availability, measured as weighted usable area, under H3_ELT compared to Existing Conditions (Table 11-4A-31). SacEFT predicts that there would be no difference in the percentage of years with good (lower) redd scour risk under H3_ELT relative to Existing Conditions. SacEFT predicts that there would be a 33% relative decrease in the percentage of years with good (lower) egg incubation conditions under H3_ELT compared to Existing Conditions. SacEFT predicts that there would be a 20% relative decrease in the percentage of years with good (lower) redd dewatering risk under H3_ELT compared to Existing Conditions. These results indicate that spawning and egg incubation conditions for spring-run Chinook salmon under H3_ELT would be substantially lower relative to Existing Conditions. Spawning habitat consists of the appropriate depth, substrate, and water temperatures, among other variables. SacEFT indicates that depth, as a result of flow, and temperature conditions would be degraded under H3_ELT relative to Existing Conditions. However, it is not known whether spawning habitat is limiting to the spring-run Chinook salmon population in the Sacramento River, especially given the recent sharp decline in annual escapement estimates.

Clear Creek

Flows in Clear Creek were examined during the spring-run Chinook salmon spawning and egg incubation period (September through January). Mean flows under H3_ELT would generally be similar to flows under Existing Conditions, except for a 40% increase for January of wet years, a 19% decrease for September of critical years, and 10% increases for January and December of critical years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

The potential risk of spring-run Chinook salmon redd dewatering in Clear Creek was evaluated by comparing the magnitude of flow reduction each month during the incubation period to the flow in September when spawning is assumed to occur. The greatest reduction in flows under H3_ELT would be 41 cfs, 67 cfs, and 33 cfs lower (worse) than under Existing Conditions in above normal, dry, and critical years, respectively, and would be 53 cfs higher (better) than under Existing Conditions in below normal years (Table 11-4A-32).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River low-flow channel under H3_ELT are not different from Existing Conditions during the September through January spring-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flows in October through

January (800 cfs) would be equal to or greater than the spawning flows in September (773 cfs) for all model scenarios.

Oroville Reservoir mean storage volume at the end of September would be similar or up to 29% lower under H3_ELT relative to Existing Conditions, depending on water year type (Table 11-4A-33).

The potential risk of redd dewatering in the Feather River low-flow channel was evaluated by comparing the magnitude of flow reduction each month during the incubation period to the flow in September when spawning is assumed to occur. Minimum flows in the low-flow channel during October through January were identical between H3_ELT and Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effect of H3_ELT on redd dewatering in the Feather River low-flow channel.

Mean monthly water temperatures in the low-flow channel under H3_ELT would be no different (<5%) under H3_ELT relative to Existing Conditions during the September through January spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

Effects of H3_ELT on water temperature in the Feather River were analyzed by determining the percent of months between September and January over the 82-year CALSIM modeling period that exceed a 56°F temperature threshold in the low-flow channel (above Thermalito Afterbay) (Table 11-4A-34). In general, the percent of months exceeding the threshold under H3_ELT would be similar to or greater by up to 22% (absolute difference) than the percent under Existing Conditions. This comparison includes the effects of climate change.

The effects of H3_ELT on water temperature in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 56°F NMFS threshold during the September through January spring-run Chinook salmon spawning and egg incubation period for all 82 years (Table 11-4A-35). Total degree-months (all water years combined) would be 14% to 425% higher under H3_ELT relative to Existing Conditions for September through November and would be the identical for December and January. These comparisons include the effects of climate change.

H4_ELT /HOS_ELT

Sacramento River

Mean flows in the Sacramento River between Keswick and upstream of RBDD under H4_ELT during the September through January spring-run Chinook salmon spawning and egg incubation period would be up to 20% lower and 53% higher than flows under Existing conditions during September and would be generally similar or up to 19% lower than flows under Existing conditions during October through January.

Shasta Reservoir mean storage at the end of September under H4_ELT would be similar to or up to 12% lower than storage under Existing Conditions, depending on water year type (Table 11-4A-36).

Mean water temperatures in the Sacramento River under H4_ELT would not differ (<5%) from those under Existing Conditions for any month or water year type at both Keswick and Bend Bridge (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Clear Creek

Mean flows in Clear Creek during the spring-run Chinook salmon spawning and egg incubation period (September through January) under H4_ELT would generally be similar to those under Existing Conditions, except for a 40% increase for January of wet years (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effects of H4_ELT on spring-run Chinook salmon spawning and egg incubation in Clear Creek relative to Existing Conditions.

Feather River

Flows in the Feather River low-flow channel during the spring-run Chinook salmon spawning and egg incubation period (September through October) would be similar between Existing Conditions and H4_ELT (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Oroville Reservoir mean storage volume at the end of September under H4_ELT would be similar to or greater than storage under Existing Conditions in dry and critical water years (32% higher for critical year types) and about 24% lower in below normal, above normal and wet water years (Table 11-4A-39). Higher storage in drier water year types would generally benefit spring-run Chinook salmon spawning and rearing habitat.

Mean water temperatures in the low-flow channel would be up to no different (<5%) under H4_ELT relative to Existing Conditions during the September through January spawning and egg incubation period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

There would be an increased percent of months (up to 20% on an absolute scale) above the 56°F threshold under H4_ELT compared to Existing Conditions during September through November and no change in December and January (Table 11-4A-40).

The total number of degree-months (all water year types combined) exceeding the threshold under H4_ELT would be up to 1,125% higher than the number under Existing Conditions during September through November, but no there would be no differences during December and January (Table 11-4A-41).

Summary of CEQA Conclusion

Under Alternative 4A (including climate change effects), there are flow and storage reductions, as well as temperature increases in the Sacramento River that would lead to biologically meaningful increases in egg mortality and overall reduced habitat conditions for spawning spring-run and egg incubation, as compared to Existing Conditions. Flows in the Feather River low-flow channel do not differ between Alternative 4A and Existing Conditions. However, water temperature analyses in the Feather River low-flow channel using thresholds developed in coordination with NMFS indicate that there would be moderate to large negative effects on temperature conditions during spring-run Chinook salmon spawning and egg incubation.

Contrary to the NEPA conclusion set forth above, these modeling results indicate that the difference between Existing Conditions and Alternative 4A could be significant because the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of spring-run as a result of egg mortality.

As discussed in Section 11.3.3, because of differences between the CEQA and NEPA baselines, it is sometimes possible for CEQA and NEPA significance conclusions to vary between one another under the same impact discussion. The baseline for the CEQA analysis is Existing Conditions at the time the NOP was prepared. Both the action alternative and the NEPA baseline (NAA_ELT) models anticipated future conditions that would occur at 2025 (ELT implementation period), including the projected effects of climate change (precipitation patterns), sea level rise and future water demands, as well as implementation of required actions under the 2008 USFWS BiOp and the 2009 NMFS BiOp. Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change, and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment. The comparison to the NAA_ELT is a better approach because it isolates the effect of the alternative from those of sea level rise, climate change, and future water demands.

When compared to NAA_ELT and informed by the NEPA analysis above, flows, reservoir storage, and water temperatures in the Sacramento River would be similar between NAA_ELT and Alternative 4A. There would be no effects of Alternative 4A on spawning and egg incubation conditions in Clear Creek, and small beneficial or no effects on flows, reservoir storage, and water temperatures in the Feather River. These modeling results represent the increment of change attributable to the alternative, demonstrating the similarities in flows, reservoir storage, and water temperature under Alternative 4A and the NAA_ELT, and addressing the limitations of the CEQA baseline (Existing Conditions). Therefore, this impact is found to be less than significant and no mitigation is required.

Impact AQUA-59: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Spring-Run ESU)

In general, Alternative 4A would not affect the quantity and quality of rearing habitat for fry and juvenile spring-run Chinook salmon relative to the NAA_ELT.

H3_ELT /ESO_ELT

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). At Keswick, mean flows under H3_ELT would be up to 23% lower during November than under NAA_ELT and would generally be similar in the remaining months. Upstream of Red Bluff, mean flows under H3_ELT would be up to 18% lower during November than under NAA_ELT and similar in the remaining months. These results indicate that there would be very few reductions in flows due to H3_ELT in the Sacramento River.

As reported in Impact AQUA-40, May Shasta mean storage volume under H3_ELT would be similar to storage under NAA_ELT for all water year types (Table 11-4A-12), so there would be no biologically meaningful effects on downstream flows.

As reported in Impact AQUA-58, September Shasta mean storage volume under H3_ELT would generally be similar to storage under NAA_ELT in all water year types (Table 11-4A-27).

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the November through March spring-run Chinook salmon juvenile rearing period (Appendix

11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between NAA_ELT and H3_ELT in any month or water year type throughout the period at either location except for a 7% increase for August in critical years at Keswick.

SacEFT predicts that the percentage of years with good juvenile rearing WUA conditions under H3_ELT would be 12% greater than that under NAA_ELT (Table 11-4A-31) and predicts no difference in the percentage of years with good (lower) juvenile stranding risk conditions under H3_ELT. On an absolute scale, juvenile rearing WUA increase in only 3% of years, which would not have a biologically meaningful effect on spring-run Chinook salmon.

SALMOD predicts that spring-run smolt equivalent habitat-related mortality would be similar to (<5% different from) NAA_ELT.

Clear Creek

Mean flows in Clear Creek during the November through March rearing period under H3_ELT would be similar to flows under NAA_ELT (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) during November through June were reviewed to determine flow-related effects on larval and juvenile spring-run rearing period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Relatively constant flows in the low-flow channel throughout this period under H3_ELT would not differ from those under NAA_ELT. In the high-flow channel, mean flows under H3_ELT would generally be similar to or greater than flows under NAA_ELT for February through June (by up to 106% greater for June, above normal years). For November through January, flows would generally be similar to those under NAA_ELT, with minor exceptions.

May Oroville mean storage volume under H3_ELT would be similar to storage under NAA_ELT for all water year types (Table 11-4A-42).

As reported in Impact AQUA-58, September Oroville mean storage volume under H3_ELT would be similar to volume under NAA_ELT in wet, above normal, and below normal water years and 12% to 15% greater than volume under NAA_ELT during dry and critical water years (Table 11-4A-33). Consequently, there would be minimal effects on downstream flows.

Table 11-4A-42. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Alternative 4A (Model Scenario H3_ELT)

Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Wet	-21 (-1%)	-2 (-0.05%)
Above Normal	-111 (-3%)	-52 (-2%)
Below Normal	-162 (-5%)	3 (0.1%)
Dry	-332 (-12%)	18 (1%)
Critical	-157 (-9%)	-17 (-1%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

Mean water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between NAA_ELT and H3_ELT in any month or water year type throughout the period at either location.

The percent of months exceeding the 63°F temperature threshold in the Feather River above Thermalito Afterbay (low-flow channel) was evaluated during May and June (Table 11-4A-43). Although spring-run typically rear in the Feather River from November through June, NMFS requested that these months be evaluated to be consistent with water temperature targets set during the Oroville Dam FERC relicensing process, and evaluated in the NMFS (2009) Draft BiOp on the Oroville Dam project. As indicated in Table 11-4A-13, this criterion applies to both spring-run Chinook salmon and steelhead rearing. Therefore, the months of interest to spring-run Chinook salmon here are May and June only. The steelhead analysis below includes the remaining months. In general, differences in the percent of months exceeding the threshold between NAA_ELT and H3_ELT would be negligible (<5% on an absolute scale), although there are some small (up to 9% on an absolute scale) decreases in percent of months exceeding the threshold during June and August, depending on the degrees above the threshold.

Table 11-4A-43. Differences between Baseline and H3_ELT Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 63°F Threshold, May through August

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H3_ELT					
May	4 (NA)	2 (NA)	0 (NA)	0 (NA)	0 (NA)
June	20 (36%)	20 (73%)	15 (300%)	4 (NA)	0 (NA)
July	0 (0%)	0 (0%)	1 (1%)	26 (36%)	36 (91%)
August	0 (0%)	11 (13%)	27 (47%)	26 (91%)	26 (263%)
NAA_ELT vs. H3_ELT					
May	0 (0%)	1 (100%)	0 (NA)	0 (NA)	0 (NA)
June	-4 (-5%)	-7 (-14%)	-9 (-30%)	0 (0%)	0 (NA)
July	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)
August	0 (0%)	0 (0%)	5 (6%)	0 (0%)	6 (21%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

NA = could not be calculated because the denominator was 0.

The effects of H3_ELT on water temperature-related juvenile rearing conditions for spring-run Chinook salmon in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 63°F NMFS threshold during May and June for all 82 years (Table 11-4A-44). As discussed above, although this table includes results through August, only May and June results apply to spring-run Chinook salmon. The steelhead analysis below includes the remaining months. Combining all water year types, there would be little difference in total degree-months (<5 degree-months) exceeded between NAA_ELT and H3_ELT during May and a (16 degree-month reduction (12% lower) during June). There would be small decreases (up to 6 degree-months) for the different water year types in June.

Table 11-4A-44. Differences between Baseline and H3_ELT Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 63°F in the Feather River above Thermalito Afterbay, May through August

Month	Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
May	Wet	0 (NA)	0 (NA)
	Above Normal	1 (NA)	0 (0%)
	Below Normal	0 (NA)	0 (NA)
	Dry	2 (NA)	1 (100%)
	Critical	2 (NA)	0 (0%)
	All	5 (NA)	1 (25%)
June	Wet	11 (73%)	-6 (-19%)
	Above Normal	6 (43%)	-2 (-9%)
	Below Normal	7 (54%)	-6 (-23%)
	Dry	13 (57%)	-2 (-5%)
	Critical	10 (167%)	0 (0%)
	All	47 (66%)	-16 (-12%)
July	Wet	24 (20%)	1 (1%)
	Above Normal	9 (20%)	-1 (-2%)
	Below Normal	15 (25%)	0 (0%)
	Dry	19 (27%)	0 (0%)
	Critical	22 (42%)	4 (6%)
	All	89 (26%)	4 (1%)
August	Wet	17 (19%)	7 (7%)
	Above Normal	9 (36%)	2 (6%)
	Below Normal	15 (39%)	1 (2%)
	Dry	28 (70%)	4 (6%)
	Critical	14 (33%)	-6 (-10%)
	All	83 (35%)	8 (3%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).
NA = could not be calculated because the denominator was 0.

H4_ELT/HOS_ELT

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H4_ELT would be up to 20% lower than flows under NAA_ELT during November and would generally be similar to flows under NAA_ELT in remaining months and water year types of the period.

September Shasta mean storage volume under H4_ELT would be similar to September storage volume under NAA_ELT in all years except critical, in which storage would be 24% greater under H4_ELT (Table 11-4A-36).

Mean monthly water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA_ELT and H4_ELT in any month or water year type throughout the period at either location.

Clear Creek

Mean flows in Clear Creek during the November through March rearing period under H4_ELT would generally be similar to flows under NAA_ELT (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, effects of H4_ELT regarding larval and juvenile spring-run Chinook salmon rearing habitat in Clear Creek would be similar to those under NAA_ELT.

Feather River

Flows in the Feather River low-flow channel during November through June would not differ between NAA_ELT and H4_ELT (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows in the high-flow channel during the November through June juvenile rearing period under H4_ELT would generally be similar to or greater than flows under NAA_ELT for February through June (by up to 548% greater for April, below normal years). For November through January, flows would generally be similar to those under NAA_ELT, with a few exceptions.

May Oroville mean storage under H4_ELT would be 11% to 16% lower than storage under NAA_ELT in wet, above normal, and below normal water years, similar in dry water years, and 24% greater in critical water years (Table 11-4A-45). September Oroville storage under H4_ELT would be similar to storage under NAA_ELT in wet, above normal, and below normal years, but 28% and 44% higher in dry and critical years, respectively (Table 11-4A-39).

Table 11-4A-45. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Oroville Reservoir for Baseline and H4_ELT Scenarios

Water Year Type	EXISTING CONDITIONS vs. H4_ELT	NAA_ELT vs. H4_ELT
Wet	-399 (-11%)	379 (-11%)
Above Normal	-613 (-18%)	-553 (-16%)
Below Normal	-613 (-19%)	-448 (-15%)
Dry	-331 (-12%)	19 (1%)
Critical	267 (15%)	407 (24%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA_ELT and H4_ELT in any month or water year type throughout the period at either location.

Differences in the percent of months exceeding the 63°F threshold between NAA_ELT and H4_ELT would be negligible (<5% on an absolute scale) for May and 1% to 14% lower (absolute difference) for June (Table 11-4A-46). This represents a small benefit of H4_ELT on spring-run spawning habitat conditions in the Feather River.

Table 11-4A-46. Differences between Baseline and H4 Scenarios in Percent of Months during the 82-Year CALSIM Modeling Period during Which Water Temperatures in the Feather River above Thermalito Afterbay Exceed the 63°F Threshold, May through August

	Degrees Above Threshold				
Month	>1.0	>2.0	>3.0	>4.0	>5.0
EXISTING CONDITIONS vs. H4_ELT					
May	2 (NA)	0 (NA)	0 (NA)	0 (NA)	0 (NA)
June	10 (18%)	17 (64%)	11 (225%)	2 (NA)	0 (NA)
July	0 (0%)	0 (0%)	0 (0%)	21 (29%)	28 (72%)
August	0 (0%)	11 (13%)	22 (38%)	22 (78%)	12 (125%)
NAA_ELT vs. H4_ELT					
May	-1 (-33%)	-1 (-100%)	0 (NA)	0 (NA)	0 (NA)
June	-14 (-17%)	-10 (-18%)	-12 (-43%)	-1 (-33%)	0 (NA)
July	0 (0%)	0 (0%)	-1 (-1%)	-5 (-5%)	-6 (-8%)
August	0 (0%)	0 (0%)	0 (0%)	-4 (-7%)	-7 (-25%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).
NA = could not be calculated because the denominator was 0.

Combining all water year types, total degree-months above the 63°F threshold under H4_ELT would be similar (<5 degree-months difference) to those under NAA_ELT for May, but 131 degree-months lower for June, (Table 11-4A-47). This represents a small benefit of H4_ELT on spring-run spawning habitat conditions in the Feather River.

Table 11-4A-Table 11-4A-47. Differences between Baseline and H4 Scenarios in Total Degree-Months (°F-Months) by Month and Water Year Type for Water Temperature Exceedances above 63°F in the Feather River above Thermalito Afterbay, May through August

Month	Water Year Type	EXISTING CONDITIONS vs. H4_ELT	NAA_ELT vs. H4_ELT
May	Wet	0 (NA)	0 (NA)
	Above Normal	0 (NA)	-1 (-100%)
	Below Normal	0 (NA)	0 (NA)
	Dry	0 (NA)	-1 (-100%)
	Critical	0 (NA)	-2 (-100%)
	All	0 (NA)	-4 (-100%)
June	Wet	-15 (-100%)	-32 (-100%)
	Above Normal	-14 (-100%)	-22 (-100%)
	Below Normal	-13 (-100%)	-26 (-100%)
	Dry	-22 (-96%)	-37 (-97%)
	Critical	-4 (-67%)	-14 (-88%)
	All	-68 (-96%)	-131 (-98%)
July	Wet	-85 (-71%)	-108 (-76%)
	Above Normal	-22 (-50%)	-32 (-59%)
	Below Normal	-35 (-59%)	-50 (-68%)
	Dry	-34 (-48%)	-53 (-59%)
	Critical	-36 (-69%)	-54 (-77%)
	All	-213 (-62%)	-298 (-69%)
August	Wet	56 (63%)	46 (46%)
	Above Normal	32 (128%)	25 (78%)
	Below Normal	38 (100%)	24 (46%)
	Dry	54 (135%)	30 (47%)
	Critical	31 (74%)	11 (18%)
	All	210 (90%)	135 (44%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).
NA = could not be calculated because the denominator was 0.

NEPA Effects: Collectively, these modeling results indicate that the effect is not adverse because rearing habitat conditions would not be substantially reduced. Both SacEFT and SALMOD predicts no substantial effects on spring-run rearing habitat in the Sacramento River. In the Feather River, habitat conditions would improve under Alternative 4A relative to the NAA_ELT, particularly in the H4 scenario. There would be no effects on spring-run Chinook salmon rearing in Clear Creek.

CEQA Conclusion: In general, Alternative 4A could reduce the quantity and quality of rearing habitat for spring-run Chinook salmon relative to Existing Conditions. However, as further described below in the Summary of CEQA Conclusion, reviewing the alternative's impacts in relation to the NAA_ELT is a better approach because it isolates the effect of the alternative from those of sea level rise, climate change, and future water demand. Informed by the NAA_ELT comparison, Alternative 4A would not affect the quantity and quality of rearing habitat for spring-run Chinook salmon relative to the CEQA baseline.

H3_ELT /ESO_ELT

Sacramento River

Flows were evaluated during the November through March larval and juvenile spring-run Chinook salmon rearing period in the Sacramento River between Keswick Dam and just upstream of Red Bluff (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). At Keswick, mean flows under H3_ELT would be up to 14% greater during February, up to 18% lower during November, and similar in the remaining three months. Upstream of Red Bluff, mean flows under H3_ELT would generally be similar to those under Existing Conditions throughout the period. These results indicate that there would be very little reduction in flows due to H3_ELT in the Sacramento River.

As reported in Impact AQUA-40, Shasta Reservoir mean storage volume at the end of May under H3_ELT would be similar to volume under Existing Conditions for all water years types (Table 11-4A-19). As reported in AQUA-58, Shasta Reservoir storage volume at the end of September under H3_ELT would be up to 11% lower relative to Existing Conditions (Table 11-4A-27).

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both sites, mean water temperature under H3_ELT would be similar to (<5%) those under Existing Conditions in all months except for July through October at Keswick, in which temperatures in critical years would be 14% higher for August, 10% higher for September, and 9% higher for July under H3_ELT. Temperatures in the other year types in July through October would be up to 8% higher under H3_ELT.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under H3_ELT would be 27% higher than under Existing Conditions (Table 11-4A-31). In addition, the percentage of years with good (low) juvenile stranding risk under H3_ELT is predicted to be 5% higher than under Existing Conditions. This indicates that the quantity and quality of juvenile rearing habitat in the Sacramento River would be higher under H3_ELT relative to Existing Conditions.

SALMOD predicts that spring-run smolt equivalent habitat-related mortality under H3_ELT would be 9% lower than under Existing Conditions.

Clear Creek

Flows in Clear Creek during the November through March rearing period under H3_ELT would generally be similar to flows under Existing Conditions, except during January and February of wet year types, in which flows would be 40% and 13% greater, respectively (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Relatively constant flows in the low-flow channel throughout the November through June rearing period under H3_ELT would not differ from those under Existing Conditions. In the high-flow channel, flows under H3_ELT during January through March, November, and December would be up to 48% lower than flows under Existing Conditions, and during April through June would be up to 140% greater than flows under Existing Conditions.

May Oroville mean storage volume under H3_ELT would be 12% lower than volume under Existing Conditions in dry year types and generally similar to volume under Existing Conditions in other water year types (Table 11-4A-42).

As reported in Impact AQUA-58, September Oroville mean storage volume under H3_ELT would be similar to or up to 29% lower than storage volume under Existing Conditions depending on water year type (Table 11-4A-33).

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). In the low-flow channel, mean water temperatures under H3_ELT would be similar (<5%) for all months and water year types. In the high-flow channel, mean water temperatures under H3_ELT would be similar for all months and water years types except July of critical years (6.5% higher) and August of dry years (5.3% higher).

Effects of H3_ELT on water temperature-related effects on spring-run Chinook salmon juvenile rearing conditions in the Feather River were analyzed by comparing the percent of months during May and June over the 82-year CALSIM modeling period that exceed a 63°F temperature threshold in the low-flow channel (above Thermalito Afterbay) (Table 11-4A-43). Although spring-run typically rear in the Feather River from November through June, NMFS requested that these months be evaluated to be consistent with water temperature targets set during the Oroville Dam FERC relicensing process, and evaluated in the NMFS (2009) Draft BiOp on the Oroville Dam project. As indicated in Table 11-4A-13, this criterion applies to both spring-run Chinook salmon and steelhead rearing. Therefore, the months of interest to spring-run Chinook salmon here are May and June only. The steelhead analysis below includes the remaining months. In general, the percent of months exceeding the threshold under H3_ELT would be similar or up to 20% greater (absolute difference) than those under Existing Conditions. This comparison includes the effects of climate change.

The effects of H3_ELT on water temperature-related juvenile rearing conditions for spring-run Chinook salmon in the Feather River were also analyzed by comparing the total degree-months for months that exceed the 63°F NMFS threshold during May through August for all 82 years (Table 11-4A-44). As discussed above, although this table includes results through August, only May and June results apply to spring-run Chinook salmon. The steelhead analysis below includes the remaining months. Combining all water year types, there would be a very small difference (5 degree-months) between Existing Conditions and H3_ELT during May, but 47 degree-month increases for June. These comparisons include the effects of climate change.

H4_ELT/HOS_ELT

Sacramento River

Mean flows in the Sacramento River between Keswick and upstream of RBDD under H4_ELT during the September through January spring-run Chinook salmon spawning and egg incubation period would generally be similar to or slightly lower than flows under Existing Conditions during January and October through December, and would be up to 20% lower and 53% higher in September. September mean Shasta storage volume under H4_ELT would be similar to or up to 12% lower than storage volume under Existing Conditions (Table 11-4A-36).

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the year-round spring-run Chinook salmon juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both locations, there would be no differences (<5%) in mean water temperature between Existing Conditions and H4_ELT in any month or water year type.

Clear Creek

Flows in Clear Creek during the November through March rearing period under H4_ELT would generally be similar to or up to 40% higher than flows under Existing Conditions. Therefore, effect of H4_ELT regarding larval and juvenile spring-run Chinook salmon rearing habitat in Clear Creek would be similar to or beneficial relative to Existing Conditions.

Feather River

Flows in the Feather River low-flow channel during November through June would not differ between Existing Conditions and H4_ELT (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). In the high-flow channel, mean flows under H4_ELT would be up to 36% lower than flows under Existing Conditions during November through March and up to 509% greater than flows under Existing Conditions during April through June.

May Oroville mean storage volume under H4_ELT would be 11% to 19% lower relative to Existing Conditions except in critical water years, in which storage would be 15% greater (Table 11-4A-45). September Oroville mean storage under H4_ELT would be similar to storage under Existing Conditions in dry water years, 32% greater in critical water years, and about 24% lower in wet, above normal, and below normal water years (Table 11-4A-39).

Mean monthly water temperatures in the Feather River both above (low-flow channel) and at Thermalito Afterbay (high-flow channel) were evaluated during November through June (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). At both locations, mean water temperatures under H4_ELT would be no different (<5%) as temperatures under Existing Conditions for all months and water year types.

Differences in the percent of months exceeding the 63°F threshold between Existing Conditions and H4_ELT would be negligible (<5% on an absolute scale) during May and between 0% and 17% (absolute difference) higher under H4_ELT during June (Table 11-4A-46). These comparisons include the effects of climate change.

Combining all water year types, total degree-months above the 63°F threshold under H4_ELT would be the same as those under Existing Conditions during May, but 68 and 213 degree-months lower than those under Existing Conditions for June and July, and 210 degree-months higher for August (Table 11-4A-47). Changes by water year type are the same direction (positive or negative) as the differences of the months that combined the water year types. These comparisons include the effects of climate change.

Summary of CEQA Conclusion

Under Alternative 4A, there would be small to moderate flow reductions and temperature increases in the Feather River. SacEFT predicts improvements to spawning habitat availability for spring-run Chinook salmon in the Sacramento River under Alternative 4A and SALMOD predict slightly reduced habitat conditions. Exceedances above NMFS temperature thresholds would be higher under

Alternative 4A relative to Existing Conditions. Results would be similar among model scenarios. Contrary to the NEPA conclusion set forth above, these modeling results indicate that the difference between Existing Conditions and Alternative 4A could be significant because the alternative could substantially reduce rearing habitat and substantially reduce the number of spring-run Chinook salmon as a result of fry and juvenile mortality.

However, this interpretation of the biological modeling results is likely attributable to different modeling assumptions for four factors: sea level rise, climate change, future water demands, and implementation of the alternative. As discussed in Section 11.3.3, because of differences between the CEQA and NEPA baselines, it is sometimes possible for CEQA and NEPA significance conclusions to vary between one another under the same impact discussion. The baseline for the CEQA analysis is Existing Conditions at the time the NOP was prepared. Both the action alternative and the NEPA baseline (NAA_ELT) models anticipated future conditions that would occur at 2025 (ELT implementation period), including the projected effects of climate change (precipitation patterns), sea level rise and future water demands, as well as implementation of required actions under the 2008 USFWS BiOp and the 2009 NMFS BiOp. Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change, and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment. This suggests that the comparison of the results between the alternative and NAA_ELT is a better approach because it isolates the effect of the alternative from those of sea level rise, climate change, and future water demands.

When compared to NAA_ELT and informed by the NEPA analysis above, effects of Alternative 4A on flows, reservoir storage, and water temperatures during the months and locations analyzed would be minimal. These modeling results represent the increment of change attributable to the alternative, demonstrating the similarities in flows and water temperatures under Alternative 4A and the NAA_ELT, and addressing the limitations of the CEQA baseline (Existing Conditions). Therefore, this impact would be less than significant and no mitigation is required.

Impact AQUA-60: Effects of Water Operations on Migration Conditions for Chinook Salmon (Spring-Run ESU)

In general, the effects of Alternative 4A on spring-run Chinook salmon migration conditions relative to the NAA_ELT are not adverse.

Upstream of the Delta

H3_ELT/ESO_ELT

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were evaluated during the December through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H3_ELT would generally be similar to flows under NAA_ELT during this period.

Mean water temperatures in the Sacramento River at Red Bluff were examined during the December through May juvenile Chinook salmon spring-run emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).

There would be no differences (<5%) in mean water temperature between Existing Conditions and H3_ELT in any month or water year type.

Flows in the Sacramento River upstream of Red Bluff were evaluated during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H3_ELT would generally be similar to flows under NAA_ELT during this Mean monthly water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between NAA_ELT and H3_ELT in any month or water year type throughout the period.

Mean Shasta Reservoir storage at the end of September under H3_ELT would be similar to storage under NAA_ELT (Table 11-4A-36).

Clear Creek

Mean flows in Clear Creek during the November through May juvenile Chinook salmon spring-run migration period under H3_ELT would be similar to flows under NAA_ELT throughout the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean flows in Clear Creek during the April through August adult spring-run Chinook salmon upstream migration period under H3_ELT would generally be similar to flows under NAA_ELT, with minor exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H3_ELT would generally be similar to flows under NAA_ELT in all months and water year types of the period, with minor exceptions.

Mean water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between NAA_ELT and H3_ELT in any month or water year type throughout the period.

Flows in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H3_ELT would be up to 50% lower than flows under NAA_ELT during July and August, up to 77% greater than flows under NAA_ELT during June, and generally similar to flows under NAA_ELT during April and May. Although these flow reductions would be of moderate to large magnitude, flows under H3_ELT during these months would generally exceed flows suggested by NMFS during the Alternative 4a planning process at similar or greater frequencies as those under NAA_ELT (Table 11-4A-48).

Therefore, these reduced flows would not affect spring-run Chinook salmon in a biologically meaningful way.

Table 11-4A-48. Differences (Percentage Differences) in the Percentage of Years Exceeding NMFS Suggested Minimum Flows in the Feather River High-Flow Channel (at Thermalito)

	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Above Normal Water Year Type		
October	0 (0%)	0 (0%)
November	0 (0%)	0 (0%)
December	9 (50%)	-9 (-25%)
January	-18 (-40%)	9 (50%)
February	9 (14%)	9 (14%)
March	9 (25%)	0 (0%)
April	0 (NA)	0 (NA)
May	9 (100%)	9 (100%)
June	9 (13%)	0 (0%)
July	0 (0%)	0 (0%)
August	9 (10%)	0 (0%)
September	36 (57%)	0 (0%)
Below Normal Water Year Type		
October	-15 (-18%)	0 (0%)
November	-8 (-10%)	0 (0%)
December	-7 (-25%)	0 (0%)
January	-36 (-83%)	0 (0%)
February	-14 (-33%)	7 (34%)
March	-14 (-67%)	0 (0%)
April	0 (NA)	0 (NA)
May	0 (NA)	0 (NA)
June	21 (33%)	14 (20%)
July	0 (0%)	0 (0%)
August	0 (0%)	0 (0%)
September	-29 (-36%)	-50 (-50%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).
NA = could not be calculated because the denominator was 0.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA_ELT and H3_ELT in any month or water year type throughout the period.

H4_ELT /HOS_ELT

Sacramento River

Mean flows under H4_ELT in the Sacramento River upstream of Red Bluff during the December through May juvenile spring-run Chinook salmon migration period would be similar to flows under NAA_ELT for all months and water year types of the period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H4_ELT during the April through August adult upstream migration period would also be similar to flows under NAA_ELT.

September Shasta storage volume under H4_ELT would be similar to storage volume under NAA_ELT except in critical water years, in which it would be 24% greater under H4_ELT (Table 11-4A-36).

Mean water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between NAA_ELT and H4_ELT in any month or water year type throughout the period.

Clear Creek

Mean flows under H4_ELT in Clear Creek during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period would generally be similar to flows under NAA_ELT (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be no effects of H4_ELT on juvenile or adult spring-run Chinook salmon migration in Clear Creek relative to NAA_ELT.

Feather River

Flows under H4_ELT were evaluated in the Feather River at the confluence with the Sacramento River during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H4_ELT during November through March would generally be similar to flows under NAA_ELT, but would be up to 119% greater during April and May. Flows during July and August would be consistently lower than flows under NAA_ELT (up to 42% lower in August of wet years), although 42% greater in critical years during August. Flows during April through June would be similar to or up to 119% greater than flows under NAA_ELT. Flows under H4_ELT during these months would generally exceed flows suggested by NMFS during the Alternative 4a planning process at similar frequencies as those under NAA_ELT (Table 11-4A-49). Therefore, these reduced flows would not affect spring-run Chinook salmon in a biologically meaningful way.

Table 11-4A-49. Differences (Percentage Differences) in the Percentage of Years Exceeding NMFS Suggested Minimum Flows in the Feather River High-Flow Channel (at Thermalito) between Baseline and H4 Model Scenarios

	EXISTING CONDITIONS vs. H4_ELT	NAA_ELT vs. H4_ELT
Above Normal Water Year Type		
October	9.1 (12.5%)	9.1 (12.5%)
November	0 (0%)	0 (0%)
December	9.1 (50%)	-9.1 (-25%)
January	-18.2 (-40%)	9.1 (50%)
February	0 (0%)	0 (0%)
March	0 (0%)	-9.1 (-20%)
April	27.3 (NA)	27.3 (NA)
May	36.4 (400%)	36.4 (400%)
June	0 (0%)	-9.1 (-11.1%)
July	-9.1 (-9.1%)	-9.1 (-9.1%)
August	-18.2 (-20%)	-27.3 (-27.3%)
September	18.2 (28.6%)	-18.2 (-18.2%)
Below Normal Water Year Type		
October	-7.7 (-9.1%)	7.7 (11.1%)
November	0 (0%)	7.7 (11.1%)
December	0 (0%)	7.2 (33.6%)
January	-35.8 (-83.4%)	0 (0%)
February	0 (0%)	21.5 (100.5%)
March	0 (0%)	14.3 (201.4%)
April	42.9 (NA)	42.9 (NA)
May	35.7 (NA)	35.7 (NA)
June	14.3 (22.2%)	7.2 (10.1%)
July	-7.1 (-7.1%)	-7.1 (-7.1%)
August	-21.4 (-21.4%)	-21.4 (-21.4%)
September	-50 (-63.6%)	-71.4 (-71.4%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

NA = could not be calculated because the denominator was 0.

Mean water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between NAA_ELT and H4_ELT in any month or water year type throughout the period.

Through-Delta

Juveniles

Scenario H3_ELT operations would reduce OMR reverse flows (Appendix B, *Supplemental Modeling for Alternative 4A,* Section B.7), with a corresponding increase in net positive downstream flows, during the outmigration period of spring-run Chinook salmon through the interior Delta channels. Conditions under Scenario H3_ELT would result in slightly decreased overall average OMR flows in April and May relative to NAA_ELT, however overall average flows during these months would still be net positive (flowing towards the sea) because of relatively high average positive flows in wet water years, with negative mean negative flows in drier years of no less than around -1,500 cfs. OMR flows under Scenario H4_ELT would generally be improved compared to NAA_ELT conditions during all water year types throughout the migration period, or similar in April and May. These improved net positive downstream flows would be substantial benefits of the proposed operations.

Flows downstream of the north Delta intakes would be reduced, which may increase predation potential. During the juvenile spring-run Chinook salmon emigration period (December through May), mean monthly flows under Scenario H3_ELT in the Sacramento River below the NDD would be lower (13% to 22% reduced in monthly mean across years) compared to NAA_ELT. Mean flows by water-year type range from 2% lower in December of critical years up to 30% lower in April of above normal years. Under the high spring outflow Scenario, H4_ELT, mean flows during April and May would not decrease as much compared to NAA_ELT (4% to 9% lower under H4_ELT, compared to 18-22% lower under H3_ELT). As noted for winter-run Chinook salmon under the discussion of Impact AQUA-42, the modeling of NAA_ELT does not account for any flow entering the Yolo Bypass because of Fremont Weir modifications that would occur separately from Alternative 4A (but which are included in the modeling of H3_ELT and H4_ELT; see also section 4.1.1.3 of Section 4); this would slightly decrease the amount of water in the Sacramento River under NAA_ELT, so the above comparison of H3_ELT vs. NAA_ELT is conservative. Alternative 4A includes real-time biological and hydrological triggers developed by NMFS and DFW to adjust NDD operations to protect migrating salmonids above and beyond the operational criteria for NDD. Additional detail is provided in Chapter 3 Section 3.6.4.2.

As described above under *Predation Associated with Entrainment*, the three North Delta intake facilities proposed on the Sacramento River under Alternative 4A would attract predatory fish to the structure. Potential predation at the three North Delta intakes was estimated in two ways. As noted in Alternative 4, bioenergetics modeling with a median predator density predicts a predation loss of about 8,000 juveniles, or 0.2% of the spring-run juvenile population under Alternative 4A (Table 11-4A-26). In addition, the three intake structures and associated permanent bankline modifications would result in a permanent loss of up to 13.7 acres of aquatic habitat and the permanent modification of 2.6 miles of shoreline. A conservative assumption of 5% loss per intake would yield a cumulative loss of about 12% of juvenile spring-run Chinook salmon that reach the north Delta. This assumption is uncertain and represents an upper bound estimate. For a discussion of this topic see Impact AQUA-42 for Alternative 1A and additional discussion under Impact AQUA-42 of Alternative 4A for winter-run Chinook salmon.

As estimated by the Delta Passage Model, through-Delta survival under Scenario H3_ELT by juvenile spring-run Chinook salmon averaged 29% across all years, ranging from about 23% in drier years to 38% in wetter years (Table 11-4A-51). Scenario H3_ELT survival was slightly lower than NAA_ELT in both drier years (1.1% less survival, or 4.5% less in relative difference) and wetter years (3.1%

reduced survival, or 7.4% less in relative difference) (Table 11-4A-51). These results are based on operations that do not assume any adjustments made in real time to response to actual presence of fish.

Average survival under Scenario H4_ELT (high outflow) was 30.6%, compared to 30.7% for NAA_ELT. In wetter years, Scenario H4 had 1.7% greater survival, a 4% relative difference compared to NAA_ELT. This difference was driven by appreciably higher survival in wetter years (the above-normal year of 1980 and the wet year of 1984) as a result of greater outflow under Scenario H4_ELT. However, as noted for winter-run Chinook salmon in the discussion of Impact AQUA-42, the DPM modeling results do not account for the inclusion of Yolo Bypass improvements in NAA_ELT. Applying the same modification to NAA_ELT outputs as described in the discussion of Impact AQUA-42 resulted in the relative difference between NAA_ELT and H3_ELT/H4_ELT increasing: for H3_ELT, the relative difference across all years increased from 6% less compared to NAA_ELT to nearly 8% less compared to NAA_ELT (mod.); whereas for H4_ELT, the relative difference across all years increased from 0.3% less compared to NAA_ELT to 2.4% less compared to NAA_ELT (mod.) (Table 11-4A-51).

Table 11-4A-51. Through-Delta Survival (%) of Emigrating Juvenile Spring-Run Chinook Salmon under Alternative 4A (Scenarios H3_ELT and H4_ELT)

	Average Percentage Survival					Difference in Percentage Survival (Relative Difference)					
	Scenario					EXISTING CONDITIONS vs. Alt 4A Scenario		NAA_ELT vs. Alt 4A Scenario			
Water Year Type	EXISTING CONDITIONS	NAA_ ELT	NAA_ ELT (mod.)	H3_ ELT	H4_ ELT	H3_ELT	H4_ELT	H3_ELT	H4_ELT	H3_ELT (vs. NAA_ELT mod.)	H4_ELT (vs. NAA_ELT mod.)
Wetter Years	42.1	41.4	41.6	38.3	43.1	-3.8 (-9.1%)	0.9 (2.2%)	-3.1 (-7.4%)	1.7 (4.1%)	-3.3 (-7.9%)	1.4 (3.5%)
Drier Years	24.8	24.3	25.2	23.2	23.1	-1.6 (-6.4%)	-1.7 (-6.7%)	-1.1 (-4.5%)	-1.2 (-4.9%)	-2.0 (-7.9%)	-2.1 (-8.2%)
All Years	31.3	30.7	31.3	28.8	30.6	-2.5 (-8.0%)	-0.7 (-2.2%)	-1.8 (-6.0%)	-0.1 (-0.3%)	-2.5 (-7.9%)	-0.7 (-2.4%)

Note: Average Delta Passage Model results for survival to Chipps Island.
Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).
Wetter = Wet and Above Normal Water Years (6 years).
Drier = Below Normal, Dry and Critical Water Years (10 years).
H3_ELT = ESO_ELT operations, H4_ELT = High Outflow.
NAA_ELT (mod.) = NAA_ELT with Yolo Bypass entry % and Yolo Bypass survival of H3_ELT.

Adults

As described for winter-run Chinook, attraction flows and olfactory cues in the west Delta would be altered because of shifts in exports from the south Delta to the north Delta. Flows in the Sacramento River downstream of the north Delta intake diversions would be reduced, with concomitant proportional increases in San Joaquin River flows. The flow changes under Scenario H3_ELT would slightly decrease the olfactory cues for migrating adult salmon in the Sacramento River (by 9% or less compared to NAA_ELT) and slightly increase the olfactory cues for the San Joaquin River (Table

11-4A-52). As noted for Alternative 4, the Sacramento River would still represent a substantial proportion of Delta outflows; the changes are within the typical range and behavioral response is uncertain. Conditions under Scenario H4_ELT are expected to reduce the magnitude of this effect because it would involve fewer exports from the north Delta compared to Scenario H3_ELT.

Table 11-4A-52. Percentage (%) of Water at Collinsville that Originated in the Sacramento during the Adult Spring-Run Chinook Salmon Migration Period for Alternative 4A (Scenario H3_ELT)

Month	EXISTING CONDITIONS	NAA_ELT	H3_ELT	EXISTING CONDITIONS vs. H3_ELT	NAA vs. H3_ELT
March	78	77	69	-9	-8
April	77	76	67	-10	-9
May	69	67	61	-8	-7
June	64	61	57	-7	-5
	Shading indicates 10% or greater absolute difference.				
Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).					

NEPA Effects: Upstream of the Delta, these modeling results indicate that the effect would not be adverse because it does not have the potential to substantially interfere with the movement of fish. Flows in the Sacramento River and Clear Creek, and water temperatures in the Sacramento and Feather Rivers would generally not be affected by Alternative 4A. Flows in the Feather River under Alternative 4A scenarios would be lower during summer months, although flows would otherwise be similar to or greater than the NEPA baseline and would generally exceed NMFS thresholds at similar or greater frequencies than those under the baseline.

Near-field effects of Alternative 4A NDD on spring-run Chinook salmon related to impingement and predation associated with three new intake structures could result in negative effects on juvenile migrating spring-run Chinook salmon, although there is high uncertainty regarding the overall effects. Estimates within the effects analysis range from very low levels of effects (<1% mortality) to more significant effects (~ 12% mortality above current baseline levels). As noted for Alternative 4, Environmental Commitment 15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, as described in the adaptive management and monitoring program in Section 4.1, several pre-construction studies to better understand how to minimize losses associated with the three new intake structures will be implemented as part of the final NDD screen design effort. Similarly, Alternative 4A also includes investigations to better understand factors affecting juvenile through-Delta migration (as described in the adaptive management and monitoring program in Section 4.1) and includes biologically-based triggers to inform real-time operations of the NDD, intended to provide adequate migration conditions for spring-run Chinook. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of predation-related mortality expected from near-field effects at the NDD remains highly uncertain.

As noted for Alternative 4 and as discussed for winter-run Chinook salmon above, two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 4A related to reduced interior Delta entry (Environmental Commitment 16) and reduced south Delta entrainment suggest that these could offset the far-field effects of reduced flow (see, for example, Table 5.C.5.3-36 in the *BDCP Effects Analysis Appendix 5.C hereby incorporated by reference*). As noted for winter-run Chinook salmon, the overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and will be investigated as part of the adaptive management and monitoring program described in Section 4.1.

As described for Alternative 4 and as discussed for winter-run Chinook salmon above, the DPM is a flow-based model incorporating flow-survival and junction routing relationships with flow modeling of Alternative 4a operations to estimate relative differences between scenarios in smolt migration survival throughout the entire Delta. The DPM predicted that smolt migration survival under Alternative 4A would be somewhat lower than survival estimated for NAA_ELT, based on operations assuming no adjustments made in real-time in response to actual presence of fish. Although refinements to the DPM are likely to occur based on new data available from future studies and the current analysis has some uncertainty, the DPM analysis of Alternative 4A on juvenile spring-run Chinook salmon migration suggests a potential adverse effect of small magnitude. As noted for winter-run Chinook salmon, the DPM focuses on smolt-sized individuals (70 mm or more) and is not based on survival data for fry-sized individuals, which also may be migrating and could be affected by Alternative 4A operations. There are no fry through-Delta survival data to inform the effects to these individuals in relation to operations and it is uncertain whether the relative difference between scenarios estimated from the DPM for smolt-sized fish would be representative of relative differences for fry. The potential adverse effect of Alternative 4A would be minimized through the bypass flow criteria and real-time operations outlined above, as well as inclusion within Alternative 4A of specific important Environmental Commitments. These include *Environmental Commitment 6 Channel Margin Enhancement* to offset loss of channel margin habitat to the NDD footprint and far-field (water level) effects, *Environmental Commitment 15 Localized Reduction of Predatory Fishes* to limit predation potential at the NDD and *Environmental Commitment 16 Nonphysical Fish Barriers* to reduce entry of spring-run Chinook salmon juveniles into the low-survival interior Delta.

CEQA Conclusion: In general, Alternative 4A would not substantially affect migration conditions for spring-run Chinook salmon relative to the CEQA baseline.

Upstream of the Delta

H3_ELT /ESO_ELT

Sacramento River

Flows in the Sacramento River upstream of Red Bluff were examined during December through May juvenile spring-run Chinook salmon migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H3_ELT would generally be similar to flows under Existing Conditions during all months and water year types of the period.

Mean water temperatures in the Sacramento River at Red Bluff were examined during the December through May juvenile Chinook salmon spring-run emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between Existing Conditions and H3_ELT in any month or water year type.

Flows in the Sacramento River upstream of Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H3_ELT would generally be similar to flows under Existing Conditions, with minor exceptions.

Mean water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between Existing Conditions and H3_ELT in any month or water year type.

Mean September Shasta Reservoir storage volumes under H3_ELT would be up to 11% lower than those under Existing Conditions (Table 11-4A-27).

Clear Creek

Flows in Clear Creek were examined during the November through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H3_ELT would generally be similar to or up to 40% greater than flows under Existing Conditions, depending on water year type.

Flows in Clear Creek were examined during the April through August adult spring-run Chinook salmon upstream migration period. Mean flows under H3_ELT would generally be similar to flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Water temperatures were not modeled in Clear Creek.

Feather River

Flows in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile Chinook salmon spring-run migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H3_ELT would be similar to or up to 17% lower than flows under Existing Conditions during January through March, would be 19% lower in critical years and 18% higher in above normal years in December, and would be similar during November, April and May.

Mean water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between Existing Conditions and H3_ELT in any month or water year type.

Flows were examined for the Feather River at the confluence with the Sacramento River during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H3_ELT would be up to 55% lower than flows under Existing Conditions during July and August, would be up to 71% greater in June, and similar during April and May. However, the frequencies of exceedance above flow thresholds suggested by NMFS during the Alternative 4a planning process under H3_ELT would be similar to those under Existing Conditions during the two periods in above normal water years (Table 11-4A-48). The frequencies of exceedance during the two periods in below normal water years would be lower during January through March.

Mean water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between Existing Conditions and H3_ELT in any month and water year type except July of critical years, in which temperatures under H3_ELT would be 6% greater.

H4_ELT/HOS_ELT

Sacramento River

Mean flows under H4_ELT in the Sacramento River upstream of Red Bluff during the December through May juvenile spring-run Chinook salmon migration period would generally be similar to flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H4_ELT during the April through August adult upstream migration period would generally be similar to flows under Existing Conditions.

Mean Shasta Reservoir storage at the end of September under H4_ELT would be similar to or up to 12% lower than storage under Existing Conditions (Table 11-4A-36).

Mean water temperatures in the Sacramento River at Red Bluff were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between Existing Conditions and H4_ELT.

Clear Creek

Flows under H4_ELT in Clear Creek during the November through May juvenile spring-run Chinook salmon migration period would generally be similar to or up to 40% greater than flows under Existing Conditions, and flows during the April through August adult upstream migration period would generally be similar (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Therefore, there would be occasional beneficial effects of H4_ELT on spring-run Chinook salmon migration conditions in Clear Creek relative to Existing Conditions.

Feather River

Flows under H4_ELT were evaluated in the Feather River at the confluence with the Sacramento River during the November through May juvenile spring-run Chinook salmon migration period and the April through August adult upstream migration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows under H4_ELT during November through March would generally be similar to flows under Existing Conditions. Flows during April and May would be similar to or up to 112% greater than flows under Existing Conditions. Flows under H4_ELT during April through August would, as described above, be up to 112% greater in April and May than flows under Existing Conditions, but flows would be up to 51% lower in June through August

The exceedance of monthly minimum flows in the Feather River suggested by NMFS during the Alternative 4a planning process was evaluated for H4_ELT relative to Existing Conditions (Table 11-4A-49). The percent of years exceeding minimum flows would be lower under H4_ELT relative to Existing Conditions during January, July and August of both above normal and below normal water years.

Mean water temperatures in the Feather River at the confluence with the Sacramento River were examined during the November through May juvenile spring-run Chinook salmon migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between Existing Conditions and H4_ELT in any month.

Mean monthly water temperatures in the Feather River at the confluence with the Sacramento River were examined during the April through August adult spring-run Chinook salmon upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between Existing Conditions and H4_ELT except in July and of critical years, for which temperatures under H4_ELT would be 5% higher.

Through-Delta

Juveniles

Scenario H3_ELT has lower through-Delta survival averaged across all years compared to Existing Conditions (2.5% reduced survival, or 8% less in relative difference) (Table 11-4A-51). Survival under the high outflow Scenario H4_ELT would be similar to Existing Conditions (0.7% less averaged for all years, a 2.2% relative difference), particularly in wetter years; this estimate does not account for the adjustments that can be made during real-time operations to further protect migrating spring-run Chinook. Overall reductions in OMR reverse flows under all flow scenarios for Alternative 4A would be beneficial (Appendix B, *Supplemental Modeling for Alternative 4A*, Section B.7). Conditions under Scenario H4_ELT would further improve OMR flow conditions (i.e., less reverse) relative to Scenario H3_ELT. Flows below the north Delta intakes would be reduced, which may increase predation potential. The impact is considered less than significant due to somewhat lower survival under Alternative 4A relative to Existing Conditions being minimized by bypass flow criteria, real-time operational adjustments based on biological and hydrological triggers developed by NMFS and DFW to adjust NDD operations to protect migrating salmonids, and the inclusion in Alternative 4A of Environmental Commitment 6, Environmental Commitment 15, and Environmental Commitment 16 (see additional discussion below).

Adults

As described above, attraction flows will be altered because of shifts in exports from the south Delta to the north Delta These changes would slightly decrease the olfactory cues for migrating adult salmon in the Sacramento River (reduced by 8–10% in March–May under the Scenario H3_ELT compared to Existing Conditions) and slightly increase olfactory cues for the San Joaquin River (Table 11-4A-52). Conditions between all flow scenarios under Alternative 4A would be similar; there would only be small changes in olfactory cues for migrating adult spring-run Chinook salmon. Overall, impacts related to migration conditions for spring-run Chinook salmon are considered less than significant.

Summary of CEQA Conclusion

Collectively, the results indicate that the effects would be less than significant because it would not substantially reduce the suitability of migration habitat or interfere with the movement of fish. Flows in the Sacramento River and Clear Creek and water temperatures in the Sacramento and Feather Rivers would generally not be affected by Alternative 4A. Flows would be lower in 2 months of the 5-month adult migration period in the Feather River, although flows generally exceed NMFS thresholds as often as flows under the CEQA baseline throughout the period. Reductions in spring-run Chinook salmon juvenile survival under Alternative 4A relative to Existing Conditions suggested by the DPM would be limited during all water year types by bypass flow criteria, real-time operational adjustments, and the inclusion in Alternative 4A of Environmental Commitment 6, Environmental Commitment 15, and Environmental Commitment 16 (see additional discussion below). Additionally, as described in the adaptive management and monitoring program in Section 4.1, several pre-construction studies to better understand how to minimize losses associated with the three new intake structures will be implemented as part of the final NDD screen design effort. Similarly, Alternative 4A also includes investigations to better understand factors affecting juvenile through-Delta migration (as described in the adaptive management and monitoring program in Section 4.1) and includes biologically based triggers for real time operations. With incorporation of these measures and the lack of difference in adult migration cues between Alternative 4A scenarios and Existing Conditions, the impact would be less than significant. No mitigation is necessary.

Restoration Measures (Environmental Commitment 4, Environmental Commitment 6, Environmental Commitment 7, and Environmental Commitment 10)

As described for winter-run Chinook salmon, Alternative 4A includes a greatly reduced extent of restoration measures relative to Alternative 4 and Alternative 1A, upon which the discussion of impacts for Alternative 4 is based. The general discussion of impacts to winter-run Chinook salmon (Impacts AQUA-43, AQUA-44, and AQUA-45) also applies to spring-run Chinook salmon.

Impact AQUA-61: Effects of Construction of Restoration Measures on Chinook Salmon (Spring-Run ESU)

As noted above, the impact discussion for winter-run Chinook salmon (Impact AQUA-43) is also applicable to spring-run Chinook salmon.

NEPA Effects: For the same reasons described under Impact AQUA-43, the effects of short-term construction activities would not be adverse to spring-run Chinook salmon because effects would be avoided by limiting the frequency, duration, and spatial extent of in-water work and implementing the commitments described in detail under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*.

CEQA Conclusion: As discussed for winter-run Chinook salmon, habitat restoration activities could result in short-term effects on spring-run Chinook salmon, primarily as a result of increased potential for contaminated sediments to enter the water column. However, these effects are likely to be localized, sporadic, and of low magnitude. Adverse effects during restoration would be avoided by limiting the frequency, duration, and spatial extent of in-water work and implementing the commitments described in detail under Impact AQUA-1 and in Appendix 3B, *Environmental Commitments*. The potential impact of habitat restoration activities is considered less than significant because it would not substantially reduce spring-run Chinook salmon habitat, restrict its range or interfere with its movement. Additionally, there would be substantial long-term net benefits of habitat restoration. Consequently, no additional mitigation would be required.

Impact AQUA-62: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Spring-Run ESU)

As noted above, the impact discussion for winter-run Chinook salmon (Impact AQUA-44) is also applicable to spring-run Chinook salmon.

NEPA Effects: As noted for winter-run Chinook salmon, the effect of restoration measures on chemical contaminants is not adverse to spring-run Chinook salmon with respect to selenium, copper, ammonia, pesticides, and methylmercury (with implementation of Environmental Commitment 12).

CEQA Conclusion: As noted for winter-run Chinook salmon, the impact of contaminants is considered less than significant. Alternative 4A restoration actions are likely to result in slightly increased production, mobilization, and bioavailability of methylmercury. However, implementation of *Environmental Commitment 12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury from restoration areas and it would not substantially affect spring-run Chinook salmon either directly or through habitat modifications. Consequently, no mitigation would be required.

Impact AQUA-63: Effects of Restored Habitat Conditions on Chinook Salmon (Spring-Run ESU)

As noted above, the impact discussion for winter-run Chinook salmon (Impact AQUA-45) is also applicable to spring-run Chinook salmon.

NEPA Effects: The effects of restored habitat conditions on spring-run Chinook salmon would not be adverse because restoration is intended to provide habitat benefits to Chinook salmon.

CEQA Conclusion: As described for winter-run Chinook salmon, habitat restoration would be undertaken to offset loss/modification of habitat from water facility construction and operation. The effects of restored habitat conditions on spring-run Chinook salmon would be less than significant. Consequently, no mitigation would be required.

Other Environmental Commitments (Environmental Commitment 12, Environmental Commitment 15, and Environmental Commitment 16)

As noted for winter-run Chinook salmon, Alternative 4A includes three other Environmental Commitments, which are reduced in their extent relative to the Conservation Measures included in other Alternatives (e.g., Alternative 1A and Alternative 4). While the extent of these measures is reduced compared to these alternatives, the nature of the mechanisms remains the same. The general discussion of impacts to winter-run Chinook salmon (Impacts AQUA-46, AQUA-49, and AQUA-50) also applies to spring-run Chinook salmon.

Impact AQUA-64: Effects of Methylmercury Management on Chinook Salmon (Spring-Run ESU) (Environmental Commitment 12)

As noted above, the impact discussion for winter-run Chinook salmon (Impact AQUA-46) is also applicable to spring-run Chinook salmon.

NEPA Effects: The effects of methylmercury management on spring-run Chinook salmon would not be adverse because it is expected to reduce overall methylmercury levels resulting from habitat restoration.

CEQA Conclusion: As noted for winter-run Chinook salmon, effects of *Environmental Commitment 12 Methylmercury Management* within the areas restored under Alternative 4A are expected to reduce overall methylmercury levels resulting from habitat restoration. Because it is designed to improve water quality and habitat conditions, impacts would be less than significant. Consequently, no mitigation is required.

Impact AQUA-67: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Spring-Run ESU) (Environmental Commitment 15)

As noted above, the impact discussion for winter-run Chinook salmon (Impact AQUA-49) is also applicable to spring-run Chinook salmon.

NEPA Effects: As noted for winter-run Chinook salmon, Environmental Commitment 15 would not have adverse impacts and could benefit spring-run Chinook salmon. Due to the uncertainty in the effectiveness of Environmental Commitment 15, however, it is concluded that there would be no demonstrable effect of this conservation measure on spring-run Chinook salmon.

CEQA Conclusion: As noted for winter-run Chinook salmon, Environmental Commitment 15 would not have a significant impact and could benefit spring-run Chinook salmon. Due to the uncertainties associated with this Environmental Commitment, however, it is concluded that there would be no demonstrable effect on spring-run Chinook salmon. Consequently, no mitigation would be required.

Impact AQUA-68: Effects of Nonphysical Fish Barriers on Chinook Salmon (Spring-Run ESU) (Environmental Commitment 16)

As noted above, the impact discussion for winter-run Chinook salmon (Impact AQUA-50) is also applicable to spring-run Chinook salmon.

NEPA Effects: The effects of the NPB would not be adverse because it is intended to improve migratory conditions for juvenile Sacramento River salmon.

CEQA Conclusion: As concluded for winter-run Chinook salmon, the impacts of *Environmental Commitment 16 Nonphysical Fish Barriers* are expected to be less than significant because it is intended to improve migratory conditions for juvenile Sacramento River salmon. Consequently, no mitigation would be required.

Fall-/Late Fall–Run Chinook Salmon

Construction and Maintenance of Water Conveyance Facilities

The discussion of potential effects to delta smelt from construction and maintenance of Water Conveyance Facilities under Alternative 4A is also relevant to fall-run/late fall-run Chinook salmon. Adult and juvenile fall-run/late fall-run Chinook salmon would have the potential to overlap construction and maintenance to a minor degree (Table 11-8).

Impact AQUA-73: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Fall-/Late Fall–Run ESU)

The potential effects of construction of the water conveyance facilities on fall-run/late fall-run Chinook salmon would be the same as those described for Alternative 4, Impact AQUA-73.