

# EXECUTIVE SUMMARY

## BACKGROUND AND PURPOSE

The Steering Committee for the Bay-Delta Conservation Plan (BDCP) is developing a comprehensive conservation plan for the Sacramento and San Joaquin Delta pursuant to a planning agreement that was executed on October 6, 2006. The BDCP planning area is the legal Delta (see Figure E-1). In the first half of 2007, the Steering Committee developed a list of ten conceptual conservation strategies, evaluated those strategies, and shortened that list to four Conservation Strategy Options (Options). Those four Options are evaluated in this report. The Steering Committee is intent on further narrowing the remaining Options to a single Option (derived from one or more of the evaluated Options) that will be carried forward into a detailed conservation planning process over the course of the next year. The Option chosen or created will serve as the nucleus for the larger conservation plan and other major elements of the strategy will be formulated around it. This larger, more comprehensive conservation plan will then be evaluated through a formal, public environmental review process under the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA).

The purpose of this evaluation is to assist the Steering Committee in identifying which Option to carry forward into the planning process. This report describes how each of the four Options performs with respect to seventeen evaluation criteria identified by the Steering Committee for this purpose. It should be emphasized that this evaluation provides only an initial assessment of the relative performance of each of the four Options as described herein. It is likely that some elements of the selected Option will need to be refined further in light of information contained in this report and elsewhere. The Steering Committee may over the course of the fall elect to select one of the four Options to carry forward, or it may choose instead to modify or otherwise refine one of the Options and carry that modified Option into the planning process.

The evaluation is organized into seven sections. Section 1 explains the purpose of the report and includes descriptions of the Options evaluated. Section 2 describes the methods used in the evaluation. Sections 3 through 6 contain the detailed assessment on an Option-by-Option basis, starting with Option 1 (section 3) and ending with Option 4 (section 6). Section 7 provides a summary of the overall conclusions of the evaluation. Section 8 provides an overview of other key conservation elements not included in the four Options evaluated in the report. These other conservation elements, while important to the success of the conservation plan, do not help distinguish performance differences among the Options because they could be implemented with any of the four Options.

## COVERED SPECIES

At this stage in development of the BDCP, the Steering Committee has identified nine fish species that are anticipated to be covered under Federal and State regulations by the BDCP. The Options Evaluation Report evaluates the relative ability of each of the four Options to meet the biological objectives for these nine potentially covered species:

- delta smelt,
- longfin smelt,
- winter-run Chinook salmon,
- spring-run Chinook salmon,
- fall- and late-fall-run Chinook salmon,
- Central Valley steelhead,
- green sturgeon,
- white sturgeon, and
- Sacramento splittail.

## **DESCRIPTIONS OF THE CONSERVATION STRATEGY OPTIONS**

The four Options evaluated in the report were developed by the Steering Committee around two key components:

- Conveyance – the structural approach to conveyance of water to meet the goals for conservation of covered species and water supply reliability.
- Habitat restoration – the general type and location of habitat restoration opportunities in the Delta and in adjacent Suisun Marsh to address covered species conservation

The Options presented here represent a range of conveyance and habitat restoration approaches developed for the purpose of comparative evaluation. All of the Options could be refined, modified, or expanded to improve their performance in addressing the evaluation criteria.

### **Conservation Strategy Option 1: Existing Through-Delta Conveyance**

Option 1 would involve the use of existing conveyance and pump facilities with operations focused on reducing take at the export facilities and improvement of hydrologic conditions for fish in the northern and western Delta; physical habitat restoration would be focused in the north and west Delta and Suisun Marsh (Figure E-2). The estimated area available for habitat restoration encompasses approximately 28% of the BDCP planning area.

### **Conservation Strategy Option 2: Improved Through-Delta Conveyance**

Option 2 would involve improvement of through-Delta conveyance by (1) constructing operable barriers and levee improvements along Middle River; (2) constructing operable barriers on the San Joaquin and Old Rivers; (3) separating water supply conveyance flows from San Joaquin River flows with a siphon and pump facility connecting the Victoria Canal and Clifton Court Forebay; (4) operations focused on reducing take at the export facilities and improvement of hydrologic conditions for fish in the northern, western, central, and southern





Delta; and (5) physical habitat restoration focused in the north, west, central, and south Delta and Suisun Marsh (Figure E-3). The estimated area available for habitat restoration encompasses approximately 35% of the BDCP planning area

### **Conservation Strategy Option 3: Dual Conveyance**

Option 3 would involve dual conveyance facilities and physical and operational habitat restoration and enhancement (Figure E-4). Conveyance would be via: (1) a peripheral aqueduct with an intake on the Sacramento River and isolated connection at the SWP/CVP pump facilities, and (2) an improved through-Delta conveyance with operable barriers along Middle River and separated water supply flows from San Joaquin River flows by a siphon. Operations would focus on the use of the flexibility of dual conveyances to reduce take of covered fish species at the export facilities and improve hydrologic conditions for covered fish in the northern, western, central, and southern Delta. Physical habitat restoration and enhancement would be focused in the north, west, central, and south Delta and Suisun Marsh. The estimated area available for habitat restoration encompasses approximately 35% of the BDCP planning area.

### **Conservation Strategy Option 4: Peripheral Aqueduct**

Option 4 would involve construction of a peripheral aqueduct with an intake on the Sacramento River and isolated connection at the SWP and CVP pump facilities (Figure E-5). Operations would provide the flexibility to improve hydrologic conditions for covered fish species throughout the Delta and to physically restore and enhance habitat opportunistically throughout the Delta and Suisun Marsh. The estimated area available for habitat restoration encompasses approximately 75% of the BDCP planning area.

## **APPROACH TO THE EVALUATION**

The Options Evaluation Report is built around seventeen evaluation criteria developed by the Steering Committee for comparison of the Options (all criteria are included in the *Results of the Evaluation* section, below). The approach to the evaluation focused on the comparative ability of each Option to address each of the evaluation criteria. The evaluation identifies how the differing structural conveyance system and the habitat restoration opportunities among the Options distinguish the Options from each other. The seventeen evaluation criteria are grouped into four categories:

- biological criteria,
- planning criteria,
- flexibility/durability/sustainability criteria, and
- other resource impact criteria.

A combination of quantitatively or qualitatively approaches was used to score or rank the Options against each other or against base conditions (present conditions in the Delta). The evaluation criteria were designed to allow a comparison of the Options at this stage of the

process. There are other criteria and issues, not included here because they did not appear to differentiate the Options that will need to be addressed in the future as the larger strategy is developed. In addition, the evaluation makes some assumptions that are acceptable at this level of analysis but that will need to be further evaluated as the larger strategy is developed. For example, in the biological evaluation, it is assumed that habitat restoration can be effective in alleviating some stressors on the species. For this coarse analysis, this should be a valid assumption but as planning for habitat restoration proceeds, more work will be needed on those specific stressors and the habitat conditions needed to address them.

### **Biological Criteria**

For purposes of evaluating the relative ability of each of the four Options to meet the biological criteria, this report assesses the relative performance of each Option on a species-by-species basis. The comparative evaluation provided in this report is based on existing scientific information about environmental stressors affecting the nine covered fish species and Delta ecosystem processes important to supporting these species. The evaluation is largely qualitative, based on the best professional judgment of individuals who are knowledgeable about the covered species, the complex hydrology of the Delta, and the interplay of that hydrology with the ecological requirements of the individual species of fish. It includes the use of preliminary, coarse-level hydrodynamic modeling applying a broad range of input parameters to the four Options to enable a comparison of the Options' relative ability to provide flow and water quality conditions that benefit the species. For the purpose of evaluating the operating flexibility of each Option, hydrodynamic models CALSIM II and DSM 2 were applied using input parameters that spanned a range of potential operations for each Option. The results of these models were interpreted for anticipated effects on each fish species based on published and unpublished literature and best professional judgment. Each Option's effect on each species is based on an assessment of how the Option affects the species' stressors and the degree of those effects is compared among the Options using the metrics established for each of the biological criteria.

While the Options do not include any specific locations for habitat restoration, the evaluation identifies the relative opportunities and constraints of each Option for physical restoration of high functioning habitat that would improve ecological conditions for covered species. These opportunities and constraints are based on the assumption that physical habitat restoration located in areas with restored natural hydrology would be more effective than restoration in areas with hydrology controlled by water conveyance and export requirements.

### **Planning Criteria**

The planning criteria focus on the ability of each Option to achieve the BDCP planning goals. This comparative evaluation is based on the results of hydrodynamic modeling to estimate the ability of each Option to achieve water supply goals; a cost comparison of both initial construction and long-term costs; and the relative practicability of the implementation.

### **Flexibility/durability/sustainability Criteria**

These criteria address the flexibility, durability, and sustainability of each Option. These criteria focus primarily on the long-term ability of each Option to meet conservation and planning goals







in the face of changing environmental conditions and expanding ecological knowledge. The report uses information from preliminary results of Delta Risk Management Strategy (DRMS) studies in evaluating the durability of the Options in response to catastrophic events in the Delta and long-term climate change.

### **Other Resource Impacts Criteria**

The other resource impacts criteria focus on the unintended adverse effects of implementing each Option on the human environment and on other biological resources within and outside the Delta. This evaluation is based on prior environmental studies in the Delta that have evaluated actions similar to the four Options and on the outputs of the hydrodynamic modeling.

### **IMPORTANT CONSERVATION ACTIONS NOT INCLUDED IN THE EVALUATION**

A number of potentially important ecological stressors on fish are not directly addressed by the Options as they are presently defined such as toxics, predation, competition, harvest, and turbidity. While the Options may indirectly address these stressors, there are many conservation elements that could be added to the Options that would more fully address them. These important stressors and the conservation elements that could address them and benefit specific covered species are discussed in Section 8 of the evaluation. Conservation elements addressing such stressors may be equally applicable under all Options and, therefore, do not serve to distinguish among the Options in the evaluation. Conservation elements addressing these other stressors may become important components of the larger conservation strategy as it is further developed.

### **RESULTS OF THE EVALUATION**

The report presents the comparative evaluation of the Options in relation to the biological criteria by fish species as individual species (e.g., delta smelt) or groups of species (e.g., green and white sturgeon). The report presents the comparative evaluation of Options for the other groups of criteria by criterion (e.g., planning criteria #8). Table E-1 presents the comparative performance of each Option in addressing the needs of the covered fish species relative to the biological criteria. Table E-2 presents the comparison of the performance of each Option relative to the planning, flexibility/durability/sustainability, and other resource impacts criteria. Table E-3 presents the overall performance of the Options against the four criteria categories.

#### **Comparison of the Options Relative to Biological Criteria (Presented by Species)**

Criteria #1-7 for biological performance are evaluated separately in the report for each covered species. The seven biological criteria are:

1. Relative degree to which the Option would reduce species mortality attributable to non-natural mortality sources to enhance production (reproduction, growth, and survival), abundance, and distribution for each of the covered fish species.

2. Relative degree to which the Option would provide water quality and flow conditions necessary to enhance production (reproduction, growth, and survival), abundance, and distribution for each of the covered fish species.
3. Relative degree to which the Option would increase habitat quality, quantity, accessibility, and diversity to enhance and sustain production (reproduction, growth, and survival), abundance, and distribution, and to improve the resiliency of each of the covered species' populations to environmental change and variable hydrology.
4. Relative degree to which the Option would increase food quality, quantity, and accessibility (e.g., phytoplankton, zooplankton, macro-invertebrates, and forage fish) to enhance production (reproduction, growth, and survival) and abundance for each of the covered fish species.
5. Relative degree to which the Option would reduce the abundance of non-native competitors and predators to increase native species production (reproduction, growth, and survival), abundance, and distribution for each of the covered fish species.
6. Relative degree to which the Option improves ecosystem processes in the BDCP planning area to support aquatic and associated habitats
7. Relative degree to which the Option can be implemented within a timeframe to meet the near-term needs of each covered fish species (following BDCP authorization).

The summaries provided here roll up the criteria by species and present the overall biological affect of each Option on the species.

**Table E-1. Comparison of Options by Covered Fish Species**

Species	Performance Rank <sup>1</sup>			
	Option 1	Option 2	Option 3	Option 4
Delta smelt	●	●●	●●●	●●●●
Longfin smelt	●	●●	●●●	●●●●
Sacramento River Salmonids	●●●	●●●	●●●	●●●●
San Joaquin River Salmonids	●	●●	●●●	●●●●
White Sturgeon	●	●●●	●●●	●●●●
Green Sturgeon	●●●	●●●	●●●	●●●●
Sacramento splittail	●●	●●	●●●	●●●●
<i>Notes:</i> 1. Based on information presented in Tables H-1 to H-9 addressing Biological Criteria #1-7. Species performance ranks are: ●●●● = Best performing, ●●● = Second best performing, ●● = Third best performing, ● = Lowest performing Where ranks are equal the two Options receive same rank				

**Table E-2. Comparison of Options by Planning, Feasibility/ Durability/Sustainability, and Other Resource Impacts Criteria**

Criterion	Performance Rank <sup>1</sup>			
	Option 1	Option 2	Option 3	Option 4
<b>Planning Criteria</b>				
8. Water supply goals	●●	●	●●●●	●●●
9. Feasibility/practicability	●●●●	●●●●	●●●●	●●●●
10. Minimize cost	●	●●	●●●	●●●●
<b>Flexibility/Sustainability/Durability Criteria</b>				
11. Durability to catastrophic events	●	●●	●●●●	●●●
12. Minimize ongoing resource input for long-term conservation	●	●●	●●●	●●●●
13. Flexibility/adaptability	●	●●	●●●	●●●●
14. Reversibility	●●●●	●●●	●●	●●
<b>Other Resource Impacts Criteria</b>				
15. Avoidance of impacts on other native species (in-Delta)	●●●●	●●	●	●●●
16. Avoidance of impacts on human environment (in-Delta) <sup>2</sup>	●●●●	●●●	●	●●
17. Avoidance of impacts on native species (outside Delta)	●●	●●	●●●●	●●●
<p><i>Notes:</i></p> <p>1. Derived from information presented in Sections 7.2, 7.3, and 7.4.</p> <p>2. Does not include indirect effects in export service areas.</p> <p>Criteria performance ranks are:</p> <p>●●●● = Best performing,          ●●● = Second best performing,          ●● = Third best performing,          ● = Lowest performing</p> <p>Where ranks are equal the two Options receive same rank</p>				

**Table E-3. Overall Comparison of Options by Criteria Category (Rank)<sup>1</sup>**

Evaluation Criteria Category	Conservation Strategy Option			
	Option 1	Option 2	Option 3	Option 4
<b>Biological</b>	●	●●	●●●	●●●●
<b>Planning</b>	●	●	●●●●	●●●●
<b>Flexibility/ Sustainability/Durability</b>	●	●●	●●●	●●●●
<b>Impacts on Other Resources</b>	●●●●	●●●	●	●●
<p><i>Notes:</i></p> <p>1. Derived from information presented in Tables 7-1 and 7-2.</p> <p>Criteria performance ranks are:</p> <p>●●●● = Best performing          ●●● = Second best performing;          ●● = Third best performing          ● = Lowest performing</p> <p>Where ranks are equal the two Options receive same rank</p>				

### *Delta Smelt*

Option 4 would provide the greatest benefit to delta smelt because it ranks consistently best in relieving highly important and moderately important stressors. Option 3 would provide the second greatest benefit to delta smelt, followed by Option 2. Option 1 would provide the lowest benefit to delta smelt because it consistently ranked lowest in relieving important stressors to delta smelt. All Options, however, provide benefits for delta smelt relative to base conditions.

Option 1 would provide the lowest benefit to delta smelt. Although Option 1 would relieve multiple stressors, it consistently ranks lowest in performance among the Options. Option 1 is ranked lowest in benefits to quantity and quality of food, rearing and spawning habitat, turbidity, predation, and CVP/SWP entrainment. Option 1 performs best among the Options in reducing exposure of delta smelt to toxics, though this effect does not differ from base conditions.

Option 2 would provide the third highest benefit to delta smelt. Like Option 3, Option 2 would need to maintain export water quality standards in the southern Delta, but, unlike Option 3, this need would extend to all flow conditions in all water year types under Option 2. As a result, the ability to increase food quantity and accessibility and increase turbidity would be reduced under Option 2. Further, entrainment at CVP/SWP pumps would be greater under Option 2 than under Options 3 and 4.

Option 3 would provide the second highest benefit to delta smelt. A primary difference between Option 3 and Option 4 is the need under Option 3 to meet export water quality standards in the south Delta, and the adverse effects of increased reverse flows within Middle River, when the south Delta export facilities are operating, resulting in a reduced area available for potential habitat restoration. Option 3 provides the best opportunity to increase turbidity and reduce CVP/SWP entrainment. Option 3 provides the second highest opportunity (after Option 4) to increase delta smelt rearing and spawning habitat, increase food quantity, quality, and accessibility, and reduce predation by non-natives.

Option 4 would perform best among the Options for delta smelt because it would provide the best opportunity to relieve four of the five highly important stressors. This Option provides the greatest increase in food quantity and quality by providing the largest area, with the greatest geographic distribution, in which to restore habitat that, if appropriately designed, would promote the growth and abundance of native prey species and reduce abundances of non-native competitors and predators. Food quantity would also likely improve under Option 4 by reducing exports of nutrients and organic carbon by CVP/SWP pumps and increasing hydraulic residence time throughout the Delta. Turbidity levels, which positively affect both risk of predation and foraging efficiency of delta smelt, would likely be highest under Option 4. The quantity, quality, and accessibility of probable spawning habitat would be the greatest under Option 4 by allowing the greatest area of the Delta to be available for restoration. CVP/SWP entrainment of delta smelt would be virtually eliminated under Option 4 because there would be no south Delta diversions and the Hood diversion is located upstream of the main distribution of the delta smelt population. One major stressor to delta smelt that Option 4 could increase is exposure to toxics as a result of reduced Sacramento River dilution flows and increased relative contribution of lower quality San Joaquin River water. Opportunities for

pollutant source control to reduce the potential risk of toxicity effects would be equally applicable across all Options.

### *Longfin Smelt*

Option 4 would allow the greatest benefit to longfin smelt because it performs best in relieving highly important and moderately important stressors. Option 3 would provide the second greatest benefit to longfin smelt, Option 2 would rank third, and Option 1 would provide the lowest benefit to longfin smelt because it relieved stressors the least amount. All Options, however, provide benefits for delta smelt relative to base conditions.

Option 1 would provide the lowest benefit to longfin smelt. Although Option 1 would relieve multiple stressors, it consistently ranks lowest in performance among the Options. Option 1 would rank lowest in potential benefits to longfin smelt in terms of quantity and quality of food, rearing and spawning habitat, turbidity, predation, and CVP/SWP entrainment. Option 1 performs best among the Options in reducing exposure of longfin smelt to toxics, though this effect is identical to base conditions.

Option 2 would provide the third highest benefit to longfin smelt. Like Option 3, Option 2 would need to rely on the use of the Middle River channel for water conveyance to the export facilities and maintain export water quality standards in the south Delta, but, unlike Option 3, this need would extend to all flow conditions in all water year types under Option 2. Therefore, the ability to increase food quantity and accessibility and increase turbidity would be reduced under Option 2. Entrainment at CVP/SWP pumps would increase under Option 2 when compared with operations under either Options 3 or 4.

Option 3 would provide the second highest benefit to longfin smelt. A primary difference between Option 3 and Option 4 is the requirement under Option 3 to meet export water quality standards in the south Delta when south Delta pump facilities are operating, resulting in a reduced area available for potential habitat restoration. In addition, operation under Option 3 would continue to use Middle River as the primary pathway for water conveyance from the Sacramento River to the south Delta export facilities and therefore would degrade opportunities for habitat enhancement in the Middle River area and east side tributaries. Along with Option 4, Option 3 provides the best opportunity to increase turbidity and reduce CVP/SWP entrainment. Option 3 provides the second highest opportunity (after Option 4) to increase longfin smelt rearing and spawning habitat, increase food quantity, quality, and accessibility, and reduce predation by non-natives.

Option 4 would provide the greatest benefit to longfin smelt among the Options because it would provide the best opportunity to relieve multiple highly important stressors. Option 4 provides the greatest increase in food quantity and quality by providing the largest area, with the greatest geographic distribution, in which to restore habitat that, if appropriately designed, would promote abundances native prey species and reduce abundances of non-native competitors. Option 4 also provide hydrodynamic conditions, including reduced channel velocities and increased residence times, that would be expected to result in greater phytoplankton and zooplankton production within the Delta. Food quantity would also likely increase under Option 4 by reducing exports of nutrients and organic carbon by CVP/SWP pumps and increasing hydraulic residence time throughout the Delta. Turbidity levels would

likely be greatest under Option 4. The quantity, quality, and accessibility of probable spawning habitat would be the greatest under Option 4 by allowing the largest area of the Delta to be available for restoration. Option 4 would also rank highest in reducing the risk of predation by non-native species by providing the greatest area of the Delta to be available for restoration, which, if appropriately designed, would reduce conditions for non-native predators. CVP/SWP entrainment of longfin smelt would decrease under Option 4 because there would be no south Delta diversions and the Hood diversion is upstream of the main distribution of the longfin smelt population. In addition, the diversion at Hood would be equipped with a state-of-the-art positive barrier fish screen that would be expected to effectively exclude juvenile and adult longfin smelt, and other fish species, from being entrained as a result of diversion operations. One major stressor to longfin smelt that Option 4 could increase is exposure to toxics due to reduced Sacramento River dilution flows and increased relative contribution of lower quality San Joaquin River water.

### ***Sacramento River Salmon and Steelhead***

Option 4 would provide the greatest benefit to Sacramento River Chinook salmon and steelhead (salmonids) because it ranks consistently best in relieving highly important and moderately important stressors. Option 3 would provide the second greatest benefit to Sacramento River salmonids, followed by Option 2. Option 1 would provide the lowest benefit to Sacramento River salmonids because it consistently ranked lowest in relieving important stressors to Sacramento River salmonids.

The overall performances of Options 1, 2, and 3 for Sacramento River salmonids are largely indistinguishable. Each Option scores highly with respect to relieving some stressors and poorly with respect to relieving others. For example, Option 3 performs well with respect to CVP/SWP entrainment, but scores poorly with respect to exposure to toxics. Option 1 performs well in reducing rearing and spawning habitat, but has no other benefits to Sacramento River salmonids. Because of the high natural variability and resulting level of uncertainty associated with the Delta ecosystem, it is not possible to distinguish among these Options with reasonable confidence.

Option 4 would perform best among the Options for Sacramento River salmonids because it would relieve, to the greatest degree, all of the stressors identified as highly important including non-native predation, rearing and outmigration habitat, staging and spawning habitat, and CVP/SWP entrainment.

### ***San Joaquin River Salmon and Steelhead***

Option 4 is expected to provide the highest level of benefit for San Joaquin River salmonids relative to base conditions and the other Options. Options 1, 2, and 3 would all be expected to provide similar benefits.

Based on the evaluation of the potential effects of the Options on important San Joaquin River salmonid stressors, Option 1 is expected to provide the lowest level of benefits relative to base conditions and the other Options because it consistently provides the lowest benefit to reducing the effects of both very high and moderately high stressors. The only stressor for which Option

Option 1 would provide the greatest benefit to the exposure of San Joaquin River salmonids to toxics, but this effect would be no greater than base conditions.

Option 2 is expected to provide the third highest benefit to San Joaquin River salmonids. Option 2 is expected to perform marginally better than Option 1 by providing increased rearing and outmigration habitat and reducing the risk to predation by non-native species. Option 2 would perform lower than Option 1 with respect to exposure to toxics. It is expected that the effects of Option 2 on all other stressors will be similar to Option 1.

Option 3 is expected to provide the second highest benefit to San Joaquin River salmonids. Option 3 is expected to perform marginally better than Option 2 by providing increased staging and spawning habitat and reducing entrainment risk. Option 3 would perform lower than Option 2 with respect to exposure to toxics. It is expected that the effects of Option 3 on all other stressors will be similar to Option 2.

Option 4 is expected to provide the highest level of benefit relative to base conditions and the other Options because it is likely to be more effective than the other Options in:

- improving access to staging and spawning habitat,
- improving rearing and outmigration habitat conditions,
- reducing predation risk, and
- reducing SWP/CVP entrainment risk.

### *Green and White Sturgeon*

Option 1 is expected to provide a low benefit for green sturgeon and a very low benefit for white sturgeon relative to base conditions. Options 2 and 3 would have a low beneficial effect relative to base conditions for both sturgeon species. Option 4 would be expected to have a moderate beneficial effect relative to base conditions and would be expected to provide the greatest benefit among the Options for green and white sturgeon.

The important stressors for green and white sturgeon that are addressed by each of the Options include exposure to toxics and reduced rearing habitat. The remaining important stressors for this species can only be addressed outside of the planning area. Based on the evaluation of the potential effects of the Options on these stressors, Options 1, 2, and 3 are expected to provide a low level of benefit for green sturgeon relative to base conditions. These Options provide a lower level of benefit than under Option 4 because they provide fewer geographic opportunities for restoring habitat in the range of the green sturgeon within the planning area. Option 1 is expected to provide a very low level of benefit for white sturgeon relative to base conditions and the other Options because it provides the fewest opportunities for restoring habitat in the range of the white sturgeon within the planning area.

Options 2 and 3 are expected to provide a low level of benefit to white sturgeon relative to base conditions, a higher benefit relative to Option 1, and a lower level of benefit relative to Option 4 because these Options provide greater geographic opportunities for restoring habitats in the Delta relative to Option 1, but fewer opportunities relative to Option 4.

Option 4 is expected to provide a moderate benefit for green and white sturgeon relative to base conditions and the greatest benefit among the Options because it provides greater geographic

opportunities for restoring aquatic shallow water subtidal and intertidal habitats. Unlike Options 1 and 2, there would be a reduction in Delta inflows under Options 3 and 4 that could have a low adverse affect on exposure of sturgeon to toxics because the ability of inflows to dilute toxic concentrations would be reduced.

Options 3 and 4 perform lower than Options 1 and 2 with regard to exposure of green sturgeon and white sturgeon to toxics because Sacramento River inflows to the Delta, which are assumed to dilute concentrations of toxics, are lower relative to base conditions and Options 1 and 2. However, the effects of reductions in Sacramento River inflows under Options 3 and 4 on increasing the exposure of sturgeon to toxics are highly uncertain. Allowing San Joaquin River water, which has a high selenium load, to discharge into the Delta with reduced dilution from the Sacramento River under Options 2, 3, and 4 could increase the bioaccumulation of selenium in sturgeon. This evaluation assumes that, because source control reductions in San Joaquin River selenium loads have been mandated by the Regional Water Quality Board to be in place by 2012, selenium concentrations would not become elevated from base conditions under Options 2, 3, and 4. If source controls are unsuccessful and selenium concentrations were to increase in the Delta, Options 2, 3, and 4 would be expected to have an overall adverse effect on sturgeon.

### ***Sacramento Splittail***

The important stressors on Sacramento splittail that are addressed by each of the Options include reduced juvenile rearing/adult habitat; reduced food availability; reduced spawning/larval rearing habitat; exposure to toxics; predation; and SWP/CVP entrainment. Based on the evaluation of the potential effects of the Options on important splittail stressors, Option 4 is expected provide the highest level of benefit relative to base conditions. Option 3 is expected to perform better than Options 1 and 2.

Options 1 and 2 would be expected to provide a low level of benefit relative to base conditions and lower levels of benefit compared to Options 3 and 4 primarily because they are not expected to improve food availability or address entrainment as effectively as those Options.

Option 3 is expected to perform better than Options 1 and 2, because it is more likely to improve habitat conditions and food availability and reduce the effects of entrainment losses to a greater extent than those Options.

Option 4 is expected to provide a greater level of benefit than the other Options because it is more likely to improve habitat conditions and food availability and reduce effects of predation and entrainment losses to a similar or greater degree than the other Options.

### **Comparison of the Options Relative to the Planning Criteria**

***Criterion #8. Relative degree to which the Option allows covered activities to be implemented in a way that meets the goals and purposes of those activities.***

Criterion #8 addresses the ability of the Options to achieve the water supply goals of the CVP and SWP. For the purposes of this evaluation, CVP/SWP export water reliability, project operational flexibility, and export water quality were used for describing the relative capability

of each Option to meet this criterion. Option 3 is expected to perform the best with regard to meeting the goals and purposes of the covered activities, with Option 4 second. Option 2 is ranked third and Option 1 fourth.

Option 1 has the lowest export water quality with highest salinity and organics. Although the existing engineered system of Option 1 allows for high export reliability, regulatory restrictions significantly reduce reliability with the Option 1 structural configuration of through-Delta conveyance and limited protection of fish from pump facilities.

Option 2 provides higher quality water than Option 1, but the gravity-fed siphon appears to be a design flaw that would need to be solved for Option 2 to provide reliable water supply. Assuming an engineered solution (i.e., a low-head pump facility) to the siphon limitation under Reconfigured Option 2, anticipated water supply reliability is expected to be equal to or higher than Option 1. Physical constraints to operations (i.e., channel capacity of Victoria Canal) would need to be address for Option 2 to function in meeting supply reliability goals.

Hydrodynamic modeling results suggest that Option 3 provides the greatest combination of water supply reliability, flexibility of operations, and water quality. The dual facility operation allows opportunistic use of the most effective and efficient facility when hydrologic, hydrodynamic, and regulatory conditions limit the use of the other facility.

Option 4 performs well in meeting the goals of the covered activities, but its water reliability is constrained by the reliance on Sacramento River water only with the intake isolated from using east side tributary and San Joaquin River waters. Export water quality under Option 4 is consistently the highest of all Options.

***Criterion #9. The relative feasibility and practicability of the Option, including the ability to fund, engineer, and implement.***

Criterion #9 addresses the feasibility and practicability of implementing each of the Options. The evaluation of this criterion was based on a qualitative assessment of the certainty of technologies for successfully engineering new facilities, likely level of regulatory uncertainties, implementation cost, and practicability of the Option to meet both planning and conservation goals. All Options were determined to be of equivalent feasibility and practicability with each Option having different strengths and constraints contributing to this conclusion.

While Option 1 could be considered the most feasible Option because it would be of lowest initial cost, would not test any new technologies, and would avoid the new regulatory compliance, this Option does not offer a strong solution to meeting the key goals of species conservation and water supply reliability and would continue to face regulatory uncertainty for Delta operations. Option 1 is considered of moderate feasibility.

Option 2 would require some technological challenges in developing a siphon and pump system, modifying channels to support high flows, and operating the barriers to maximize opportunities for both conservation and water supply conveyance. Option 2 is considered of moderate feasibility.

Option 3 provides a flexible approach to addressing the combined goals of species conservation and habitat restoration using practicable technologies. This Option has the highest initial construction costs and construction of the both peripheral aqueduct and in-Delta facilities would require challenging regulatory compliance. Option 3 is considered of moderate feasibility.

Option 4 provides a highly flexible approach to addressing the combined goals of species conservation and habitat restoration using practicable technologies. Construction of the peripheral aqueduct would require challenging regulatory compliance and substantial cost. Option 4 is considered of moderate feasibility.

***Criterion #10. Relative costs (including infrastructure, operations, and management associated with implementing the Option.***

The Options were evaluated in terms of expected construction costs, Delta conveyance disruption costs, and redirected water quality costs. Because this evaluation assumes that the overall amount of habitat restoration would be roughly the same for each Option, costs for habitat restoration were not used to differentiate the four Options and therefore were not calculated. It is important to emphasize that much of the data and information relied on for the cost evaluation was cursory in nature. In all cases professional judgment was used to assess order-of-magnitude and relative costs. Key parts of the evaluation relied on information developed for the Delta Risk Management Strategy, some of which may be revised or updated as work products from that effort are refined and finalized. As new information comes to light the ordering of relative costs presented here could be affected. Therefore findings regarding the relative costs of the four Options should be viewed as preliminary rather than definitive. For example, the cost analysis does not include an assumption that levee improvements might be conducted by other programs for other reasons with associated direct cost savings and economic benefits to in-Delta uses such as species conservation.

The evaluation concluded that Option 4 would have the lowest long-term costs with Option 3 slightly higher or equivalent to Option 4. Option 2 ranked third because the long-term cost savings were estimated to be less than Options 3 and 4. The cost of Option 1 was estimated to be the highest as a result of on-going costs over the long-term.

Option 1 is anticipated to have the highest overall cost of all Options over the long term. While the cost of construction is anticipated to be much lower<sup>1</sup> than the other Options, the periodic cost of recovery from seismic and flood events and the on-going cost of municipal water treatment are expected to overcome the construction cost savings over time. Anticipated risk and cost of catastrophic loss under Option 1 is much higher than other Options, possibly as much as \$10-50 Billion in costs at a 50% chance of occurrence in the next 25 years. Option 1 is not expected to significantly improve water quality over existing conditions and therefore would not accrue the substantial water treatment cost savings as other Options - ranging from \$1.0-2.5 Billion over the next 25 years.

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<sup>1</sup> Note, however, that additional construction cost under Option 1 to improve CVP and SWP screening and salvage facilities could be on the order of \$1.3 billion and were not included in the cost comparison here.

Options 2 would have a higher overall cost than Options 3 and 4 and a lower overall cost than Option 1. While construction costs for Option 2 are \$3 to \$5 Billion less than Option 3 and \$3 to \$4.5 Billion less than Option 4, the risk of catastrophic loss of conveyance and the cost for recovery from such events under Option 2 is much higher than under Options 3 and 4 and the cost savings to water treatment in service area is less under Option 2 than under Options 3 and 4. For these reasons, Option 2 is anticipated to result in higher overall costs over the long term than Options 3 and 4. Option 2 would have lower overall cost than Option 1 because the savings over time in recovery costs from seismic or flood events and in water treatment costs under Options 2 is anticipated to overcome the initial \$0.5-2.8 Billion higher construction costs.

Option 3 would be expected to have the second lowest overall cost over the long term. This low cost is the result of savings from lower frequency of catastrophic events shutting down the water supply system and lower per-event costs for recovery from catastrophic events, and from substantial on-going savings resulting from reduced costs for water treatment in service areas. These savings are expected to recover over time the construction cost differences between Option 3 and Options 1 and 2. Option 3, as configured, is considered more expensive than Option 4 because the initial construction costs would be higher, on-going operational costs would be higher (operating and maintaining 2 facilities rather than 1), and savings on water treatment costs would be less. The on-going cost of Option 3, however, could be reduced by the value of increased water delivery capability from the operational flexibility provided by multiple intakes. Option 3 may have a lower risk of supply cutoff from seismic or flood events and, therefore, a lower long-term cost for recovery following catastrophic events than Option 4, but it cannot be concluded whether this difference is substantial enough to offset other costs over time.

Option 4 would be expected to have the lowest overall cost over the long term. This low cost is the result of savings from lower frequency of catastrophic events shutting down the water supply system and lower per-event costs for recovery from catastrophic events, and from substantial on-going savings resulting from reduced costs for water treatment in service areas. These savings are expected to recover over time the construction cost differences between Option 4 and Options 1 and 2.

### **Comparison of the Options Relative to Flexibility/Durability/Sustainability Criteria**

*Criterion #11. Relative degree to which the Option will be able to withstand the effects of climate change (e.g., sea level rise, changes in runoff), variable hydrology, seismic events, subsidence of Delta islands, and other large-scale changes to the Delta*

Criterion #11 addresses the ability of the Options to withstand predicted possible large-scale changes to the Delta. The evaluation of this criterion was based on a qualitative assessment of the durability of each Option to withstand the effects of catastrophic events, such as earthquake or flood and climate change-caused sea level rise, on habitat restoration and water supply conveyance. Options 3 and 4 afford the greatest protection from catastrophic disruption of water supply and Option 4 the greatest protection from loss of restored habitat. Option 1 offers the least protection from catastrophic events and sea level rise. Option 2 falls between Options 1 and Options 3 and 4 in avoiding these risks.

Option 1 is expected to be at the greatest risk of water supply disruption from catastrophic levee failures that could result from seismic and flood events because Option 1 does not include improvements to protect conveyance facilities. Option 1 would support the least durable habitat restoration sites because a smaller area (approximately 28% of the planning area) is available for locating these sites. Greater clustering of restoration sites results in more vulnerability to larger losses of habitat with localized levee failures. In addition, habitat restoration under Option 1 is less likely to be located at sites that could be adapted to address sea level rise because there are fewer locations from which to choose. All Options, however, include restoration outside the planning area at Suisun Marsh, an area that likely is less subject to habitat loss from seismic or flood events than much of the planning area.

Option 2 affords a better level of protection of water supply from catastrophic events, but is still at a higher risk than Options 3 and 4 because the levees that direct conveyance through the north Delta are at greater risk of failure from seismic and flood events than the peripheral aqueduct included in Options 3 and 4 (the aqueduct would be expected to be engineered to withstand probable seismic and flood events). Option 2 provides more area (approximately 35% of the planning area) than Option 1 to distribute restoration sites more broadly to avoid large losses from localized levee failures. Because Option 2 provides more area for habitat restoration than Option 1 it provides more flexibility to locate restoration sites in areas suitable to withstand sea level rise.

Option 3 would provide more protection to water supply from seismic and flood events than Options 1 and 2 because the peripheral aqueduct component of Option 3 is more durable in a seismic or flood event than through-Delta conveyance. Option 3 offers redundancy in the protection of water supply delivery through its dual system and each conveyance offers a back-up to the other should one fail. Option 3 is the only Option with this feature. Option 3 provides more area (approximately 35% of the planning area) than Option 1 to distribute restoration sites more broadly to avoid large losses from localized levee failures. Because Option 3 provides more area for habitat restoration than Option 1 it provides more flexibility to locate restoration sites in areas suitable to withstand sea level rise. Option 3 is comparable to Option 2 in the protection of restoration sites and less protective of restoration sites than Option 4.

Option 4 would provide more protection to water supply facilities from seismic or flood events than Options 1 and 2 because the peripheral aqueduct component is expected to be more durable than in-Delta levees. Option 4 does not have the conveyance redundancy that provides a back-up system for water supply that is part of Option 3. Relocating the intake to the vicinity of Hood reduces the potential for sea level rise to affect water quality. Option 4 provides substantially more area (approximately 75% of the planning area) than all other Options for habitat restoration and, therefore, the most flexibility to find sites suitable to address sea level rise and to better distribute sites to avoid large habitat losses from localized levee failures.

***Criterion #12. Relative degree to which the Option could improve ecosystem processes that support the long term needs of each of the covered species and their habitats with minimal future input of resources***

This criterion addresses the performance of each Option with regard to avoiding the need for future on-going input of resources to support the conservation of covered species. The evaluation determined that Option 4 would rank highest in sustainability and avoiding such

costs. Option 3 ranked second and Options 1 and 2 lowest because of on-going costs of in-Delta facilities operations and fish salvage to achieve conservation objectives.

Options 1 and 2 would entail ongoing management actions (i.e., salvage and hauling) and costs to address entrainment of covered fish species at the SWP/CVP export facilities and provide limited flexibility for adaptively managing Delta flows to meet species needs in the future. Use of the Delta for both fish habitat and through-Delta conveyance often results in competing operational priorities. Options 1 and 2 are wholly dependent on through-Delta conveyance and therefore are more likely to incur the costs associated with export restrictions. Option 2 requires the on-going cost of barrier management and monitoring to maintain the conservation benefits the barriers provide for fish.

Option 3 would be more likely to sustain ecosystem processes into the future than Options 1 and 2. This Option's dual conveyance facilities provide opportunities to adjust the timing of through-Delta pumping to minimize the likelihood for fish entrainment and its associated salvage costs. Use of the Delta for both fish habitat and through-Delta conveyance often results in competing operational priorities. Option 3, therefore, is considered less likely than Option 4 to sustain ecosystem processes with minimal future inputs because of ongoing costs that would be associated with barrier management and monitoring.

Option 3 also may require ongoing management actions depending on operational rules and changes in fish status as a result of overall conservation actions.

Option 4 provides the greatest habitat sustainability with the lowest future input of resources of the Options because it allows for the largest area of the Delta to be used for physical and hydrological habitat restoration. Natural processes could be allowed to support fish habitat, as opposed to more engineered solutions required under Options that must balance within-Delta operations between habitat and water supply conveyance. Habitat management under Option 4 is expected to require less input of funds and other resources to sustain fish populations. In addition, the much reduced level of entrainment under Option 4 would avoid the need for funding ongoing fish salvage at CVP and SWP intake facilities or to incur the costs associated with export restrictions.

***Criterion #13. Relative degree to which the Option can be adapted to address needs of covered fish species over time***

Criterion #13 addresses the ability to which the Options can be adapted to address the potential future needs of the covered fish species. The evaluation of this criterion was based on a qualitative assessment of the likely flexibility under each Option to adaptively manage Delta flows and restore additional habitat areas to address current uncertainties and future needs of the covered fish species. Option 4 is the most flexible in allowing for adaptive management of both hydrologic patterns and location of habitat restoration in the Delta. Options 2 and 3 are ranked second because of constraints on adaptive management. Option 1 ranked last with the most limited flexibility.

Option 1 is considered to be the least adaptable of the Options because, to meet water supply objectives, opportunities to adaptively manage Delta flow patterns are minimal. This Option lacks the flexibility for restoring habitats in the central, south, and east Delta if needed to meet

the future needs of covered fish species. Under Option 1, only about 28% of the Delta is available for restoration of natural hydrology.

Option 3 is more constrained than Option 4, but does provide opportunities to adaptively manage Delta flows, having the ability to opportunistically convey water through-Delta or via a peripheral aqueduct to maximize benefits for covered species. The operable barriers along Middle River under Option 3 and 2 limit the opportunities for managing Delta flows to a much smaller proportion of the Delta than under Option 4. Under Options 2 only about 35% of the Delta is available for restoration of natural hydrology. With the opportunity to use the peripheral aqueduct, Option 3 would have greater flexibility than Option 2 in the operation of the in-Delta barriers to manage hydrologic conditions east of Middle River for the benefit of covered fish species and other aquatic organisms. The extent of areas available for habitat restoration and adaptive management is more limited under Option 3 than under Option 4.

Option 4 is expected to provide the greatest flexibility among the Options to adaptively manage Delta flows and restored physical habitat for the benefit of covered fish species. Because it is not constrained by the need to maintain the export quality of water in a through-Delta conveyance, Option 4 provides for the greatest geographic extent and percentage of the Delta area available for habitat restoration should it be necessary to increase the extent of or redistribute restored habitat for covered species in the future. Under Option 4, approximately 75% of the Delta would be available for restoration of natural hydrology and therefore would provide the best locations for physical habitat restoration.

#### ***Criterion #14. Relative degree of reversibility of the Option once implemented***

Criterion #14 addresses the relative ability to reverse each of the Options once they are implemented. The evaluation of this criterion was based on a qualitative assessment of the practicability for reversing the Options based on likely levels of engineering feasibility, public acceptance, and costs for doing so. Option 1 is expected to be the most reversible based on the assumption of limited new facilities. Option 2 would be more reversible than Options 3 and 4 because it does not involve the peripheral aqueduct. Option 4 ranked third because of greater limits on reversing a completed peripheral aqueduct. Option 3 ranked last because it includes the largest amount of initial capital investment.

Option 1 is considered to be the most easily reversed of the Options because no costs associated with the removal of infrastructure would be incurred relative to current conditions.

Option 2 is less reversible than Option 1, but is considered to be substantially more reversible than Options 3 and 4, which would entail removal or abandonment of a peripheral aqueduct at likely enormous cost and loss of capital investment. Likely costs associated with reversing Option 3, which would also include removal or abandonment of Delta barriers, would be somewhat higher than Option 4. Because costs associated with reversing Options 3 and 4 and the consequent loss of capital investment would be substantial, the probability for obtaining the level of public acceptance necessary to reverse these Options is considered low.

## Comparison of the Options Relative to Other Resource Impacts Criteria

### *Criterion #15: Relative degree to which the Option avoids impacts on the distribution and abundance of other native species in the BDCP Planning Area*

Criterion #15 addresses the degree to which each of the Options avoids potential impacts on native species (other than the covered species) in the planning area. The evaluation of this criterion was based on a qualitative assessment of the likely degree of impacts on native aquatic organisms and terrestrial species present in the Delta. Option 1 would have the least impact on terrestrial species but potentially the greatest impact on aquatic species. Ranked second, Option 4 avoids much of the impacts on aquatic species but has large effects on terrestrial species. Option 2 was ranked third because it has the largest effects on aquatic species and substantial effects on terrestrial species from levee construction. Ranked lowest, Option 3 impacts aquatic species and has large effects on terrestrial species.

Without new facilities, Option 1 would have no construction impacts on native terrestrial species, but on-going entrainment of native aquatic species at the pump facilities would continue. Option 1 would be expected to have greater entrainment of aquatic organisms than the other Options because of the location and more exposed condition of the pump facilities.

Option 2 would have minor impacts on terrestrial and aquatic species associated with construction of operable barriers and the siphon, but 34 miles of levee improvements could result in substantial impacts on riparian and terrestrial species on islands surrounding Middle River and Victoria Canal. Option 2 would have a higher probability for entraining aquatic organisms from the south Delta than Options 3 or 4 because south Delta exports under Option 3 would be much reduced and exports would not be taken from the south Delta under Option 4. The placement and operation of the barriers along Middle River under Options 2 could result in impacts on native aquatic organisms if the barriers sufficiently impede the movement of aquatic species to and from the east and central Delta. Because the barriers are expected to be operable, there is the opportunity to adjust operation of barriers to minimize these potential impacts.

Overall, Option 3 is anticipated to have the largest impacts on native species in the planning area as a result of the large construction impacts of the peripheral aqueduct and additional impact of the barriers and siphon. Options 3 would result in substantial impacts on terrestrial native species due to construction of a peripheral aqueduct across over 40 miles of upland, riparian, and wetland habitats. The placement and operation of the barriers along Middle River under Options 3 could result in impacts on native aquatic organisms if the barriers sufficiently impede the movement of aquatic species to and from the east and central Delta. Because the barriers are expected to be operable, there is the opportunity to adjust operation of barriers to minimize these potential impacts.

Options 4 would result in substantial impacts on terrestrial native species due to construction of a peripheral aqueduct across over 40 miles of upland, riparian, and wetland habitats. Option 4 is expected to have the least impacts on native aquatic organisms. Water would not be exported from the south Delta, thereby eliminating the probability of entrainment at the SWP/CVP pumping facilities. Operation of a state-of-the-art fish screen at the intake of the peripheral aqueduct is expected to minimize entrainment of aquatic organisms. The loss of food from the

Sacramento River may result in greater impacts on aquatic food supply in the Delta than under Options 1 and 2.

***Criterion #16. Relative degree to which the Option avoids impacts on the human environment***

Criterion #16 addresses the relative degree to which implementation of each Option could impact the human environment. The evaluation of this criterion was based on a qualitative assessment of likely impacts on NEPA/CEQA resource categories. The evaluation of Criterion #16 focuses on the likely range of adverse direct and indirect impacts of the Options in the planning area and not the indirect impacts to water quality and water supply reliability and in the service areas. These issues in the service areas are addressed in Criteria #8 and #11. Option 1 is expected to have the least adverse effects on the human environment with limited new construction. Option 2 was ranked second with more moderate construction impact due to the extent and location of new facilities. Option 4 ranked third and Option 3 last with the large amount of construction impacts associated with new facilities.

Option 1 would have the least overall impacts on the human environment because it would not entail any construction that could disrupt use of the Delta or degrade the human environment and water quality conditions for agriculture in the Delta would be similar to existing conditions. Although Option 1 would have the fewest direct impacts, it is expected to result in the lowest export water quality with consequent adverse effects on treatment costs, agricultural production, and human health. Option 1 is also the most vulnerable among the Options to future disruption of water supply to service areas as a result of catastrophic events.

Option 2 is expected to have fewer impacts than Options 3 and 4 because improvements of levees under Option 2 is anticipated to affect fewer resources and with less magnitude of impact than the peripheral aqueduct construction. Option 2, is expected to provide higher water quality and be less vulnerable to supply disruption than Option 1, but portions of the conveyance system would still be vulnerable to future disruption and loss of water supply to service areas.

Options 3 and 4 entail construction of a peripheral aqueduct which could lead to substantial permanent (e.g., removal of agricultural land from production; changes in land use) and temporary (e.g., noise, traffic, air quality) impacts. Because Option 3 includes construction of dual conveyance facilities, it would result in greater overall impacts on the human environment than the other Options. Options 3 and 4 are expected to be substantially less vulnerable than Options 1 and 2 to future disruption of water supply. Export water quality improvements would be successively greater and attendant impacts on treatment costs, agricultural production, and human health successively reduced under Options 2, 3, and 4 in that order.

***Criterion #17. Relative degree of risk of the Option causing impacts on sensitive species and habitats in areas outside of the BDCP Planning Area***

Other Resource Impacts Criterion #17 addresses the degree of risk for causing impacts on other sensitive species and habitats outside of the planning area. The evaluation of this criterion was based on hydrodynamic modeling results for Delta outflows and end-of-September reservoir storage volumes as indicators of how each of the Options may affect species and habitats downstream and upstream of the Delta, respectively. Option 3 ranked highest because it is

most flexible in supporting both upstream and downstream operations beneficial to biological resources. Option 4 ranked second because of its ability to support greater Delta outflows than Options 1 and 2. Options 1 and 2 were considered similar in their effects on species outside the planning area.

Options 1 and 2 are expected to have a neutral affect relative to base conditions on species and habitats downstream of the Delta because outflows provided under Options 1 and 2 are expected to be similar to base conditions.

Options 3 and 4 would provide average annual Delta outflows higher than Options 1 and 2 and base conditions. Delta outflows during critical months of March and April in critical dry years are similar across all Options. Because they generally would provide for greater Delta outflows, Option 3 and 4 would be the less likely to impact species and habitats in Suisun Marsh and Bay and other downstream locations.

In most water year types, the capacity for providing cold water releases from Shasta, Folsom, and Oroville Reservoirs would be similar under each of the Options and to current conditions. Reservoir storage volumes under Option 4 may be less than under the other Options in dry and critical water years and therefore may be the least likely to provide for cold water releases in those years. If selected, operations under Option 4 would need to be refined so that cold water temperature requirements are met.

## **CONCLUSIONS - OVERALL COMPARISON OF OPTIONS**

### **Biological Criteria**

The comparison of overall biological benefits of the Options focused primarily on the estuarine species that are most dependent on the Delta (delta smelt, longfin smelt, and splittail). These species are at greater population-level vulnerability to in-Delta impacts than salmon, steelhead, and sturgeon.

Option 4 would provide the greatest benefits among all Options to the estuarine species most dependent on the Delta (Table E-3). Option 4 would provide the most opportunity to address important stressors to delta smelt, longfin smelt, and splittail. Option 4 also would perform well for salmonids relative to other Options.

Option 3 would provide the next greatest benefits to the most vulnerable estuarine fish and also would perform well for salmonids.

Option 2 would not perform as well as Options 4 for any species; it would provide comparable benefit to salmonids and sturgeon as Option 3, but provides lower benefit to the more vulnerable estuarine species. Option 2 would outperform or match Option 1 for all species.

Option 1 performs the poorest for covered fish species. Option 1 would be outperformed by all other Options for delta smelt, longfin smelt, San Joaquin River salmonids and white sturgeon. Option 1 is matched in performance by all other Options for Sacramento River salmonids, green sturgeon, and splittail.

## **Planning Criteria**

Options 3 and 4 both address planning criteria well and rank higher than Options 1 and 2 in all cases (Table E-3). Option 4 may be slightly more cost effective and practicable than Option 3, but Option 3 provides greater flexibility to meet water supply goals. Overall Options 3 and 4 were tied for first rank.

Options 1 and 2 were both considered poor in meeting planning criteria. Option 1 was considered too limiting to meet dual habitat conservation and water supply goals and too expensive in the long term due to large on-going costs of low export water quality. Option 2 includes a number of technical challenges for both conservation and water supply objectives. Option 2 costs are relatively high because of levee construction, more limited improvement in export water quality, and additional high cost facilities likely to be necessary (e.g., pump facility and fish screens).

## **Flexibility/Durability/Sustainability Criteria**

Option 4 has the most flexibility and adaptability to adjust conservation approaches both for physical habitat restoration and flow management with the least input of future resources (Table E-3). Options 3 and 4 both rank highest for durability in the face of sea level rise and catastrophic seismic and flood events. Options 3 and 4 are the least reversible as they involve the most input of resources. Overall Option 4 was ranked highest for flexibility, durability and sustainability. Option 3 ranked second because of its more limited adaptability due to smaller area available for restoration of natural hydrology and physical habitat restoration for covered fish species.

Option 2 is less durable than Options 3 and 4 and more durable than Option 1 in the face of catastrophic events and sea level rise. Option 2 is less flexible than Option 3 and much less flexible than Option 4 to conduct adaptive management to address the needs of covered fish species and with a minimum input of future resources.

Option 1 was ranked the lowest because of its high risk to loss of habitat and water supply from catastrophic events and sea level rise. While Option 1 is obviously the most reversible, it has the least flexibility to adapt water operations and physical habitat restoration to meet the future needs of species without substantial input of resources.

## **Other Resource Impacts Criteria**

Option 1 ranked highest for avoiding direct impacts on other biological and human resources because of the minimal amount of new infrastructure required (Table E-3). The high indirect effects of Option 1 in service areas were not addressed in this category, but were addressed in the planning criteria under costs. If indirect effects on the human environment of Options 1 in water service areas over the long-term were included in the evaluation of other resource impacts criteria grouping rather than in the planning criteria, then Option 1 may have been ranked lowest for other resource impacts.

Option 2, with a smaller construction impact footprint than Options 3 or 4, ranked second in avoiding impacts. Impacts on biological resources both inside and outside the Delta would be higher than Option 4.

Option 4 ranked third in avoiding impacts. It was ranked behind Option 2 because of the greater direct impacts human environment and ahead of Option 3 because it does not include the new in-Delta facilities of Option 3.

Option 3 ranked last as it would involve the most new construction and would have the most direct impacts on biological resources and the human environment in the Delta. Options 3 and 4 allowed for the most Delta Outflow and would be expected to benefit aquatic species in Suisun Marsh and Bay.

### **Overall Conclusions**

Each Option offers opportunities and constraints to meeting conservation and water supply goals. The conclusions presented in this evaluation regarding which Option would be most successful in meeting the various criteria are dependent on many assumptions used in the analysis, reflecting the uncertainties in the current state of knowledge. Drawing more general conclusions about how each option performs across all of the criteria compounds these assumptions and their uncertainties. Thus, hard and fast conclusions about the overall performance of any particular option should be approached cautiously.

With the above caveats in mind, the conclusion of this report is that both Options 3 and 4 appear to provide significant improvements over the first two options across the biological, planning and flexibility criteria, and both, in turn, score less well in the “other resource impacts” category.

Options 1, 2, and 3 all geographically split the Delta in some way to accommodate the dual use for water conveyance and species conservation. Option 1 focuses physical habitat restoration in the north and west Delta to avoid the conflict at sites in the central and south Delta between conveyance hydrology and the restoration of natural hydrology. Options 2 and 3 split the Delta through engineered structures to separate conveyance to the east and habitat conservation to the west. In doing so, Options 2 and 3 fall in between the extent of habitat opportunities provided by Option 1 (the lowest) and Option 4 (the highest).

Option 3 appears to perform better than all other options in its ability to meet water supply planning goals and objectives, and in its resiliency in response to catastrophic events. Its performance biologically is consistently superior to Options 1 and 2, but is less robust than Option 4. Its dual conveyance feature may provide significant operational flexibility over and above the other options.

Option 4 appears to provide the greatest opportunity to meet the greatest number of criteria. It allows for the most opportunities over a much larger proportion of the Delta to combine the restoration of natural hydrology beneficial to covered fish species with the restoration of physical habitat for those species. It separates geographically and hydrologically the frequently conflicting requirements (structural and operational) of export water conveyance and aquatic species conservation (allowing for the greatest flexibility in accomplishing habitat

conservation). Finally, it provides high long-term water supply reliability with the highest export water quality at the lowest overall cost. A key constraint of Option 4 is the limitation of export capabilities to a single north Delta intake – a limitation which affects both water supply reliability and Delta inflows for conservation.

In summary, this evaluation describes how each of the Options performs in relation to a wide range of criteria. This information will assist the Steering Committee over the course of the fall in selecting an option to carry forward into the planning process. The Steering Committee may select of the four options as is, or it may further refine an option into a new hybrid to take into the planning process.