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Acronyms and Abbreviations

AKART	all known, available, and reasonable technology
BiOp	biological opinion
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CER	Conceptual Engineering Report
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CNDDDB	California Natural Diversity Database
CS5	Combined Scenario 5
CVP	Central Valley Project
Delta	Sacramento–San Joaquin Delta
Delta Reform Act	Sacramento–San Joaquin Delta Reform Act
DHCCP	Delta Habitat Conservation and Conveyance Program
DRERIP	Delta Regional Ecosystem Restoration Implementation Plan
DWR	California Department of Water Resources
EIR	environmental impact report
EIS	environmental impact statement
ESA	Endangered Species Act
GIS	geographic information system
HCP	habitat conservation plan
HCP Handbook	<i>Habitat Conservation Planning and Incidental Take Permit Processing Handbook</i>
HOS	high-outflow scenario
I/E ratio	inflow/export ratio
MAF	million acre-feet
MPTO	Modified Pipeline/Tunnel Option
MWD	Metropolitan Water District of Southern California
NA	not available/applicable
NCCP	Natural Community Conservation Plan
NCCPA	Natural Community Conservation Planning Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NO _x	nitrogen oxides
OMR	Old and Middle River
PM10	particulate matter of 10 microns in diameter or less
ppt	parts per thousand
PTM	Particle Tracking Model
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
ROA	restoration opportunity area

ROG	reactive organic gas
RPA	reasonable and prudent alternative
SDBSIM	Supply – Demand Balance Simulation Model
SFBAAB	San Francisco Area Air Basin
SVAB	Sacramento Valley Air Basin
SWAP	Statewide Agricultural Production
SWP	State Water Project
USFWS	U.S. Fish and Wildlife Service
YSAQMD	Yolo-Solano Air Quality Management District

1

9.1 Introduction

The BDCP (or Plan) will provide the basis for long-term compliance with the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA) with respect to the operation of the existing State Water Project (SWP) and Central Valley Project (CVP) facilities in the Sacramento–San Joaquin Delta (Delta). As part of the development of the BDCP, participants considered a broad range of alternate approaches to achieve the goal to provide a comprehensive conservation strategy for the Sacramento–San Joaquin River Delta designed to restore and protect ecosystem health, water supply, and water quality within a stable regulatory framework.

The alternative approaches considered here would cause different levels of incidental take of, or overall conservation benefit to, covered species than would the actions proposed in this Plan, as described in Chapter 5, *Effects Analysis*. Consistent with the requirements of the ESA, this chapter describes take alternatives considered during the development of the BDCP that would result in less incidental take or more conservation benefit for at least some covered species and sets out the reasons such take alternatives were not adopted as part of the actions proposed in this Plan.

This section provides a summary of the regulatory framework for take alternatives and an overview of the process of evaluating take alternatives. Section 9.2, *Descriptions of Take Alternatives*, describes each of the take alternatives. Section 9.3, *Methods of Analysis*, describes the methods used in the analysis. Section 9.4, *Level of Incidental Take and Conservation Benefit by Species Group*, describes the evaluation of take alternatives by species group. Section 9.5, *Assessment of Take Alternatives*, evaluates each take alternative relative to four criteria: the effects on covered species, consistency with BDCP goals, practicability, and other environmental consequences. Section 9.5 also describes why the various take alternatives were not adopted in the BDCP. Section 9.6, *Summary*, provides a summary of the conclusions of the evaluation of all take alternatives.

9.1.1 Regulatory Background

The ESA requires that Section 10 permit applicants specify in habitat conservation plans (HCPs) that the alternatives to the taking of federally listed threatened and endangered species were considered and why those take alternatives are not being proposed (50 Code of Federal Regulations [CFR] 17.22(b)(1)(iii)(C)). This chapter addresses this requirement by identifying and analyzing a range of take alternatives that would avoid or reduce the level of take of the covered fish and wildlife species likely to result from the activities covered by the BDCP.

The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (HCP Handbook) (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1996) provides guidance for the analysis of take alternatives. Specifically, the HCP Handbook identifies two types of take alternatives that are typically considered in HCPs: take alternatives that would result in take levels below those anticipated for the proposed actions, and take alternatives that would cause no incidental take, thereby eliminating the need for an incidental take permit. The analysis must explain why the take

1 alternatives were not adopted (U.S. Fish and Wildlife Service and National Marine Fisheries Service
 2 1996). The evaluation of take alternatives is a requirement solely of the ESA. The Natural
 3 Community Conservation Planning Act (NCCPA) requires that take alternatives be considered in the
 4 environmental impact report (EIR) / environmental impact statement (EIS) but not in the natural
 5 community conservation plan (NCCP). The following descriptions and analyses of take alternatives
 6 have, therefore, been developed solely for the purpose of meeting the requirements of Section 10 of
 7 the ESA.

8 As part of the California Environmental Quality Act (CEQA) and the National Environmental Policy
 9 Act (NEPA) process, a wider range of project alternatives has been identified and evaluated. The
 10 analysis of take alternatives in this chapter serves a specific and narrow regulatory purpose, which
 11 is separate and apart from the analysis of project alternatives under CEQA and NEPA. The EIR/EIS
 12 for the BDCP identifies a reasonable range of project alternatives and evaluates the potential
 13 environmental impacts of those alternatives in relation to the no-action or no-project alternative.¹

14 **9.1.2 Evaluation Process**

15 The BDCP reflects the culmination of a multiyear effort to achieve the goal to provide a
 16 comprehensive conservation strategy for the Sacramento–San Joaquin River Delta designed to
 17 restore and protect ecosystem health, water supply, and water quality within a stable regulatory
 18 framework. The planning process included a systematic and in-depth evaluation of a wide range of
 19 conceptual approaches to advancing these goals. These approaches differed largely in terms of the
 20 type of water conveyance infrastructure that would be employed and the nature and extent of
 21 habitat protection, restoration, and enhancement actions that would be implemented. During the
 22 development of the BDCP, promising elements of these approaches were synthesized into discrete
 23 conservation measures that, in total, compose the conservation strategy (Chapter 3, *Conservation*
 24 *Strategy*).

25 The conservation strategy consists of multiple components that have been developed to collectively
 26 advance the Plan goals and achieve a broad set of biological goals and objectives. The conservation
 27 strategy sets out these biological goals and objectives and establishes the actions to achieve them,
 28 including conservation measures and a monitoring, research, and adaptive management program.
 29 When implemented together, the specific conservation measures are expected to provide for the
 30 conservation and management of the covered species. The following section (Section 9.1.3,
 31 *Development of the BDCP Proposed Action*) summarizes the extensive effort and analysis that was
 32 involved in developing the actions proposed in the Plan, called the *BDCP Proposed Action* in this
 33 chapter². (For a detailed history of the development of the conservation strategy and its key
 34 components, see Appendix 3.A, *Background on the Process of Developing the BDCP Conservation*
 35 *Measures*.)

1 The term *take alternative* refers to take alternatives associated with the BDCP; the term *alternative* refers to the project alternatives evaluated in the EIR/EIS.

2 The term *BDCP Proposed Action* is used only in this chapter and its appendices for the purposes of the take assessment.

1 **9.1.3 Development of the BDCP Proposed Action**

2 BDCP development began in 2006. During the development of the BDCP, the participants carried out
 3 a focused effort to identify and consider a range of alternative approaches to water conveyance
 4 infrastructure and operating criteria (CM1³), as well as a number of different approaches to natural
 5 community restoration and enhancement. Development and evaluation of a range of alternatives
 6 was also guided by the Delta Reform Act. California Water Code Section 85320(b)(2) specifically
 7 requires including a comprehensive review and analysis of seven factors.

- 8 • A reasonable range of flow criteria, rates of diversion, and other operational criteria required for
 9 an NCCP, and other operational requirements and flows necessary for recovering the Delta
 10 ecosystem and restoring fisheries under a reasonable range of hydrologic conditions, which will
 11 identify the remaining water available for export and other beneficial uses.
- 12 • A reasonable range of conveyance alternatives including through-Delta, dual conveyance, and
 13 isolated conveyance; and including further capacity and design options of a lined canal, unlined
 14 canal, and pipelines.
- 15 • The potential effects of climate change, possible sea level rise up to 55 inches, effects of
 16 precipitation changes and runoff patterns, on the alternatives and habitat restoration activities
 17 considered in the EIR.
- 18 • Potential effects on migratory fish and aquatic resources.
- 19 • Potential effects on Sacramento River and San Joaquin River flood management.
- 20 • Resilience and recovery of the conveyance alternatives in the event of catastrophic loss caused
 21 by earthquake or flood or other natural disaster.
- 22 • Potential effects of each conveyance alternative on Delta water quality.

23 The range of alternatives for evaluation in the EIR/EIS was developed through the following steps.

- 24 • Identify a range of conveyance alignment concepts.
- 25 • Identify a range of operational concepts.
- 26 • Identify a range of restoration concepts.
- 27 • Combine conveyance alignment concepts and operational criteria concepts to develop potential
 28 EIR/EIS alternatives.
- 29 • Screen the potential alternatives in the context of screening criteria.

³ The conservation measures, referred to by number in this chapter, are as follows: *CM1 Water Facilities and Operation; CM2 Yolo Bypass Fisheries Enhancement; CM3 Natural Communities Protection and Restoration; CM4 Tidal Natural Communities Restoration; CM5 Seasonally Inundated Floodplain Restoration; CM6 Channel Margin Enhancement; CM7 Riparian Natural Community Restoration; CM8 Grassland Natural Community Restoration; CM9 Vernal Pool and Alkali Seasonal Wetland Complex Restoration; CM10 Nontidal Marsh Restoration; CM11 Natural Communities Enhancement and Management; CM12 Methylmercury Management; CM13 Invasive Aquatic Vegetation Control; CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels; CM15 Localized Reduction of Predatory Fishes; CM16 Nonphysical Fish Barriers; CM17 Illegal Harvest Reduction; CM18 Conservation Hatcheries; CM19 Urban Stormwater Treatment; CM20 Recreational Users Invasive Species Program; CM21 Nonproject Diversions; and CM22 Avoidance and Minimization Measures.*

1 The screening process included three levels of screening criteria, which were developed in
 2 consideration of project goals and objectives, requirements of the Sacramento–San Joaquin Delta
 3 Reform Act (Delta Reform Act), comments received during the NEPA/CEQA scoping process, and
 4 existing legal and regulatory requirements. The first level focused on the capacity of an alternative
 5 to provide for the conservation and management of covered species. The second level focused on
 6 avoiding or substantially lessening expected significant environmental impacts of the BDCP
 7 Proposed Action. The third level focused on consideration of technical and economic feasibility;
 8 whether an alternative would violate federal or state statutes or regulations; and whether an
 9 alternative balanced relevant economic, environmental, social, and technological factors For further
 10 details regarding the screening criteria, see Appendix 3.A, *Background on the Process of Developing*
 11 *the BDCP Conservation Measures* and EIR/EIS Appendix 3A, *Identification of Water Conveyance*
 12 *Alternatives Conservation Measure 1.*

13 **9.1.3.1 Identifying Conveyance Alignment Concepts**

14 The deliberations of the Steering Committee from 2006 to 2010 and the subsequent EIR/EIS scoping
 15 process produced a number of potential water conveyance alignment concepts. The Steering
 16 Committee, established to provide a public forum where key policies and strategy issues could be
 17 discussed, met from 2006 to 2010. The Steering Committee conducted a preliminary analysis of
 18 broadly defined conveyance alignment concepts to consider benefits and constraints of different
 19 conveyance alignment approaches and refined the range of conveyance alignment concepts to four
 20 conservation strategy options (BDCP Steering Committee 2007).

21 The Steering Committee analysis of conveyance alignment concepts was supplemented with the
 22 results of the EIR/EIS scoping process and conveyance alignment concepts. This resulted in 15
 23 potential water conveyance concepts (EIR/EIS Appendix 3A, *Identification of Water Conveyance*
 24 *Alternatives Conservation Measure 1*).

25 Eight of the fifteen water conveyance concepts were eliminated through the first screening process
 26 (for description of the concepts that were eliminated, see EIR/EIS Appendix 3A, *Identification of*
 27 *Water Conveyance Alternatives Conservation Measure 1*). The remaining seven concepts are listed
 28 below.

- 29 ● **Dual Conveyance Concept A.** Dual conveyance with a tunnel between north Delta intakes and
 30 the SWP and CVP pumping plants, and continued use of existing south Delta intakes.
- 31 ● **Dual Conveyance Concept B.** Dual conveyance with a lined or unlined east canal between north
 32 Delta intakes and the SWP and CVP pumping plants, and continued use of existing south Delta
 33 intakes.
- 34 ● **Dual Conveyance Concept C.** Dual conveyance with a lined or unlined west canal between
 35 north Delta intakes and the SWP and CVP pumping plants, and continued use of existing south
 36 Delta intakes.
- 37 ● **Isolated Conveyance Concept A.** Isolated conveyance with a tunnel between north Delta
 38 intakes and the SWP and CVP pumping plants, and abandonment of existing south Delta intakes.
- 39 ● **Isolated Conveyance Concept B.** Isolated conveyance with a lined or unlined east canal
 40 between north Delta intakes and the SWP and CVP pumping plants, and abandonment of
 41 existing south Delta intakes.

- 1 • **Isolated Conveyance Concept C.** Isolated conveyance with a lined or unlined west canal
2 between north Delta intakes and the SWP and CVP pumping plants, and abandonment of
3 existing south Delta intakes.
- 4 • **Through-Delta Conveyance Concept.** Separate corridors with new fish screens along the
5 Sacramento River at the Delta Cross Channel and Georgiana Slough to convey water through the
6 lower Mokelumne River system and across the San Joaquin River to Middle River and Victoria
7 Canal; a siphon under Old River for continued conveyance to the existing SWP and CVP pumping
8 plants; operable barriers on Snodgrass Slough, Head of Old River, Three Mile Slough or Seven
9 Mile Slough, and between Old River and Middle River (at Woodward Canal, Railroad Cut, and
10 Connection Slough); dredging and setback levees along portions of Middle River; and continued
11 use of the existing SWP and CVP south Delta intakes during flood periods.

12 The general approaches to conveyance could be implemented with facilities of different diversion
13 and conveyance capacities (i.e., 3,000, 6,000, 9,000, or 15,000 cubic feet per second [cfs]). The
14 ultimate decisions regarding what capacities should be addressed in particular EIR/EIS alternatives
15 would depend in large part on how differing capacities would affect overall SWP/CVP systems
16 operations. Operational issues are discussed below in the following sections.

17 **9.1.3.2 Identifying Operational Concepts**

18 Steering Committee workgroups and technical teams developed the operational and restoration
19 concepts for the EIR/EIS alternatives through an iterative process from 2006 to 2010. Further
20 refinements were made to the BDCP Proposed Action and take alternatives in 2013 after the
21 EIR/EIS alternatives were selected. This process is discussed in detail in Appendix 3.A, *Background*
22 *on the Process of Developing the BDCP Conservation Measures*, and EIR/EIS Appendix 3A,
23 *Identification of Water Conveyance Alternatives Conservation Measure 1*) and summarized below.

24 In 2008, the Steering Committee approved a draft set of elements of a conservation strategy, which
25 was evaluated by the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) to refine
26 existing, and develop new, Delta-specific restoration actions. Based on the DRERIP analysis, the
27 Steering Committee performed additional analyses to further evaluate water conveyance and
28 operations, taking into account climate change; north Delta bypass flows and operations; tidal
29 marsh and Delta simulations; daily operations; and Delta island consumptive use.

30 In 2011, state and federal agencies and environmental organizations identified a range of north
31 Delta intake capacities and several additional conveyance operation concepts.

32 Screening of these concepts generated a list of 21 potential EIR/EIS alternatives, which were then
33 evaluated according to the first-, second-, and third-level screening criteria described above. At this
34 point, conveyance and operational scenarios that would likely be inconsistent with federal or state
35 statutes or regulations, or that had potentially undesirable policy implications, were flagged for
36 elimination. The final list of conveyance and operational scenarios was evaluated for consistency
37 relative to legal rights and entitlements of entities that are not BDCP participants and whose legal
38 rights and entitlements are beyond the authority and reach of the California Department of Fish and
39 Wildlife (CDFW), USFWS, and NMFS (also referred to as the fish and wildlife agencies). Specifically,
40 operational scenarios were evaluated to determine whether the alternative would result in the
41 impairment of existing senior water rights. Based on preliminary model analysis, it was determined

1 that two of the operational scenarios carried through the second screening would result in
2 reductions in water deliveries to Sacramento River water rights holders.⁴ All of the other
3 operational scenarios carried through the second screening were determined to be consistent with
4 legal rights of entities outside the BDCP.

5 At this point, conveyance, operations, and restoration concepts had been identified and screened.
6 These were then assembled into a range of alternatives for evaluation in the EIR/EIS. During the
7 second screening, it had been determined that the conveyance facilities for some dual conveyance
8 concepts would be identical except for the number of north Delta intakes and that the footprint of
9 disturbance for construction of a tunnel would be substantially the same for a range of north Delta
10 intake capacities between 6,000 and 15,000 cfs (3,000 cfs alternatives were also considered; these
11 alternatives have a substantially smaller project footprint). It was also determined that results of
12 detailed analyses of construction of conveyance facilities with an eastern canal or western canal for
13 dual conveyance concepts would be adequate to disclose adverse impacts and benefits.
14 Consequently, conveyance concepts that would not substantially differ in scope of impacts were
15 dismissed. The remaining conveyance concepts were renumbered for clarity and carried forward for
16 analysis in the EIR/EIS.

17 **9.1.3.2.1 Refinement of Operating Criteria**

18 Further refinement of the CM1 operating criteria for the BDCP Proposed Action occurred after
19 selection of the EIR/EIS alternatives, in a process that began in mid-2010 and continued into spring
20 2013.

21 **9.1.3.2.2 Preliminary Proposal and Scenario 6 Operations**

22 The evaluation and screening process for EIR/EIS alternatives, described above, combined with
23 various biological and policy-level discussions in December 2009 and January 2010, led to a draft set
24 of long-term water operations criteria for evaluation in the effects analysis for the BDCP, which at
25 that time included five north Delta intakes with a combined capacity of 15,000 cfs, and conveyance
26 via a tunnel. These criteria comprised the *preliminary proposal*. These water criteria were presented
27 in the November 2010 preliminary administrative draft BDCP, and were analyzed in the effects
28 analysis that appeared in the February 2012 administrative draft BDCP. Aspects of that analysis
29 focused on entrainment, Delta flow, salinity, and upstream rearing and spawning habitat. During
30 discussions associated with initial effects analysis on the preliminary proposal, a variant operational
31 proposal known as Scenario 6 was developed in collaboration with the fish and wildlife agencies.
32 This proposal, in comparison with the preliminary proposal, provided more restrictive south Delta
33 operations and a Fall X2 requirement. The February 2012 effects analysis also included analysis of
34 the Scenario 6 criteria⁵.

35 **9.1.3.2.3 Modified Spring Outflow Criteria**

36 In spring 2012, the fish and wildlife agencies were tasked with developing operating criteria to
37 provide for improved spring outflow. Initial model runs in support of a potential new operational

⁴ Discussed in detail in EIR/EIS Appendix 3A, *Identification of Water Conveyance Alternatives for Bay Delta Conservation Plan Environmental Impact Report/Environmental Impact Statement* [Screening Report] [Conservation Measure 1].

⁵ See Appendix 5.J, *Scenario 6 Comparison*, in the February 2012 administrative draft BDCP.

1 scenario focused on maximizing ecological benefits for aquatic covered species in the Delta,
 2 assuming that only flow changes would provide benefits, without consideration of the likely benefits
 3 provided by the Plan’s other conservation measures. This scenario⁶ was acknowledged at the outset
 4 to be a very rough approximation of desired flow conditions that attempted to balance the following
 5 needs.

- 6 • The unique needs for competing species.
- 7 • The need to protect the Shasta River cold water pool.
- 8 • The need to protect other beneficial uses.

9 Analysis showed that by meeting the modified spring outflow target and protecting the Shasta
 10 Reservoir cold water pool, unacceptable impacts would occur on Trinity, Folsom, and Oroville
 11 Reservoirs. These unacceptable adverse effects included hydropower generation and recreation use
 12 of the reservoirs. Of greater concern, however, was the potential impact on the cold water pool in
 13 Shasta Reservoir needed for winter run salmon, which would be adversely affected by proposed
 14 high spring outflows for longfin smelt if adverse effects on other reservoirs were avoided. Reduced
 15 storage in Folsom Reservoir could also lead to adverse biological impacts from temperature
 16 increases on the Lower American River. Further drawdown of Trinity Reservoir could be
 17 inconsistent with the 2000 Trinity River Flow Decision, intended to restore fisheries to the Trinity
 18 River after decades of adverse effects resulting from excessive exports from the Trinity/Klamath
 19 coastal watershed to the Sacramento River through Whiskey Town Reservoir. Other adverse
 20 impacts could include groundwater overdraft from upstream water users who might lose part of
 21 their existing water supply to greatly increased outflows.

22 In light of these potential adverse effects, proposed operations were adjusted to maintain outflows
 23 as high as possible, consistent with avoiding such adverse effects, meeting the BDCP objectives and
 24 other policies of the Delta Reform Act, and contributing to the recovery of the covered species
 25 intended to benefit from the BDCP. Subsequently, additional modeling and analysis determined how
 26 much the initial modified spring outflow could be provided without impacts on upstream biological
 27 resources, water bodies, water users, and other upstream project purposes for the SWP and CVP.

28 **9.1.3.2.4 Proposed Water Facility Operations**

29 Based on agency comments and review of the effects analysis, the operating criteria for the water
 30 facility (CM1) were revised to improve the expected biological outcomes for covered species. The
 31 detailed criteria are presented in Chapter 3, Section 3.4.1.4.3, *Flow Criteria*. The criteria vary
 32 seasonally and with water year type; additional constraints apply, as detailed in CM1. The flow
 33 criteria are based on management of Old and Middle River flows, Head of Old River gate operations,
 34 Delta outflow, north Delta bypass flows, and the export-to-inflow ratio. Related to fall and spring
 35 outflow, the CM1 operations incorporate a decision tree process that includes a low-outflow
 36 scenario and a high-outflow scenario, variations of which can result in substantial differences in
 37 water supply.

⁶ This scenario was known informally as *Combined Scenario 5* (CS5)

1 **9.1.3.3 Development and Selection of Alternate Approaches to Natural**
 2 **Community Restoration**

3 Alternative approaches to natural community restoration were also considered in the development
 4 of take alternatives. Altering CM4, CM5, and CM6 would substantially change the levels of take and
 5 beneficial effects for covered species, and these conservation measures can be readily scaled to
 6 produce alternative scenarios. Conservation measures that do not vary by take alternative relate
 7 either to the terrestrial species (CM3, CM6 through CM11) or to aquatic other stressors (CM12
 8 through CM21). Changing or removing these conservation measures would not result in reduced
 9 levels of take, but would reduce species benefits. CM2 and CM18 may result increased level of take
 10 for some terrestrial species; however, CM2 and CM18 are the same for all take alternatives.
 11 Consequently, conservation measures and other covered activities not specifically identified in this
 12 chapter are held constant for each take alternative.

13 The conservation strategy for terrestrial species was designed to contribute to the conservation of
 14 the covered species in the Plan Area. Many of the terrestrial species overlap in their conservation
 15 needs (e.g., restoration of one natural community benefits multiple covered species), so a single
 16 strategy was developed to meet those needs. It was not feasible to develop a smaller reserve system
 17 (CM3, CM11), for example, because it risks no longer meeting the regulatory standards for some of
 18 the terrestrial covered species: to minimize and mitigate to the maximum extent practicable (ESA
 19 standard), and to provide for the conservation and management of the species in the Plan Area
 20 (NCCPA standard). A larger reserve system would meet the regulatory standards, but would be
 21 infeasible due to cost, existing land uses, infrastructure, and implementation constraints (e.g., vernal
 22 pool and alkali seasonal wetland restoration opportunities are limited in the Plan Area, and
 23 additional restoration would not have been feasible). For additional information see Appendix 3.A,
 24 *Background on the Process of Developing the BDCP Conservation Measures*.

25 Other stressors conservation measures (CM12 through CM21) are intended to contribute to the
 26 conservation of the covered fish species. Varying take alternatives using fewer other stressors
 27 conservation measures (or in some cases less of the same measures) was considered, but not
 28 applied because the other stressors conservation measures represent a small part of the overall
 29 conservation strategy and would not contribute to substantial differences between take alternatives.

30 **9.1.4 Development of Take Alternatives**

31 Most of the take alternatives were developed using the EIR/EIS alternatives as a basis. As discussed,
 32 an extensive process to develop and screen alternatives for the EIR/EIS (Section 9.1.3, *Development*
 33 *of the BDCP Proposed Action*) focused on the identification of alternatives that reduced the scope and
 34 intensity of potential environmental effects, including adverse effects on covered fish and wildlife
 35 species. It was thus appropriate that the process of identifying ESA take alternatives started with the
 36 EIR/EIS alternatives. This approach has ensured consistency in the analyses of alternatives in the
 37 EIR/EIS and in the BDCP, and has allowed for substantial modeling and other analyses to be used in
 38 both documents. The take alternatives, however, have been developed to allow for a more focused
 39 analysis of the effects of different project components on covered fish and wildlife species. A
 40 complete description of the EIR/EIS alternatives can be found in EIR/EIS Chapter 3, *Description of*
 41 *Alternatives*.

42 The 15 EIR/EIS alternatives were screened to include only those alternatives that were initially
 43 predicted to result in different levels of incidental take or conservation benefit for at least some

1 covered fish and wildlife species. This criterion resulted in using eight EIR/EIS alternatives as a
 2 basis for take alternatives (Table 9-1); seven of the EIR/EIS alternatives were eliminated as a basis
 3 for take alternatives, for reasons described in Table 9-2.

4 **Table 9-1. Take Alternatives Evaluated**

Take Alternative	Take Alternative Description	Equivalent or Similar EIR/EIS Alternative
BDCP Proposed Action	Dual conveyance with Intakes 2, 3, and 5, and up to 9,000 cfs diversion capacity	Alternative 4
A: W Canal 15,000 cfs	Dual conveyance with west canal alignment, Intakes W1 through W5, and up to 15,000 cfs diversion capacity	Alternative 1C
B: Tunnels 6,000 cfs	Dual conveyance with Intakes 1 and 2 and up to 6,000 cfs north Delta diversion capacity	Alternative 3
C: Tunnels 15,000 cfs	Dual conveyance with pipelines and tunnels alignment, five intakes, and up to 15,000 cfs diversion capacity	Alternative 1A
D: Tunnels 3,000 cfs	Dual conveyance with Intake 1 with up to 3,000 cfs north Delta diversion capacity; reduce tidal natural communities restoration to 40,000 acres	Alternative 5
E: Isolated 15,000 cfs	Isolated conveyance with pipeline and five intakes, with up to 15,000 cfs north Delta diversion capacity	Alternative 6A
F: Through Delta	Through Delta conveyance with Delta channel modifications and different intake locations	Alternative 9
G: Less Tidal Restoration	Reduce tidal natural communities restoration to 50,000 acres	Alternative 4, except amount of tidal restoration in CM4 is reduced.
H: More Restoration	Increase tidal natural communities restoration to 75,000 acres, seasonally inundated floodplain restoration to 20,000 acres, and channel margin enhancement to 40 linear miles	Alternative 7, except tidal natural communities restoration under CM4 is increased.
I: Modified Spring Outflow	Increase spring outflow to 44,500 cfs	Alternative 4, except March through May outflow increased to 44,500 cfs
Notes: cfs = cubic feet per second		

5

1 **Table 9-2. EIR/EIS Alternatives Not Used as Basis for Take Alternatives**

EIR/EIS Alternative Not Used as Basis for Take Alternative	Rationale
Alternative 1B —Dual conveyance with east canal alignment and Intakes 1-5 (15,000 cfs)	Similar to Take Alternative C . Analysis of western canal (Take Alternative A) would be adequate to disclose adverse impacts and benefits that could occur with this eastern alignment and would also accommodate analysis of western intakes.
Alternative 2A —Dual conveyance pipelines and tunnels alignment, with east alignment and five intakes (15,000 cfs)	Impacts and benefits would not substantially differ from Take Alternative C .
Alternative 2B —Dual conveyance with east canal alignment and five intakes (15,000 cfs)	Analysis of western canal (Take Alternative A) would be adequate to disclose adverse impacts and benefits that could occur with eastern alignment and would also accommodate analysis of western intakes.
Alternative 2C —Dual conveyance with west canal alignment and Intakes W1-W5 (15,000 cfs)	Impacts and benefits would not substantially differ from Take Alternative A , and would also accommodate analysis of western intakes
Alternative 6B —Isolated conveyance with east canal alignment and Intakes 1-5 (15,000 cfs)	Analysis of Take Alternative A would be adequate to disclose adverse impacts and benefits that could occur with eastern canal alignment. Analysis of Take Alternative E sufficient to evaluate impacts of isolated conveyance.
Alternative 6C —Isolated Conveyance with West Alignment and Intakes W1-W5 (15,000 cfs)	Similar to Take Alternative A , and impacts and benefits would not substantially differ from Take Alternatives C and E .
Alternative 8 —Dual Conveyance with pipelines and tunnels alignment, Intakes 2, 3, and 5, and Increased Delta Outflow (9,000 cfs)	Impacts and benefits would not substantially differ from the BDCP Proposed Action.
Notes: cfs = cubic feet per second	

2

3 **9.1.4.1 Relationship Between the Take Alternatives and the Alternatives**

4 **in the EIR/EIS**

5 As described above, a range of project alternatives has been identified and evaluated in the EIR/EIS

6 to satisfy separate regulatory requirements of CEQA and NEPA. The EIR/EIS for the BDCP identifies

7 a reasonable range of project alternatives and evaluates the potential environmental impacts of

8 those alternatives in relation to the no-action or no-project alternative. The analysis of take

9 alternatives in this chapter serves a more specific and narrow regulatory purpose under the ESA. In

10 this chapter, take alternatives are evaluated against a set of criteria in comparison to the BDCP

11 Proposed Action (Section 9.3, *Methods of Analysis*).

12 Some EIR/EIS alternatives were used as a basis for the take alternatives. However, except for

13 Alternative 4 (equivalent to the BDCP Proposed Action), these EIR/EIS alternatives do not include

14 the high-outflow scenario and other water facility operating criteria that are part of the BDCP

15 Proposed Action. To provide a clear comparison of take alternatives, the EIR/EIS alternatives were

1 modified where needed in this chapter (as take alternatives) to incorporate the same operational
 2 criteria included in the BDCP Proposed Action (e.g., high-outflow scenario, south Delta operations).
 3 A single-bore tunnel, rather than a dual-bore tunnel was considered for the Take Alternative D
 4 (Tunnels 3,000 cfs). However, a single tunnel would not provide the necessary reliability. A
 5 catastrophic failure of the single tunnel could prevent operations of the north Delta diversions from
 6 six months to 18 months, depending on the nature of damage. Dual tunnels, however, meet the BDCP
 7 reliability goal by enabling the system to continue operating in the event of a catastrophic failure of
 8 one of the tunnels, though at a reduced capacity.

9 The EIR/EIS alternatives chosen as the basis for take alternatives were modified further to include
 10 alternative approaches to natural community restoration that would increase or decrease the take
 11 of terrestrial covered species and change the level of ecological benefit to aquatic species. The
 12 process to develop alternative approaches to natural community restoration and the rationale used
 13 to select different levels of ecological restoration incorporated into the take alternatives is described
 14 in Section 9.1.3.3, *Development and Selection of Alternate Approaches to Natural Community*
 15 *Restoration*.

16 An additional take alternative was evaluated that provides more spring outflow than the BDCP high-
 17 outflow scenario. In this take alternative, spring outflow is 44,500 cfs of average monthly outflow for
 18 March, April, and May in 50% of years. (In comparison, the BDCP Proposed Action high-outflow
 19 scenario would result in an average outflow of 44,500 cfs or above from March to May in
 20 approximately 20% of the years.) All other components of this take alternative are the same as the
 21 BDCP high-outflow scenario. This take alternative was included in order to evaluate the differences
 22 in take and practicability of providing more outflow for covered fish than the BDCP Proposed Action.
 23 More detail on all take alternatives is provided in Section 9.2, *Descriptions of Take Alternatives*.

24 **9.1.4.2 Alternative Approaches to CM4 Tidal Natural Communities**
 25 **Restoration**

26 The BDCP Proposed Action would restore 65,000 acres of tidal wetland natural community and
 27 associated upland transitional areas. This acreage target was developed via a planning process
 28 described in Appendix 3.A, *Background on the Process of Developing the BDCP Conservation Measures*
 29 *(Section 3.A.7.3.1.5 Establishing Natural Community Enhancement and Restoration Targets)*.
 30 Principal criteria used to evaluate the potential acreage of tidal wetland restoration included land
 31 surface elevations, land uses, land ownership, infrastructure, and potential tidal connectivity (Delta
 32 Habitat Conservation and Conveyance Program 2012), but the complete process included evaluation
 33 of 17 different variables coupled with extensive analysis of geographic data.

34 Ultimately, a restoration target of 65,000 acres (55,000 of subtidal and intertidal habitat, and 10,000
 35 acres of transitional uplands) was determined to represent the best balance of biological and
 36 physical criteria for tidal restoration within the Plan Area. Based on this analysis and the screening
 37 criteria, three different tidal natural communities restoration targets based on total area restored
 38 are considered in the take alternatives.

- 39 ● Restoration of 75,000 acres, which would include all the very high-value, high-value, and most of
 40 the moderate-value acres. This take alternative would increase costs and reduce the
 41 practicability of the conservation strategy but would increase benefits to some covered species.
- 42 ● Restoration of 50,000 acres, which would include only very high-value and most (89%) of the
 43 high-value tidal natural communities restoration opportunities. This take alternative would

1 provide fewer benefits to covered species dependent on tidal wetlands but would reduce take of
 2 covered species associated with cultivated land (the primary source of restoration sites).

- 3 • Restoration of 40,000 acres, the lowest level of tidal natural communities restoration
- 4 considered, which would be paired with the 3,000 cfs north Delta conveyance alternative in the
- 5 EIR/EIS.

6 **9.1.4.3 Alternative Approaches to CM5 Seasonally Inundated Floodplain**
 7 **Restoration**

8 The BDCP Proposed Action would restore 10,000 acres of seasonally inundated floodplain.
 9 Locations suitable for restoring seasonally inundated floodplain were identified based on the
 10 following major criteria.

- 11 • Land surface elevations relative to mean sea level.
- 12 • Existing ecological values of potentially affected habitats.
- 13 • Opportunities to recreate historical connectivity of floodplains with tidal marshes.
- 14 • Land uses.
- 15 • Opportunities to coincidentally improve capacity of the flood control system.

16 The primary opportunities for creating floodplain habitats would entail breaching or setting back
 17 levees along the Old, Middle, and San Joaquin Rivers. Different levee setback distances from either
 18 side of these river channels were evaluated. Restoration of 10,000 acres could be accommodated by
 19 setting back levees by approximately 1,500 feet along approximately 29 miles of the San Joaquin
 20 River between Vernalis and French Camp Slough and 12 miles of Old River and/or Middle River (for
 21 detailed assumptions regarding the location and configuration of setback levees see Chapter 8,
 22 *Implementation Costs and Funding Sources*). The extent of restoration could be reduced or increased
 23 by either increasing or decreasing the length of levees that are set back. Setback distances ranging
 24 from 500 feet upwards were considered (BDCP Steering Committee 2009). Increasing the restored
 25 floodplain acreage target, however, was not deemed practicable because sufficient flood flows to
 26 inundate a larger area would likely only occur at very low frequencies, resulting in a minimal
 27 increase in benefits for covered fish species (*Appendix 3.A, Background on the Process of Developing*
 28 *the BDCP Conservation Measures*). However, for the purpose of analysis, the take alternatives
 29 consider either 10,000 or 20,000 acres of seasonally inundated floodplain restoration.

30 **9.1.4.4 Alternative Approaches to CM6 Channel Margin Enhancement**

31 The BDCP Proposed Action would restore 20 miles of channel margin. This target was established to
 32 enhance rearing and migration habitat for juvenile salmonids and to mitigate effects of the
 33 construction of intakes along the Sacramento River. Restoration would occur along channels used by
 34 migrating juvenile salmonids. The Habitat Restoration Program Technical Team coordinated with
 35 NMFS to identify opportunities for enhancing channel margin to benefit rearing and out-migrating
 36 juvenile salmonids. The team generally identified leveed channels along major juvenile salmonid
 37 migration pathways through the Delta (e.g., Sutter and Steamboat Sloughs and San Joaquin River).
 38 Potential linear distances of channel margin enhancement targets considered in developing CM6
 39 ranged from 15 miles to 55 miles. The 15-linear-mile target is based on channel margin
 40 enhancement along 20% of the channel lengths of Sutter and Steamboat Sloughs and San Joaquin
 41 River (BDCP Steering Committee 2009). The 55-mile target would be equivalent to channel margin

1 enhancement along 60% of total channel margin along Middle River, Steamboat and Sutter Sloughs,
 2 and the San Joaquin River from Vernalis to Mossdale (BDCP Steering Committee 2009).

3 Enhancement of 20 linear miles of channel margin was deemed sufficient to create a meaningful
 4 increase in this habitat type (Appendix 3.A, *Background on the Process of Developing the BDCP*
 5 *Conservation Measures*). For the purpose of analysis, the take alternatives consider either 20 or 40
 6 linear miles of channel margin enhancement.

7 **9.2 Descriptions of Take Alternatives**

8 This section summarizes the take alternatives, which differ primarily in the location and scale of
 9 water conveyance facilities and operations. Each take alternative would involve the construction of
 10 new conveyance facilities and improvements to the existing SWP and CVP south Delta export
 11 facilities. Additionally, each take alternative includes operating criteria for the water supply
 12 infrastructure and conservation measures. The take alternatives also vary with respect to the extent
 13 of habitat that would be restored and enhanced for tidal, floodplain, and channel margin natural
 14 communities (CM4, CM5, CM6).

15 The various approaches to water conveyance and habitat restoration were assembled in
 16 combinations to create a range of take alternatives that could be directly compared to the BDCP
 17 Proposed Action, including the covered activities, measures to minimize or mitigate project impacts,
 18 and actions designed to contribute to the conservation of covered species. Therefore, each take
 19 alternative includes one or more components that are different from the BDCP Proposed Action,
 20 allowing for a meaningful comparison. For each covered fish and wildlife species, the effect of
 21 changing these components was evaluated to assess the level of incidental take and conservation
 22 benefit in comparison with the BDCP Proposed Action (Section 9.4, *Level of Incidental Take by*
 23 *Species Group*).⁷

24 Table 9-3 provides a summary of each take alternative, including specific differences with the BDCP
 25 Proposed Action. Components that do not vary from the BDCP Proposed Action are not described.
 26 Similarly, components that differ among take alternatives but do not change the conclusions
 27 regarding level of potential take of covered fish or wildlife species are not identified. This approach
 28 is intended to highlight the differences between each take alternative and the BDCP Proposed Action
 29 that could affect the level of take. For some take alternatives, a single conservation measure has
 30 been altered; for others, multiple conservation measures have been altered.

31 Table 9-4 provides a summary of the conveyance facilities for each take alternative, including
 32 pipelines/tunnels, barriers, intakes, pumping plants, forebays, canals, and channels

33 Table 9-5 provides a summary of the differences in configuration, exports, restoration, and upland
 34 disturbance levels between the BDCP Proposed Action and the other alternatives to take. Table 9-6
 35 summarizes the effects that each take alternative would have on the covered natural communities.
 36 These effects are discussed in the following subsections for each take alternative. A brief summary
 37 of potential differences in the level of take is set out in Table 9-7 and take is described more fully in
 38 the analysis of each take alternative.

⁷ All estimates of incidental take are based on uncertain and unpredictable circumstances and are not intended to be precise.

1 **Table 9-3. Take Alternatives Overview**

Take Alternative	Take Alternative Description	Operational Criteria ^a	Average Annual Water Deliveries ^b	Primary Differences between Take Alternative and BDCP Proposed Action
BDCP Proposed Action	Dual conveyance with Intakes 2, 3, and 5, and up to 9,000 cfs diversion capacity	Decision tree for Fall X2 and spring outflow, Scenario 6 OMR, without San Joaquin River I/E ratio	4.71–5.59 MAF ^c north Delta: 49% south Delta: 51%	N/A
A: W Canal 15,000 cfs	Dual conveyance with west canal alignment, Intakes W1 through W5, and up to 15,000 cfs diversion capacity	Modified spring outflow, Fall X2, OMR criteria same as BiOp RPAs, without San Joaquin River I/E ratio	5.01 MAF north Delta: 52% south Delta: 48%	CM1 components: <ul style="list-style-type: none"> • Location and type of primary conveyance facility • Location of intakes and associated intake facilities • Number of pumping plants • Water facility components
B: Tunnels 6,000 cfs	Dual conveyance with Intakes 1 and 2 and up to 6,000 cfs north Delta diversion capacity	Modified spring outflow, Fall X2, Scenario 6 OMR criteria, without San Joaquin River I/E ratio	4.49 MAF north Delta: 41% south Delta: 59%	CM1 components: <ul style="list-style-type: none"> • Number and location of intakes and associated intake facilities • Number of pumping plants • Number of forebays • Location of conveyances pipelines and initial tunnel between intake pumping plants and intermediate forebay • North Delta diversion capacity • South Delta diversions
C: Tunnels 15,000 cfs	Dual conveyance with pipelines and tunnels alignment, five intakes, and up to 15,000 cfs diversion capacity	Same as Take Alternative A	5.01 MAF north Delta: 52% south Delta: 48%	CM1 components: <ul style="list-style-type: none"> • Number and location of intakes and associated intake facilities • Number of pumping plants • Number of forebays • Location of conveyances pipelines and initial tunnel between intake pumping plants and intermediate forebay • North Delta diversion capacity • South Delta diversions

Take Alternative	Take Alternative Description	Operational Criteria ^a	Average Annual Water Deliveries ^b	Primary Differences between Take Alternative and BDCP Proposed Action
D: Tunnels 3,000 cfs	Dual conveyance with Intake 1 with up to 3,000 cfs north Delta diversion capacity; reduce tidal natural communities restoration to 40,000 acres	Modified spring outflow, Fall X2, Scenario 6 OMR criteria, without San Joaquin River I/E ratio	4.19 MAF north Delta: 28% south Delta: 72%	CM1 components: <ul style="list-style-type: none"> • Number and location of intakes and associated intake facilities • Number of pumping plants • Number of forebays • Location of conveyances pipelines and initial tunnel between intake pumping plants and intermediate forebay • North Delta diversion capacity • South Delta diversions CM4 components: <ul style="list-style-type: none"> • Amount/location of tidal natural communities restored
E: Isolated 15,000 cfs	Isolated conveyance with pipeline and five intakes, with up to 15,000 cfs north Delta diversion capacity	Modified spring outflow and Fall X2; no south Delta criteria because it is not operating	3.40 MAF north Delta: 100% south Delta: 0%	CM1 components: <ul style="list-style-type: none"> • Operation of existing SWP and CVP south Delta export facilities for Clifton Court Forebay and Jones Pumping Plant • Number and location of intakes and associated intake facilities • Number of forebays
F: Through Delta	Through Delta conveyance with Delta channel modifications and different intake locations	Modified spring outflow and Fall X2, OMR criteria same as BiOp RPAs, without San Joaquin River I/E ratio except when flows at Vernalis > 10,000	4.17 MAF north Delta: 0% south Delta: 100%	CM1 components: <ul style="list-style-type: none"> • Location and type of primary conveyance facility • Number of intake pumping plants • Number of diversion pumping plants • Number of intermediate pumping plants
G: Less Tidal Restoration	Reduce tidal natural communities restoration to 50,000 acres ^c	Same as BDCP Proposed Action	4.71–5.59 MAF ^c north Delta: 49% south Delta: 51%	CM4 components: <ul style="list-style-type: none"> • Amount/location of tidal natural communities restoration

Take Alternative	Take Alternative Description	Operational Criteria ^a	Average Annual Water Deliveries ^b	Primary Differences between Take Alternative and BDCP Proposed Action
H: More Restoration	Increase tidal natural communities restoration to 75,000 acres, seasonally inundated floodplain restoration to 20,000 acres, and channel margin enhancement to 40 linear miles ^c	Same as BDCP Proposed Action	4.71–5.59 MAF ^c north Delta: 49% south Delta: 51%	CM4 components: <ul style="list-style-type: none"> Amount/location of tidal natural communities restoration CM5 components: <ul style="list-style-type: none"> Amount/location of seasonally inundated floodplain restoration CM6 components: <ul style="list-style-type: none"> Amount/location of channel margin enhancement
I: Modified Spring Outflow	Spring outflow at 44,500 cfs	Same as BDCP Proposed Action but modified spring outflow criteria (44,500 cfs in 50% of years instead of average monthly outflow scaled to the 90% forecast for the water year, with scaling ^c	4.34 MAF north Delta: 51% south Delta: 49%	CM1 components: <ul style="list-style-type: none"> Rate of flow for spring outflow operating criteria

Notes:

- ^a Reverse flow criteria improved from NMFS 2009 BiOp reasonable and prudent alternative.
- ^b Values are for the early long-term (2025). Entries with ranges represent take alternatives with the decision tree. Proportions associated with north Delta and south Delta represent the fraction of water deliveries from each point of diversion, on average based on the historic frequency of water year types.
- ^c Take Alternatives G and H include the same CM1 operating criteria as is included in the BDCP Proposed Action. Although the water supply shown for these take alternatives is the same as what is shown for the BDCP Proposed Action, Take Alternatives G and H include different restoration configurations for CM4 than the BDCP Proposed Action. These differences in tidal wetland restoration may affect the outflow requirements and therefore may result in different water supply than what is shown in this table. No information exists to more specifically estimate water supply for these take alternatives. Therefore, the water supply shown in this table is a reasonable estimate. The March through May average outflow criteria for the high-outflow outcome of the spring outflow decisions tree are noted as follows.

Exceedance	10%	20%	30%	40%	50%	60%	70%	80%	90%
Outflow criterion (cfs)	>44,500	>44,500	>35,00	>32,00	>23,00	17,200	13,300	11,400	9,200

OMR = Old and Middle River; I/E ratio = inflow/export ratio MAF = million acre-feet; BiOp = biological opinion; RPA = reasonable and prudent alternative; cfs = cubic feet per second; TBD = to be determined; HOS = high-outflow scenario; SWP = State Water Project; CVP = Central Valley Project

1 **Table 9-4. Water Conveyance Facilities Components of Each Take Alternative**

Water Conveyance Component	BDCP Proposed Action ^a 9,000 cfs	Take Alternative								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified spring Outflow
Similar EIR/EIS Alternative	4	1C	3	1A	5	6A	9	4	7	4
Pipelines/tunnels	X	X	X	X	X	X		X	X	X
Canals		X								
Channels							X			
New operable barriers	X						X			X
Fish movement and habitat corridor around Clifton Court Forebay							X			
New north Delta fish screened intakes	X	X	X	X	X	X	X ^b	X	X	X
New intake pumping plants	X	X	X	X	X	X		X	X	X
New diversion pumping plants							X			
New intermediate pumping plant		X	X	X	X	X				
Use of existing SWP and CVP south Delta intake facilities	X	X	X	X	X		X	X	X	X
Byron Tract Forebay ^c		X	X	X	X	X				
Expanded Clifton Court Forebay ^d	X							X	X	X
Intermediate forebay	X		X	X	X	X		X	X	X
Notes:										
^a The BDCP Proposed Action is described in Chapter 3, <i>Conservation Strategy</i> , and Chapter 4, <i>Covered Activities and Associated Federal Actions</i> .										
^b Includes screened diversion barriers instead of intakes.										
^c Byron Tract Forebay refers to a proposed forebay either north or south of Clifton Court Forebay, depending on the take alternative.										
^d Expanded Clifton Court Forebay refers to an expansion of Clifton Court Forebay to the south in the same area that would be occupied by the Byron Tract Forebay in other take alternatives.										
cfs = cubic feet per second; SWP = State Water Project; CVP = Central Valley Project										

1 **Table 9-5. Primary Differences in Take Alternatives, Relative to the BDCP Proposed Action**

Feature	Take Alternative									
	BDCP Proposed Action (Tunnels 9,000 cfs)	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Number of intakes	3	5	2	5	1	5	2 ^a	3	3	3
Diversion capacity	9,000 cfs	15,000 cfs	6,000 cfs	15,000 cfs	3,000 cfs	15,000 cfs	15,000 cfs	9,000 cfs	9,000 cfs	9,000 cfs
Conveyance type	Tunnel	Canal and Tunnel	Tunnel	Tunnel	Tunnel	Tunnel	River channels	Tunnel	Tunnel	Tunnel
Conveyance operation	Dual	Dual	Dual	Dual	Dual	Isolated	N/A	Dual	Dual	Dual
New forebays	1	1	2	2	2	2	0	1	1	1
Total average annual project deliveries (at ELT)	4.71 MAF	+6%	-5%	+6%	-11%	-28%	-11%	0%	0%	-8%
North Delta	2.31 MAF	+14%	-21%	+14%	-48%	+49%	-100%	0%	0%	-4%
South Delta	2.40 MAF	-1%	+11%	-1%	+25%	-100%	+73%	0%	0%	-13%
Tidal habitat restoration	65,000 acres	0%	0%	0%	-38%	0%	0%	-23%	+15%	0%
Seasonal floodplain restoration	10,000 acres	0%	0%	0%	0%	0%	0%	0%	+100%	0%
Channel margin restoration	20 miles	0%	0%	0%	0%	0%	0%	0%	+100%	0%
Total project footprint ^b	129,439 acres	+2.5%	-1.4%	-1.1%	-1.5%	-1.1%	-6.2%	0%	-1.3%	0%

Notes:

^a Intakes are diversion structures blocking fish access to Georgiana Slough and the Delta Cross Channel rather than typical pump intakes. cfs = cubic feet per second; ELT = early long-term

^b Total project footprint includes all temporary and permanent construction areas of the water conveyance facility, plus all natural community restoration.

1 **Table 9-6. Permanent Effects by Natural Community and Take Alternative Relative to the BDCP Proposed Action**

	BDCP Proposed Action 9,000 cfs	Take Alternative								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Natural Community^a										
Tidal perennial aquatic	206	-153	-139	-130	-143	-130	497	N/A	N/A	0
Tidal mudflat	0	0	0	0	0	0	0	N/A	N/A	0
Tidal brackish emergent wetland	1	0	0	0	0	0	0	N/A	N/A	0
Tidal freshwater emergent wetland	14	-6	0	0	0	0	55	N/A	N/A	0
Valley/foothill riparian	718	5	14	24	12	24	27	N/A	N/A	0
Nontidal perennial aquatic	298	-34	-44	-44	-44	-44	-56	N/A	N/A	0
Nontidal freshwater perennial emergent wetland	126	-1	0	0	0	0	0	N/A	N/A	0
Alkali seasonal wetland complex	72	13	0	0	0	0	0	N/A	N/A	0
Vernal pool complex	67 ^b	14	0 ^b	-0 ^b	0 ^b	-0 ^b	0 ^b	N/A	N/A	0 ^b
Managed wetland	13,777	-7	-4	-4	-4	-4	1	N/A	N/A	0
Other natural seasonal wetland	0	2	0	0	0	0	0	N/A	N/A	0
Grassland	2,516	-102	-155	-145	-166	-145	-378	N/A	N/A	0
Inland dune scrub	0	0	0	0	0	0	0	N/A	N/A	0
Cultivated lands	55,372	1,485	-881	-751	-930	-751	-4,238	N/A	N/A	0
Total	73,167	1,216	-1,209	-1,050	-1,275	-1,050	-4,092	N/A	N/A	0
% Difference BDCP Proposed Action	--	1.6%	-1.6%	-1.4%	-1.7%	-1.4%	-5.6%	-20.8%	13.8%	0%
Notes:										
^a Areas categorized as developed or urban are not included in this table because they are not considered natural communities.										
^b Total permanent loss reduced (CM4). This reduction is based on a 10-acre cap for total loss of wetted acres, assuming 15% density of vernal pools in the area affected. Acreage of vernal pool complex loss may be higher if actual vernal pool density is lower. The maximum acreage loss is based on loss of wetted acres and not total vernal pool complex acreage.										
N/A = not available. The difference in the amount of habitat restoration was not mapped to allow for analysis of differences in effects on each natural community.										

1 **Table 9-7. Summary of Change in Take Relative to the BDCP Proposed Action**

Take Alternative	Change in Take or Conservation Benefit - Covered Wildlife Species	Change in Take or Conservation Benefit: Covered Fish Species	Change in Permanent Effects on Natural Communities
A: W Canal 15,000 cfs	Reduce take of 4 covered wildlife species but increase take of 18 covered wildlife species due to differences in conveyance facility footprint.	Increase take of 10 covered fish species due to increased number of intakes.	Increase by 1.6%.
B: Tunnels 6,000 cfs	Reduce take of 12 covered wildlife species but increase take of 4 covered wildlife species.	Reduce take of 2 covered fish species at the north Delta intakes but increase take of 8 covered aquatic species due to heavier reliance on south Delta diversions.	Decrease by 1.6%.
C: Tunnels 15,000 cfs	Reduce take of 11 covered wildlife species. Increase take of 4 covered wildlife species due to increased number of intakes.	Would not avoid or reduce take of any covered fish species. Increase take of 10 covered fish species due to increased number of intakes.	Decrease by 1.4%.
D: Tunnels 3,000 cfs	Reduce take of 20 covered wildlife species due to fewer intakes and reduced tidal habitat restoration. Reduced conservation benefit for 5 covered wildlife species.	Increase take of 8 covered fish species and reduce take for 2 covered fish species. Reduce benefit to fish from less tidal natural communities restoration.	Decrease by 1.7%.
E: Isolated 15,000 cfs	Reduce take of 11 covered wildlife species. Increase take of 4 covered wildlife species due to increased number of intakes.	Reduce take of 9 covered fish species at north Delta intakes only. Increase take of 2 fish species due to increased number of intakes.	Decrease by 1.4%.
F: Through Delta	Reduce take of 9 covered wildlife species and increase take of 8 covered wildlife species	Increased take of 11 covered fish species due to the longer fish screen, greater dredging, and wider distribution of construction activities and operational effects.	Decrease by 5.6%
G: Less Tidal Restoration	Reduce take of 20 covered wildlife species from reduced tidal natural communities restoration, but reduce conservation benefit for 5 covered wildlife species.	Decrease benefits to covered fish species.	Decrease by 20.8%
H: More Restoration	Increase take of 25 terrestrial species, but increase conservation benefit for 9 covered wildlife species.	Reduce take of 11 covered fish species and increase aquatic species conservation benefit from increased tidal habitat, floodplain and channel margin restoration.	Increase by 13.8%.
I: Modified Spring Outflow	No change	No substantial changes in the level of take of the covered fish, although 5 species would likely experience greater conservation benefits.	No change

1 **9.2.1 Take Alternative A: W Canal 15,000 cfs**

2 Under **Take Alternative A: W Canal 15,000 cfs (dual conveyance with Intakes 2, 3, and 5, and**
 3 **up to 9,000 cfs diversion capacity)**, five rather than three fish-screened intakes on the west bank
 4 of the Sacramento River between Clarksburg and Walnut Grove would be installed to divert water
 5 into pipelines leading to intake pumping plants. The intakes and water conveyance facilities would
 6 be shifted to the west rather than east side of the Sacramento River; **Take Alternative A** is the only
 7 take alternative with intakes and conveyance facilities on the west side of the Sacramento River.
 8 Water would travel through sedimentation basins and be pumped into another set of pipelines to a
 9 lined or unlined canal, rather than conveying water through subsurface tunnels. Water would be
 10 carried south along the western side of the Delta to an intermediate pumping plant, rather than an
 11 intermediate forebay, and then pumped through a tunnel to a continuing canal to Byron Tract
 12 Forebay immediately northwest of Clifton Court Forebay. Along the conveyance route, diverted
 13 water would travel under existing watercourses and would make one rail crossing through culvert
 14 siphons. In addition, Byron Tract Forebay would be designed to provide water to Jones Pumping
 15 Plant 24 hours per day. This arrangement would enhance water supply operational flexibility, using
 16 forebay storage capacity to regulate flows from north Delta intakes to south Delta pumping plants.
 17 Use of existing SWP/CVP south Delta export facilities would continue. This facility could convey up
 18 to 15,000 cfs from the north Delta. The west alignment would be approximately 52 miles long from
 19 the north Delta intakes to the Byron Tract Forebay.

20 The new water facility components would include the following elements.

- 21 • Conveyance pipelines between transition structures and canal transition structures with radial
22 gates and stop logs.
- 23 • Lined or unlined canal between the intake pumping plants and an intermediate pumping plant.
- 24 • An intermediate pumping plant at the entrance of a tunnel would convey diverted water
25 through the tunnel.
- 26 • A dual-bore tunnel extending 17 miles between the intermediate pumping plant and a second
27 canal segment.
- 28 • A lined or unlined canal between the tunnel exit portal and Byron Tract Forebay.
- 29 • Byron Tract Forebay, adjacent to and northwest of Clifton Court Forebay, with large-diameter
30 tunnel boring machine (TBM) launch/retrieval shafts and vent shafts at approximate 3-mile
31 intervals.
- 32 • Connections to the Banks and Jones pumping plants, comprising a canal between Byron Tract
33 Forebay and the approach canals to the Banks and Jones pumping plants and sets of gates in the
34 approach canals upstream of the connection to the canal from Byron Tract Forebay.
- 35 • Nine inverted culvert siphons along the conveyance alignment to convey diverted water under
36 ten existing shallow watercourses and one rail line.
- 37 • Sixteen bridge crossings along the conveyance alignment.
- 38 • Other road and utility crossings, including drainage and irrigation facilities.

1 A map and schematic depicting the conveyance facilities associated with **Take Alternative A** are
 2 provided in Figure 9-1 and Figure 9-2. The characteristics of the take alternative are summarized in
 3 Table 9-3, and the water conveyance components are summarized in Table 9-4.

4 **Take Alternative A** water conveyance operating criteria would include the same operational
 5 elements as those included in the BDCP Proposed Action (Fall X2 and spring outflow), with the
 6 exception of decision trees for spring and fall outflows (Chapter 3, Section 3.4.1.4.4, *Decision Trees*).
 7 Operating criteria for the Sacramento and Lisbon Weirs, Delta Cross Channel gate operations, Delta
 8 water quality and residence criteria; and the in-delta municipal, industrial and agricultural water
 9 quality requirements criteria would be the same as the BDCP Proposed Action. The following
 10 operating criteria differ from the BDCP Proposed Action.

- 11 ● North Delta diversion bypass flow criteria: restrictive, diversions of up to 6% of river flow from
 12 December to June allowed when flows are greater than 5,000 cfs and during post-pulse
 13 operations; percentages would not be required to vary linearly over a 10-day period.
- 14 ● South Delta channel flow criteria: Old and Middle River flow criteria based on the USFWS 2008
 15 biological opinion (BiOp) and NMFS 2009 BiOp related to adaptive restrictions for temperature,
 16 turbidity, salinity and presence of delta smelt. South Delta Export-San Joaquin River inflow ratio
 17 would use a single sliding scale for flow in excess of the Old and Middle River criteria; no set
 18 ratio for December to March and June.
- 19 ● Fremont Weir and Yolo Bypass criteria: Fremont Weir would include a smaller opening with
 20 operable gates and fish passage enhancement at 11.5 feet. Fremont Weir gate operations would
 21 include opening both the 17.5- and 11.5-foot elevation gates when Sacramento River flows are
 22 greater than 25,000 cfs with a lower maximum Yolo Bypass inundation of 6,000 cfs.
- 23 ● Rio Vista minimum instream flow criteria; minimum January through August flows would be
 24 lower; 3,000 cfs.
- 25 ● Delta inflow and outflow criteria: in accordance with the State Water Resources Control Board
 26 D-1641 (State Water Resources Control Board and the California Environmental Protection
 27 Agency 2010).

28 **9.2.1.1 Incidental Take and Conservation Benefits**

29 Relative to the BDCP Proposed Action, **Take Alternative A** would avoid or reduce take for some
 30 covered wildlife species and increase take for most covered fish species by altering the following
 31 components of CM1.

- 32 ● Location and type of primary conveyance structure.
- 33 ● Number and location of intakes and associated intake facilities located along west bank of
 34 Sacramento River.
- 35 ● Number of pumping plants.
- 36 ● Water facility components.
- 37 ● Water facility operation criteria.

1 The total footprint of the water conveyance infrastructure would increase by 4,100 acres⁸ (205%,
 2 from 2,000 to 6,100 acres), and the length would increase by 7 miles (16%, from 45 to 52 miles).
 3 The footprint of intake facilities would be increased by 30 acres (11%, from 270 to 300 acres) and
 4 would be located on the west bank of the Sacramento River, rather than the east bank as previously
 5 discussed. The infrastructure included in this take alternative would have the capacity to convey up
 6 to 15,000 cfs from the north Delta, rather the 9,000-cfs pipeline capacity under the BDCP Proposed
 7 Action. Annual south Delta diversions of about 2.40 million acre-feet (MAF)⁹ under Take Alternative
 8 A, is similar to the low end of the range of south Delta diversions under the BDCP Proposed Action
 9 (2.40 to 2.85 MAF). The use of multiple intakes would provide flexibility and the ability to more
 10 frequently divert water from the north Delta, which could also reduce reliance on the south Delta.
 11 This operational flexibility would partially offset the effect of a larger number of intakes. **Take**
 12 **Alternative A** would provide about 5.01 MAF in mean total project water deliveries annually, which
 13 is between 0.58 MAF less and 0.30 MAF more than the deliveries provided for under the BDCP
 14 Proposed Action (4.71 to 5.59 MAF) (Table 9-3).

15 Use of isolated conveyance canals in place of tunnels would result in greater effects on upland and
 16 aquatic habitats, but would allow for the elimination of the intermediate forebay, which
 17 encompasses approximately 245 acres. The intermediate forebay would provide a hydrologic break
 18 for the tunnel and would not be required for a surface canal. In addition, Byron Tract Forebay would
 19 be created to the northwest of Clifton Court Forebay instead of expanding the Clifton Court Forebay.
 20 The surface acreage disturbed for primary water conveyance would increase by 4,320 acres
 21 (2,541%), from 170 acres for conveyance tunnels to 4,490 acres for isolated conveyance canals and
 22 supporting infrastructure (e.g., culvert siphons, tunnels, roads). Canal conveyance requires culvert
 23 siphons to regulate surface waters that could flow into the canal, and tunnels where the canal
 24 segments significant bodies of water. In addition, a road would be built on either side of the canal for
 25 access and bridges would be required to cross the canal.

26 **Take Alternative A** would result in an increase in the total acreage affected by the water
 27 conveyance infrastructure, and increase the take of 10 fish species and 18 terrestrial wildlife
 28 species. Overall permanent effects on natural communities would increase by 1.6% compared with
 29 the BDCP Proposed Action; however, location-specific effects on nine covered species, including the
 30 riparian brush rabbit, the least Bell’s vireo and the giant garter snake, could be reduced. In addition
 31 to increasing the take on a number of fish and wildlife species, **Take Alternative A** would not result
 32 in a measurable increase in conservation benefits compared to the BDCP Proposed Action.

33 9.2.2 Take Alternative B: Tunnels 6,000 cfs

34 Under **Take Alternative B: Tunnels 6,000 cfs (dual conveyance with Intakes 1 and 2 and up to**
 35 **6,000 cfs north Delta diversion capacity)**, water would primarily be conveyed from the north
 36 Delta to the south Delta through pipelines and tunnels. Water would be diverted from the
 37 Sacramento River through two, rather than three, fish-screened intakes and pumping plants on the
 38 east bank of the Sacramento River between Clarksburg and Walnut Grove. Although different
 39 combinations of intakes could be constructed, this analysis assumes Intake 1 and 2 based on an

⁸ Acreage estimates represent the permanent surface footprints of selected facilities in all land use types (e.g., natural communities and developed /urbanized lands.

⁹ Total long term exports are simulated at year 2060 conditions with sea level rise and climate change assumptions, and increased water demand assumptions.

1 October 2011 workshop on phased construction of North Delta intakes. Water would travel in
2 pipelines from the intakes to a sedimentation basin and solids lagoon before reaching the intake
3 pumping plants. Water would be conveyed from two intakes between Clarksburg and Walnut Grove
4 to a new Byron Tract Forebay adjacent to Clifton Court Forebay. Use of existing SWP/CVP south
5 Delta export facilities would continue. Byron Tract Forebay would be designed to provide water to
6 Jones Pumping Plant 24 hours per day. This take alternative would enhance water supply
7 operational flexibility, using forebay storage capacity to regulate flows from north Delta intakes and
8 flows to south Delta pumping plants. The new water facility components would include the
9 following elements.

- 10 • Two north Delta intakes with fish screens along the east bank of the Sacramento River (Intakes
11 1-5).
- 12 • Pipelines conveying water from intakes to intake pumping plants.
- 13 • Sedimentation basins and solids handling facilities.
- 14 • Intake pumping plants at each intake location; associated facilities include an access road,
15 electrical substation, communication devices, and transformers.
- 16 • Discharge pipelines conveying water from intake pumping plants to an initial tunnel (Tunnel 1)
17 or a transition structure.
- 18 • Two surge towers at pumping plants for Intakes 1 and 2.
- 19 • Transition structures, such as stop logs and vents, between discharge pipelines and larger
20 conveyance pipelines.
- 21 • Conveyance pipelines between transition structures and intermediate forebay transition
22 structures with radial gates and stop logs.
- 23 • An intermediate forebay.
- 24 • An intermediate forebay gravity bypass that would allow water in the intermediate forebay to
25 be diverted by gravity to either bore of Tunnel 2.
- 26 • An approximately 350-acre designated inundation area to temporarily contain overflow,
27 conveyed by an emergency spillway, from the intermediate forebay.
- 28 • An intermediate pumping plant that would pump water from the intermediate forebay into
29 Tunnel 2; associated features would include an access road, electrical substations, and
30 transformers.
- 31 • A tunnel (Tunnel 2) between the intermediate pumping plant and Byron Tract Forebay.
- 32 • Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, with large-diameter TBM
33 launch/retrieval shafts and vent shafts at approximate 3-mile intervals.
- 34 • Connections and control structures to the Banks and Jones Pumping Plants.
 - 35 ○ A canal and set of gates between Byron Tract Forebay and the approach canal to the Banks
36 Pumping Plant.
 - 37 ○ A set of gates in the approach canal to the Banks Pumping Plant upstream of the connection
38 to Byron Tract Forebay.

- 1 ○ A set of gates at the outlet between the embankment of the Byron Tract Forebay and the
- 2 approach canal to the Jones Pumping Plant.
- 3 ○ A set of gates in the approach canal to the Jones Pumping Plant upstream of the connection
- 4 to Byron Tract Forebay.
- 5 ● Transmission lines running from the existing electrical grid to project substations.
- 6 ● Borrow, spoils, and tunnel muck storage/disposal areas.

7 A map and schematic depicting the conveyance facilities associated with **Take Alternative B** are
 8 provided in Figure 4-3, *Locations of the Proposed North Delta Intake and Conveyance Facilities of*
 9 Chapter 4, *Covered Activities and Associated Federal Actions*, and Figure 9-3. The characteristics of
 10 the take alternative are summarized in Table 9-3, and the water conveyance components are
 11 summarized in Table 9-4.

12 Water supply operations would be guided by the same operational scenario as the BDCP Proposed
 13 Actions, except there would be no Fall X2 decision tree and this take alternative would convey up to
 14 6,000 cfs rather than up to 9,000 cfs from the north Delta.

15 **9.2.2.1 Incidental Take and Conservation Benefits**

16 Relative to the BDCP Proposed Action, **Take Alternative B** would avoid or reduce take for some
 17 covered fish and wildlife species and increase take for other covered fish and wildlife species by
 18 altering the following components of CM1.

- 19 ● Number and location of intakes and associated intake facilities
- 20 ● Location of conveyances pipelines and initial tunnel between intake pumping plants and
- 21 intermediate forebay
- 22 ● Number of forebays
- 23 ● Number of pumping plants
- 24 ● North Delta diversion capacity
- 25 ● South Delta diversions
- 26 ● Water facility operation criteria

27 The other conservation measures would remain the same as under the BDCP Proposed Action. **Take**
 28 **Alternative B** would comprise physical and structural components similar to those under the BDCP
 29 Proposed Action, but would require two (rather than three) intakes and intake pumping plants and
 30 Byron Tract Forebay would be created north and south of Clifton Court Forebay instead of
 31 expanding the Clifton Court Forebay (Table 9-3). Conveyance pipelines and the initial tunnel
 32 between the intake pumping plants and the intermediate forebay would be adjusted to the intake
 33 locations. Water conveyance operating criteria would be similar to **Take Alternative A**, except that
 34 this take alternative would convey up to 6,000 cfs rather than 15,000 cfs from the north Delta and
 35 would result in water exports 0.22 to 1.10 MAF lower than the BDCP Proposed Action annually.
 36 South Delta diversions would change relative to the BDCP Proposed Action to between 0.27 MAF
 37 less to 0.19 MAF more (59% of total project water deliveries) annually. Fewer north Delta
 38 diversions and intakes would reduce the level of operational flexibility provided by the BDCP
 39 Proposed Action.

1 **Take Alternative B** would result in similar total acreage affected by the water conveyance
 2 infrastructure as the BDCP Proposed Action, with the exception that there would be one less fish-
 3 screened intake and pumping plant (60 acres average per site). Overall permanent effects on natural
 4 communities would decrease by 1.6% compared with the BDCP Proposed Action.

5 Changes in number and location of intakes and related infrastructure and north Delta diversion
 6 capacity would result in reduced or avoided effects on six covered species, including Pacific and
 7 river lamprey, the western burrowing owl, and greater sandhill crane. However, **Take Alternative**
 8 **B** would result in an increase in the take of 12 covered fish and wildlife species, including 8 fish
 9 species. In addition to the increased take of some species, and the similar habitat restoration to the
 10 BDCP Proposed Action, **Take Alternative B** would not result in a measurable increase in
 11 conservation benefits compared to the BDCP Proposed Action.

12 **9.2.3 Take Alternative C: Tunnels 15,000 cfs**

13 **Take Alternative C: Tunnels 15,000 cfs (dual conveyance with pipelines and tunnels alignment,**
 14 **five intakes, and up to 15,000 cfs diversion capacity)** would consist of physical and structural
 15 components similar to those for **Take Alternative B**, but would entail five fish-screened intakes and
 16 intake pumping plants located between Clarksburg and Walnut Grove. In comparison, the BDCP
 17 Proposed Action would include three fish screened intakes and intake pumping plants. Intakes 1
 18 through 5 would be located along the eastside of the Sacramento River. As with the BDCP Proposed
 19 Action, use of existing SWP/CVP south Delta export facilities would continue. A map and schematic
 20 depicting the conveyance facilities associated with **Take Alternative C** are provided in Figure 4-3,
 21 *Locations of the Proposed North Delta Intake and Conveyance Facilities* of Chapter 4, *Covered*
 22 *Activities and Associated Federal Actions*, and Figure 9-4. The characteristics of the take alternative
 23 are summarized in Table 9-3, and the water conveyance components are summarized in Table 9-4.

24 Water supply operations would be guided by the same operational criteria as **Take Alternative A**.

25 **9.2.3.1 Incidental Take and Conservation Benefits**

26 Relative to the BDCP Proposed Action, **Take Alternative C** would increase take for some covered
 27 fish and wildlife species by altering the following components of CM1.

- 28 ● Number and location of intakes and associated intake facilities.
- 29 ● Location of conveyances pipelines and initial tunnel between intake pumping plants and
 30 intermediate forebay.
- 31 ● Number of pumping plants
- 32 ● Number of forebays
- 33 ● North Delta diversion capacity.
- 34 ● South Delta diversions.
- 35 ● Water facility operation criteria.

36 The other conservation measures would remain the same as under the BDCP Proposed Action. This
 37 take alternative could convey up to 15,000 cfs from the north Delta, rather than up to 9,000 cfs
 38 under the BDCP Proposed Action. Annual south Delta diversions of about 2.40 MAF under **Take**
 39 **Alternative C**, is similar to the low end of the range of south Delta diversions under the BDCP

1 Proposed Action (2.40 to 2.85 MAF). The use of multiple intakes would provide flexibility and the
 2 ability to more frequently divert water from the north Delta, potentially reducing reliance on the
 3 south Delta, which would partially offset the effect of a larger number of intakes. This operational
 4 flexibility would partially offset the effect of a larger number of intakes. **Take Alternative C** would
 5 provide about 5.01 MAF in total project water deliveries annually, which is between 0.58 MAF less
 6 and 0.30 MAF more than the deliveries provided for under the BDCP Proposed Action (4.71 to 5.59
 7 MAF)(Table 9-3).

8 **Take Alternative C** would result in similar total acreage affected by the water conveyance
 9 infrastructure as the BDCP Proposed Action; area occupied by fish-screened intake and pumping
 10 facilities would be higher (average 60 acres per intake). Overall permanent effects on natural
 11 communities would decrease by 1.4% compared to the BDCP Proposed Action.

12 Changes in number and location of intakes and related infrastructure and north Delta diversion
 13 capacity would not result in reduced or avoided effects on any of the covered species. **Take**
 14 **Alternative C** would increase the take of 10 fish species and 4 terrestrial wildlife species. In
 15 addition to increasing the take on a number of fish and wildlife species, **Take Alternative C** would
 16 not result in a measurable increase in conservation benefits compared to the BDCP Proposed Action.

17 **9.2.4 Take Alternative D: Tunnels 3,000 cfs**

18 **Take Alternative D: Tunnels 3,000 cfs (dual conveyance with Intake 1 with up to 3,000 cfs**
 19 **north Delta diversion capacity; reduced tidal natural communities restoration to 40,000**
 20 **acres)** would consist of physical and structural components similar to those of **Take Alternative B**,
 21 but would entail a single 3,000 cfs fish-screened intake, compared to the BDCP Proposed Action’s
 22 three fish screened intakes, between Clarksburg and Walnut Grove. The 3,000 cfs conveyance
 23 facility would be designed to achieve one of the BDCP co-equal goals required for all of the
 24 conveyance options, namely water supply reliability. Water would be conveyed through a dual-bore
 25 tunnel from the intermediate pumping plant to a new Byron Tract Forebay adjacent to Clifton Court
 26 Forebay. A dual-bore tunnel would provide the necessary water supply reliability in the event of a
 27 catastrophic failure of one tunnel, which could prevent north Delta diversions from operations for
 28 six to 18 months if only one conveyance tunnel were constructed, depending on the nature of
 29 damage. Dual tunnels would also provide additional operational flexibility by allowing continued
 30 diversions from the north Delta during scheduled maintenance of the tunnels: one tunnel could
 31 remain operational while the other is dewatered, inspected, and serviced. The intermediate forebay
 32 and Byron Tract Forebay would have capacities reduced from those under **Take Alternative B**.
 33 Conveyance pipelines and the initial tunnel between the intake pumping plant and the intermediate
 34 forebay would be adjusted to the intake location. Use of existing SWP/CVP south Delta export
 35 facilities would continue. A map and schematic depicting the conveyance facilities associated with
 36 **Take Alternative D** are provided in Figure 9-5. The characteristics of the take alternative are
 37 summarized in Table 9-3, and the water conveyance components are summarized in Table 9-4.¹⁰

38 Water supply operations would be guided by the same operational criteria as the BDCP Proposed
 39 Actions, except there would be no Fall X2 decision tree and this take alternative would convey up to
 40 3,000 cfs rather than up to 9,000 cfs from the north Delta.

¹⁰ This take alternative is similar to the in-Delta components of the San Diego Natural Resources Defense Council conceptual proposal (2013) except no levee improvements are included.

1 **9.2.4.1 Incidental Take and Conservation Benefits**

2 Relative to the BDCP Proposed Action, **Take Alternative D** would avoid or reduce take for some
 3 covered fish and wildlife species and increase take for other covered fish and wildlife species by
 4 altering the following components of CM1 and CM4.

- 5 • Number and location of intakes and associated intake facilities.
- 6 • Location of conveyances pipelines and initial tunnel between intake pumping plants and
 7 intermediate forebay.
- 8 • Number of pumping plants.
- 9 • Number of forebays
- 10 • North Delta diversion capacity.
- 11 • South Delta diversions.
- 12 • Amount of tidal natural community restored.

13 The other conservation measures would remain the same as under **Take Alternative B** with the
 14 exception of CM4; under **Take Alternative D**, 40,000 acres rather than 65,000 acres of tidal natural
 15 community would be restored. This reduction in tidal natural community restoration would likely
 16 occur primarily in Yolo Bypass/Cache Slough Restoration Opportunity Area (ROA) and the Suisun
 17 Marsh ROA, where restoration potential is the highest. Water supply operations could convey up to
 18 3,000 cfs from the north Delta, compared to 9,000 cfs for the BDCP Proposed Action. South Delta
 19 diversions (about 3.00 MAF) would increase by 0.60 to 0.15 MAF, compared to the range of 2.40 to
 20 2.85 MAF diverted annually from the south Delta under the BDCP Proposed Action. **Take**
 21 **Alternative D** would provide less total project water deliveries annually (4.19 MAF) than the BDCP
 22 Proposed Action (4.71 to 5.59 MAF) (Table 9-3).

23 **Take Alternative D** would result in similar total acreage affected by the water conveyance
 24 infrastructure as the BDCP Proposed Action. Overall permanent effects on natural communities
 25 would decrease by about 20% compared with the BDCP Proposed Action, based on the reduced
 26 acres of restoration, but a smaller project footprint.

27 Changes in number and location of intakes and related infrastructure, north Delta diversion
 28 capacity, and amount of tidal habitat restoration would result in reduced or avoided effects on
 29 22 covered species, including Pacific and river lamprey, the salt marsh harvest mouse, and all
 30 covered invertebrate species. **Take Alternative D** would increase the take of 8 covered fish
 31 species. In addition to increasing the take on a number of fish, **Take Alternative D** would likely
 32 reduce the overall conservation benefits, compared to the BDCP Proposed Action, because of the
 33 38% reduction in tidal habitat restoration.

34 **9.2.5 Take Alternative E: Isolated 15,000 cfs**

35 **Take Alternative E: Isolated 15,000 cfs (isolated conveyance with pipeline and five intakes,**
 36 **with up to 15,000 cfs north Delta diversion capacity)** would convey water from five fish-
 37 screened intakes installed in the Sacramento River between Clarksburg and Walnut Grove in the
 38 north Delta through tunnels to a new Byron Tract Forebay adjacent to Clifton Court Forebay in the
 39 south Delta. However, this would be an isolated conveyance. **Take Alternative E** would eliminate
 40 the need for the operation of existing SWP/CVP south Delta export facilities for Clifton Court

1 Forebay and Jones Pumping Plant. With water facility operations discontinued in the south Delta,
 2 intake facilities in the north Delta would divert and convey up to 15,000 cfs. In comparison, the
 3 BDCP Proposed Action would include three fish screened intakes and intake pumping plants in the
 4 north Delta (with 9,000 cfs diversion and conveyance capacity) and continued operation of the
 5 south Delta intakes. A map and schematic depicting the conveyance facilities associated with **Take**
 6 **Alternative E** are provided in Figure 4-3, *Locations of the Proposed North Delta Intake and*
 7 *Conveyance Facilities* of Chapter 4, *Covered Activities and Associated Federal Actions*, and Figure 9-6.
 8 The characteristics of the take alternative are summarized in Table 9-3, and the water conveyance
 9 components are summarized in Table 9-4. The other conservation measures would remain the same
 10 as under the BDCP Proposed Action.

11 **Take Alternative E** water conveyance operational criteria would follow the guidelines described
 12 for **Take Alternatives A** and **C**, but would be modified to eliminate use of south Delta diversion
 13 points. For the SWP, the gated intake on Old River, Clifton Court Forebay, and the Skinner Fish
 14 Facility would no longer be operated. For the CVP, the diversion point on Old River and the Tracy
 15 Fish Collection Facility would no longer be operated. Therefore, there are no criteria related to south
 16 Delta channel flows or Delta water quality and residence time. This scenario would also add criteria
 17 related to Fall X2 in accordance with the USFWS 2008 BiOp and the high-outflow scenario spring
 18 outflow to modify north Delta water facility operations.

19 Delta inflow and outflow operational criteria would be the same as the BDCP Proposed Action with
 20 the exception that no criteria would be included for March through May during wet and above-
 21 normal water years and no decision trees would be included to define actual parameters for
 22 implementation of USFWS 2008 BiOp Fall X2 requirements.

23 **9.2.5.1 Incidental Take and Conservation Benefits**

24 Relative to the BDCP Proposed Action, **Take Alternative E** would avoid or reduce take for some
 25 covered fish and wildlife species and increase take for other covered fish and wildlife species by
 26 altering the following component of CM1.

- 27 ● Operation of existing SWP/CVP south Delta export facilities for Clifton Court Forebay and Jones
 28 Pumping Plant.
- 29 ● Number and location of intakes and associated intake facilities.
- 30 ● Number of pumping plants
- 31 ● Number of forebays
- 32 ● Location of conveyances pipelines and initial tunnel between intake pumping plants and
 33 intermediate forebay.
- 34 ● North Delta diversion capacity.

35 **Take Alternative E** would result in reduced operational effects because there would be fewer
 36 intake facilities and pumping plants in operation and the existing hydraulic connections between the
 37 SWP/CVP south Delta points of diversions at Clifton Court Forebay and the Tracy Fish Facility on
 38 Old River would be closed. **Take Alternative E** would provide between 1.31 and 2.19 less total
 39 project water deliveries (3.40 MAF) than the BDCP Proposed Action (4.71 to 5.59 MAF) annually.

40 **Take Alternative E** would result in a greater total acreage affected by the water conveyance
 41 infrastructure than the BDCP Proposed Action; area occupied by fish-screened intake and pumping

1 facilities would be higher because of two additional intakes (average 60 acres per intake). Overall
 2 permanent effects on natural communities would decrease by 1.4% compared with the BDCP
 3 Proposed Action.

4 This alternative would decrease or avoid take of 9 covered fish species including delta smelt, longfin
 5 smelt and splittail, primarily due to eliminating water diversions from the south Delta. However, it
 6 would increase the take of 4 covered terrestrial wildlife species. In addition to increasing the take on
 7 a number of fish and wildlife species, **Take Alternative E** would not result in a measurable increase
 8 in conservation benefits compared to the BDCP Proposed Action.

9 **9.2.6 Take Alternative F: Through Delta**

10 Under **Take Alternative F: Through Delta (through-Delta conveyance with Delta channel**
 11 **modifications and different intake locations)**, primary water conveyance would occur from the
 12 north Delta to the south Delta through separate channel corridors (Table 9-3). Construction of
 13 isolated pipeline or tunnel primary conveyance facilities, intake pumping plants, or intermediate
 14 forebay included in the BDCP Proposed Action would not be required. Instead, fish screens would be
 15 constructed to screen fish out from flows into the Delta Cross Channel and Georgiana Slough. Water
 16 would travel through a flow collection channel and radial gates into the existing waterways.
 17 Diverted water would flow south through the Mokelumne River and San Joaquin River to Middle
 18 River and Victoria Canal, which would be dredged to accommodate increased volumes of water.
 19 Along the way, diverted water would be guided by a series of 14 operable barriers. Water flowing
 20 through Victoria Canal would lead into two new canal segments and pass under two existing
 21 watercourses through culvert siphons, eventually reaching Clifton Court Forebay. From there, water
 22 would flow through existing SWP facilities, and a new intertie canal would be constructed to connect
 23 the forebay to CVP facilities. **Take Alternative F** would include the following water conveyance-
 24 related facilities.

- 25 ● Operable barriers on the Mokelumne River near Lost Slough and on Snodgrass Slough near the
 26 Mokelumne River, extension of Meadow Slough to the Sacramento River, and installation of an
 27 operable barrier on Meadow Slough. These facilities would provide a path for fish migration
 28 from the Mokelumne and Cosumnes Rivers through Lost Slough and Meadow Slough to the
 29 Sacramento River except during flood flows.
- 30 ● Engineered passive intake structures incorporating fish screens across the entrances to Delta
 31 Cross Channel and Georgiana Slough, each with a diversion capacity of 7,500 cfs.
- 32 ● A boat lock and channel at the Georgiana Slough diversion structure.
- 33 ● An operable barrier at Threemile Slough to reduce salinity in the San Joaquin River during low
 34 Delta outflow and potentially to reduce fish movement from the Sacramento River to the San
 35 Joaquin River.
- 36 ● Operable barriers along Middle River at Connection Slough, Railroad Cut, Woodward Canal, and
 37 immediately downstream of Victoria Canal to isolate Middle River from Old River. Dredging
 38 would occur at each of these locations.
- 39 ● Dredging along Middle River from Mildred Island to Victoria Canal and along Victoria Canal for a
 40 siphon to provide gravity flow into Clifton Court Forebay.
- 41 ● Expansion and extension, through dredging, of Victoria Canal under West Canal, across Coney
 42 Island, and under Old River to Clifton Court Forebay.

- 1 • Intertie canal with a control gate between Clifton Court Forebay and the Tracy Fish Facility.
- 2 • Closure of the Clifton Court Forebay inlet gate from Old River except during flood flows.
- 3 • Closure of channel between Old River and the Tracy Fish Facility except during flood flows.
- 4 Closure would include channel modification to allow continued access to River's End Marina
- 5 from Old River.
- 6 • Operable barriers along the San Joaquin to separate a fish movement corridor at the upstream
- 7 confluence of Old River and the San Joaquin River (Head of Old River), Fisherman's Cut at False
- 8 River, and Franks Tract to isolate Old River (San Joaquin separate fish movement corridor) from
- 9 the San Joaquin River.
- 10 • A 250 cfs pumping plant on the San Joaquin River at the Head of Old River to convey additional
- 11 flows with organic material into Old River.
- 12 • A 250 cfs pumping plant on Middle River upstream of Victoria Canal to convey additional flows
- 13 with lower salinity than Old River into Old River.

14 A map and schematic depicting the conveyance facilities associated with **Take Alternative F** are
 15 provided in Figure 9-7, Figure 9-8, and Figure 9-9. The characteristics of the take alternative are
 16 summarized in Table 9-3, and the water conveyance components are summarized in Table 9-4.

17 **Take Alternative F** water conveyance operating criteria would be similar to those described for
 18 **Take Alternative A**, but would be modified to conform to the conveyance components of the
 19 separate corridors option and to add the high-outflow scenario spring outflow operating criteria to
 20 south Delta water facility operations. This scenario does not include new north Delta intakes;
 21 instead, water continues to flow by gravity from the Sacramento River into two existing channels,
 22 Delta Cross Channel and Georgiana Slough. Therefore, this scenario does not include North Delta
 23 Diversion Bypass Flow Criteria and Operations for Delta Water Quality and Residence Time.
 24 Additional criteria are provided for operations of operable barriers on the Mokelumne River system.

25 South Delta channel flow criteria would be the same as under **Take Alternative A**, except the south
 26 Delta–San Joaquin River export-inflow ratio would be based on San Joaquin River at Vernalis flows
 27 that limit exports in April and May in accordance with the NMFS 2009 BiOp.

28 Delta Cross Channel gate operations:

- 29 • When Sacramento River flows at Delta Cross Channel are less than 11,000 cfs or greater than
- 30 25,000 cfs, the Delta Cross Channel gates are closed.
- 31 • When Sacramento River flows at Delta Cross Channel are 11,000 to 25,000 cfs, the Delta Cross
- 32 Channel gates are operated to divert up to 25% of Sacramento River flow at the Delta Cross
- 33 Channel.

34 Georgiana Slough operating criteria: the Georgiana Slough gate operations would limit flow from the
 35 Sacramento River into Georgiana Slough to less than 7,500 cfs to reduce impingement of fish onto
 36 fish screens at Georgiana Slough. Generally, flows are approximately 7,500 cfs in Georgiana Slough
 37 when flows in the Sacramento River at Georgiana Slough are approximately 45,000 cfs.

38 Delta inflow and outflow operational criteria would be the same as **Take Alternative E**.

39 The new barriers on the Mokelumne River system near the confluence with the Sacramento River
 40 and Delta Cross Channel would be operated to protect migrating salmonids through the Mokelumne

1 River system. From January through July, operable barriers would be closed and fish ladders may be
 2 included at some barriers. From August through December, operable barriers would be open.

3 The water supply operations of this conveyance facility could convey up to 15,000 cfs from the south
 4 Delta.

5 **9.2.6.1 Incidental Take and Conservation Benefits**

6 Relative to the BDCP Proposed Action, **Take Alternative F** would avoid or reduce take for some
 7 covered fish and wildlife species and increase take for some covered wildlife species by altering the
 8 following components of CM1.

- 9 • Location and type of primary conveyance facility.
- 10 • Number of intake pumping plants.
- 11 • Number of diversion pumping plants.
- 12 • Number of forebays.

13 The other conservation measures would remain the same as under the BDCP Proposed Action. **Take**
 14 **Alternative F** would provide at least 0.54 MAF less in mean total project water deliveries (4.17 MAF
 15 annually) than the BDCP Proposed Action, which would deliver between 4.71 and 5.59 MAF
 16 annually.

17 **Take Alternative F** would result in different areas and types of construction and operations effects
 18 compared to the BDCP Proposed Action. The total footprint of water conveyance facilities would
 19 decrease from 2,000 acres to 1,250 acres (a 38% decrease) and the footprint of intake facilities
 20 would be decreased by 66% (from 270 to 90 acres). No new or expanded forebays, which
 21 encompass a total footprint of 499 acres under the BDCP Proposed Action, would be constructed
 22 under **Take Alternative F**, but the operable barriers and surface acreage disturbed for primary
 23 water conveyance would increase surface acreage effects by 380 acres. In-water construction
 24 impacts would amount to 31.4 acres, compared to 16.2 acres under the BDCP Proposed Action, an
 25 increase of 94%. Dredging impacts would be 56.9 acres, compared to 17.1 acres under the BDCP
 26 Proposed Action, an increase of 233%. Overall, permanent effects on natural communities would
 27 decrease by 5.6% compared with the BDCP Proposed Action. However, since water conveyance
 28 would continue to rely on Delta channels; flowing from north to south, more natural tidally driven
 29 east-west flows would not be restored.

30 Nineteen covered species would have increased potential for take, including 11 covered fish species
 31 and 8 covered terrestrial wildlife species. While **Take Alternative F** would increase the take of all
 32 the covered fish species. most of the effects would be from construction activities, while the effects
 33 on green sturgeon and fall-/late fall-run Chinook are from upstream reservoir operations. it would
 34 increase the take of eight covered wildlife species, primarily due to the variety of habitat types in
 35 which facilities would be constructed. Overall, **Take Alternative F** would result in reduced
 36 conservation benefits compared to the BDCP Proposed Action. Some migrating and resident fish
 37 would benefit less from large-scale restoration in the east or south Delta due to the operable
 38 barriers, which would redirect fish out of the south delta away from operating intakes.

1 9.2.7 Take Alternative G: Less Tidal Restoration

2 **Take Alternative G: Less Tidal Restoration (reduce tidal natural communities restoration to**
 3 **50,000 acres)** would be the same as the BDCP Proposed Action, except the amount of tidal habitat
 4 restored would be reduced from 65,000 to 50,000 acres. All other conservation measures would
 5 remain the same as under the BDCP Proposed Action, as well as the operational criteria, the total
 6 annual project water deliveries, and the proportion of these deliveries occurring from the south
 7 Delta.

8 9.2.7.1 Incidental Take and Conservation Benefits

9 Relative to the BDCP Proposed Action, **Take Alternative G** would avoid or reduce take for some
 10 covered wildlife species by altering the following component of CM4 of the BDCP Proposed Action.

- 11 • Amount of tidal habitat restored.

12 While the amount of tidal habitat restoration would only be reduced from 65,000 acres to 50,000
 13 acres (about a 23.1% reduction), the overall effects on natural communities would decrease by
 14 approximately 20.8% compared with the BDCP Proposed Action.

15 Changes in the extent of tidal natural communities restoration would result in reduced or avoided
 16 effects on 20 covered terrestrial species, including riparian bush rabbit, all protected bird species,
 17 and all covered invertebrate species. However, the effects on the covered fish species and the other
 18 covered wildlife species would be the same as for the BDCP Proposed Action. Despite the similar or
 19 reduced take on the covered fish and wildlife species, **Take Alternative G** would provide less
 20 overall conservation benefits because of the reduced tidal habitat restoration.

21 9.2.8 Take Alternative H: More Restoration

22 **Take Alternative H: More Restoration (increase tidal natural communities restoration to**
 23 **75,000 acres, seasonally inundated floodplain restoration to 20,000 acres, and channel**
 24 **margin enhancement to 40 linear miles)** would consist of physical and structural components
 25 similar to those under the BDCP Proposed Action and **Take Alternative G**. Like the BDCP Proposed
 26 Action, **Take Alternative H** would also entail three fish-screened intakes (Intakes 2, 3, and 5)
 27 installed between Clarksburg and Walnut Grove. Based on the results of a workshop on the phased
 28 construction of north Delta intake facilities, Intake 1 could be constructed instead of Intake 5 under
 29 this take alternative. A final decision regarding the selection of intake locations would occur toward
 30 the end of the BDCP process. Water would be conveyed from the intakes to a new Byron Tract
 31 Forebay adjacent to Clifton Court Forebay. Use of existing SWP/CVP south Delta export facilities
 32 would continue.

33 The water supply operations could convey up to 9,000 cfs from the north Delta. Operating criteria
 34 would be the same as the BDCP Proposed Action.

35 Conservation components under **Take Alternative H** would be similar to those for the BDCP
 36 Proposed Action, with the following exceptions.

- 37 • CM4 would increase tidal restoration acreage from 65,000 acres to 75,000 acres (15% increase).
- 38 • CM5 would increase floodplain restoration acreage from 10,000 acres to 20,000 acres (100%
 39 increase).

- 1 • CM6 would increase channel margin enhancement from 20 linear miles to 40 linear miles
- 2 (100% increase).

3 **9.2.8.1 Incidental Take and Conservation Benefits**

4 Relative to the BDCP Proposed Action, **Take Alternative H** would avoid or reduce take or increase
 5 conservation benefit for some covered fish species and increase take for some covered wildlife
 6 species by altering the following components.

- 7 • Amount of tidal natural communities restored.
- 8 • Amount of seasonally inundated floodplain restored.
- 9 • Amount of channel margin enhanced.

10 Overall permanent effects on natural communities would increase by approximately 13.8% as a
 11 result of increased tidal natural communities restoration compared with the BDCP Proposed Action.

12 However, the increases in the amount of tidal habitat and seasonally inundated floodplains
 13 restoration, and channel margin enhancement would result in positive long-term effects on these
 14 natural communities and covered species that rely on these habitats. This would result in reduced or
 15 avoided effects on all covered fish species, but would increase the level of incidental take for 21
 16 covered terrestrial wildlife species. Despite increasing the take on a number of wildlife species,
 17 **Take Alternative H** would result in a measurable increase in overall conservation benefits
 18 compared to the BDCP Proposed Action, due to the increased level of habitat restoration.

19 **9.2.9 Take Alternative I: Modified Spring Outflow**

20 **Take Alternative I: Modified Spring Outflow (spring outflow of 44,500 cfs in 50% of years)**
 21 would have the same water facilities and conveyance as BDCP. Operating criteria for Old and Middle
 22 River, head of Old River barrier, export to inflow ratio, and North Delta bypass flows would be the
 23 same as BDCP. While **Take Alternative I** includes both Fall X2 and spring outflow operating
 24 criterion of 44,500 cfs in March through May in 50% of years, it does not include a decision tree, as
 25 in BDCP Proposed Action). Compared to the BDCP, this corresponds to an increase in outflow in
 26 above normal water years, with slightly reduced outflow in drier water year types. All other
 27 conservation measures under **Take Alternative I** would be the same as in BDCP.

28 As noted in Section 9.1.3.2.3, *Modified Spring Outflow Criteria*, these high outflows were found to
 29 require water management operations outside of the Plan Area, to entail conflicts within existing
 30 legal constraints without causing unresolvable conflicts between species needs or affecting
 31 upstream water rights.

32 **9.2.9.1 Incidental Take and Conservation Benefits**

33 Relative to the BDCP Proposed Action, **Take Alternative I** would *have* mixed effects. The primary
 34 mechanisms for these differences are the higher spring outflows and the changes to upstream
 35 reservoir operations.

36 CVP and SWP Delta operations would be similar to those of the BDCP high-outflow scenario, with
 37 substantially reduced exports in March through May and increased outflows in wet and above
 38 normal water years. To achieve the 44,500 cfs spring outflow, Delta water export operations would
 39 change, along with upstream reservoir operations. Specifically, exports in March through May would

1 be curtailed to the minimum health and safety standards (i.e., 1,500 cfs total CVP/SWP export from
 2 the Delta) and additional stored water would be released to supplement outflow as needed. Based
 3 on preliminary modeling of these spring outflows and considering the cold water pool requirements
 4 for Shasta Reservoir, under **Take Alternative I**, Trinity Reservoir storage would be reduced to
 5 maintain Shasta Reservoir cold water pool, resulting in increased Trinity River spring flows and
 6 decreased Trinity River summer flows. Similarly, American River (Folsom Dam) and Feather River
 7 (Oroville Dam) spring flows would be higher and summer flows would be lower than those of the
 8 BDCP. **Take Alternative I** would provide 0.37 to 1.25 MAF less total project water deliveries (4.34
 9 MAF) relative to the BDCP Proposed Action (4.71 to 5.59 MAF) annually.

10 **Take Alternative I** would result in similar total acreage affected by the water conveyance
 11 infrastructure as the BDCP Proposed Action and overall permanent effects on natural communities
 12 would be the same as the BDCP Proposed Action.

13 Changes in spring outflow would general result in reduced incidental take of some covered aquatic
 14 species, although decreased summer and fall flows due to changes in reservoir operations, could
 15 result in an increased take of juvenile winter-run Chinook salmon and sturgeon. Incidental take of
 16 terrestrial species would be the same as under the BDCP Proposed Action. Despite the potential
 17 increase in the take of some covered fish species, **Take Alternative I** is expected to provide a
 18 measurable increase in conservation benefits compared to the BDCP Proposed Action. These
 19 increased benefits would result from increased aquatic habitat and improved aquatic habitat
 20 conditions provided by the modified spring outflows during 50% of years.

21 9.3 Methods of Analysis

22 9.3.1 Criteria Used to Evaluate Take Alternatives

23 Take alternatives were evaluated against five criteria.

- 24 1. Does the take alternative reduce take of covered species?
- 25 2. Does the take alternative increase conservation benefit to covered species?
- 26 3. Is the take alternative consistent with the BDCP overall goal to provide “a comprehensive
 27 conservation strategy for the Sacramento-San Joaquin River Delta designed to restore and
 28 protect ecosystem health, water supply, and water quality within a stable regulatory
 29 framework”?
- 30 4. Is the take alternative practicable in terms of costs, logistics, and technical feasibility?
- 31 5. Are there additional significant and unavoidable adverse effects to other resources (i.e. besides
 32 covered fish and wildlife species and their habitat)?

33 9.3.2 Level of Take and Conservation Benefit to Covered 34 Species

35 Take expected to result and conservation benefits likely to accrue to covered species was assessed
 36 by comparing the likely effects of the implementation of the BDCP Proposed Action (level of take and
 37 conservation benefit), based on the primary mechanisms of impact (stressors), during three project

1 stages: construction, operations, and maintenance. These assessments were based on quantitative
 2 data such as geographic information system (GIS) overlays of species habitat distribution, modeling
 3 results of operations scenarios on key stressors of covered fish species, overlap between stressors
 4 and fish occurrence, and best professional judgment. This process provides a basis for qualitatively
 5 comparing the potential overall impacts of the take alternatives on the covered species, relative to
 6 the impacts expected for the BDCP Proposed Action.

7 After evaluating the potential effects of each individual stressor on a species, a three-stage relative
 8 ranking was assigned to each stressor and take alternative relative to the BDCP Proposed Action.
 9 The three-stage scale, below, indicates how the level of take or conservation benefit is expected to
 10 change for a species, and whether a stressor is expected to measurably affect a species relative to
 11 the BDCP Proposed Action.

- 12 • Take is likely measurably less than the BDCP Proposed Action.
- 13 • Take is not measurably different from the BDCP Proposed Action.
- 14 • Take is likely measurably greater than the BDCP Proposed Action.

15 For covered fish, the expected impacts were based on the likelihood of the species occurring in the
 16 area influenced by the impact or stressor, the degree of overlap between the species and stressor
 17 occurrences, the relative intensity and duration of the stressor, the expected effect of the stressor,
 18 and the conservation benefit of actions to reduce the stressor relative to current conditions. For
 19 covered terrestrial species, the expected impacts were based primarily on the amounts of modeled
 20 habitat identified using GIS within the conveyance and hypothetical restoration footprints. In
 21 addition, the nature of the activity and the frequency and duration of those activities were also
 22 considered in discussing and comparing the potential for take and conservation benefit.

23 The methods used to assess flows and the various flow-related parameters for covered fish species
 24 are based on CALSIM and DSM2 outputs, upstream temperature models, particle tracking models,
 25 multiple biological models, assumed and measured locations of fish, previous studies in the Delta,
 26 DRERIP analyses, life cycle models, and professional judgment. A full description of these methods
 27 and a complete analysis can be found in *Appendix 5.C, Flow, Passage, Salinity, and Turbidity*. Fifteen
 28 different models or indices were used to evaluate flow-related effects, as discussed in Appendix 5.C.
 29 These methods were applied to a comparison of the alternatives with existing conditions.

30 The qualitative and quantitative methods used to analyze the levels of take and conservation
 31 benefits of the take alternatives are generally the same as those used to analyze the BDCP Proposed
 32 Action in Chapter 5, *Effects Analysis*. However, they are described in much less detail to enable easy
 33 comparisons.

34 **9.3.3 Consistency with BDCP Goals**

35 As part of the screening process, take alternatives that were inconsistent with the overall goal of the
 36 BDCP were not carried forward for further evaluation. The overall goal of the BDCP is to provide “a
 37 comprehensive conservation strategy for the Sacramento-San Joaquin River Delta designed to
 38 restore and protect ecosystem health, water supply, and water quality in the Delta within a stable
 39 regulatory framework.” Accordingly, the take alternatives were evaluated to determine consistency
 40 with this goal. However, there are differences between the alternatives with respect to the relative
 41 achievement of ecosystem health, water supply, water quality and regulatory stability within the
 42 Delta. The ability of each take alternative to meet this goal is summarized in Table 9-8. Measures of

1 the extent to which each take alternative is or is not consistent with the goal of BDCP, how they were
2 rated and overall consistency with the goal of BDCP determined is described below:

- 3 • **Habitat protection and restoration.** Satisfies the large-scale habitat protection and restoration
4 goals of BDCP as described in Chapter 3. *Conservation Strategy*. If habitat protection and
5 restoration is less than goals in the Conservation Strategy, then the take alternative is not
6 consistent with this goal of the BDCP.
- 7 • **In-Delta water quality improvement.** Contributes to water quality improvements for aquatic
8 species. If water quality is predicted to be poorer than the Existing Conveyance High Outflow
9 scenario or results in an increase in harmful constituents (e.g., mercury, pesticides), then the
10 take alternative does not satisfy this goal of the BDCP.
- 11 • **Ecosystem restoration for aquatic species.** Incidental take of covered fish species is reduced
12 or the take alternative provides additional conservation benefits. If the take alternative does
13 neither, then it does not satisfy this goal of the BDCP.
- 14 • **Water supply (mean project water deliveries).** Would provide water supply volumes greater
15 than the Existing Conveyance High Outflow scenario. If water supplies are predicted to be less
16 than the existing conveyance scenario, then the take alternative does not satisfy this goal of the
17 BDCP.
- 18 • **Water quality (supply water).** Would provide water supplies of equal or better water quality
19 than the Existing Conveyance High Outflow scenario. If take alternative is predicted to generate
20 poorer quality water supplies than the existing conveyance scenario, then the take alternative
21 does not satisfy this goal of the BDCP.
- 22 • **Water supply reliability.** Would help to protect water supplies from floods, and seismic events.
23 If reliability is not improved relative to existing conditions, then the take alternative does not
24 satisfy this goal of the BDCP.
- 25 • **Actions within the scope of the Plan Area?** The defined geographic scope of the BDCP is
26 limited to the statutory Delta, Suisun Marsh, and Yolo Bypass. Take alternatives that include
27 actions outside this geographic scope are not consistent with the goal of the BDCP. A “no”
28 response indicates the take alternative is not consistent with this goal of the BDCP.
- 29 • **Banks Pumping Plant at capacity?** Contributes to overall water supply reliability and cost
30 effectiveness of take alternative. A “no” response indicates that the take alternative is not
31 consistent with this goal of the BDCP.

32 Section 9.5, *Assessment of Take Alternatives*, details the differences in consistency of each take
33 alternative with the overall goal of the BDCP, relative to the BDCP Proposed Action.

1 **Table 9-8. Differences in Consistency of Take Alternatives with BDCP Goals Compared with the BDCP**
 2 **Proposed Action**

BDCP Goals	Take Alternative								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Habitat protection and restoration	○	○	○	⊗	○	○	⊗	+	○
In-Delta water quality improvement	○	○	○	○	-	-	○	-	-
Ecosystem restoration for aquatic species	-	-	-	-	+	-	-	-	+
Water supply (mean project water deliveries)	+	-	+	-	⊗	-	○	-	-
Water quality (supply water)	-	-	-	-	+	-	○	○	-
Water supply reliability	+	-	+	-	○	⊗	○	○	-
Actions within the scope of the Plan Area?	Y	Y	Y	Y	Y	Y	Y	Y	N
Banks Pumping Plant at capacity?	Y	Y	Y	N	N	N	Y	Y	Y
Summary: Is take alternative consistent with BDCP goals?	Y	Y	Y	N	N	N	N	Y	N
- Consistent with goal, but less so than the BDCP Proposed Action. ○ Consistency is not measurably different from the BDCP Proposed Action. + Consistency with goal is greater than the BDCP Proposed Action. ⊗ Inconsistent with goal. Notes: cfs = cubic feet per second									

3

4 **9.3.4 Practicability**

5 The practicability analysis includes an evaluation of actions proposed under the BDCP Proposed
 6 Action and take alternatives relative to cost, logistics, and technology. The sections below describe
 7 the approach used to evaluate each of these practicability factors and the metrics used to determine
 8 whether a take alternative would be practicable in relation to that factor. A take alternative is
 9 deemed to be impracticable if it fails any one of these tests.¹¹

10 **9.3.4.1 Cost**

11 **9.3.4.1.1 Methods Used to Measure Cost**

12 For a take alternative to meet this criterion, it must be economically feasible. That is, a take
 13 alternative must generate benefits to the funding entities in excess of cost. As detailed in Chapter 8,
 14 Section 8.3 *Funding Sources*, the financial support of the state and federal water contractors

¹¹ The ESA does not provide a definition of *practicability* nor does the implementing regulations or the HCP Handbook (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1996). This analysis uses factors generally recognized in other regulatory settings to assess whether an alternative is capable of being done in light of the purpose of a project.

1 receiving water supplies from the Delta is essential to implement the Plan. There is no inducement
 2 for these agencies to participate in a conservation plan where the cost exceeds the benefits in
 3 relationship to conditions as they would likely exist without the BDCP. For this reason, the failure of
 4 a take alternative to pass the cost criteria renders it impracticable.

5 The following subsections describe how benefits and cost of the BDCP Proposed Action and the take
 6 alternatives were calculated. For details, see Appendix 9.A, *Economic Benefits of the BDCP and Take*
 7 *Alternatives* and Appendix 9.B, *Take Alternative Cost Estimation*. The economic benefits expected to
 8 accrue to the state and federal water contractors from the BDCP fall into four broad categories.

- 9 • Urban water supply
- 10 • Agricultural water supply
- 11 • Water quality
- 12 • Seismic risk reduction

13 The cost of the BDCP Proposed Action and each take alternative must be evaluated in relation to a
 14 reasonable scenario without BDCP. Without BDCP, the existing water conveyance (i.e., south Delta
 15 facilities) would remain in place and continue to operate as part of the SWP and CVP. In addition,
 16 without BDCP covered fish populations are expected to continue to decline. To arrest those declines,
 17 operational constraints proposed by BDCP to protect native fish such as the high outflow scenario of
 18 the decision tree and more protective south Delta operations could be imposed on the existing
 19 infrastructure. It is also reasonable to assume that some level of habitat restoration would be
 20 required without BDCP to comply with the current NMFS 2009 and USFWS 2008 BiOps.

21 To account for a reasonable scenario without BDCP, the cost practicability analysis compares the
 22 BDCP Proposed Action and take alternatives to a scenario called the Existing Conveyance High-
 23 Outflow Scenario that assumes the following costs for the state and federal water contractors.

- 24 • Operation of existing south Delta water conveyance facilities.
- 25 • The high- outflow scenario of the decision tree (Fall X2 and additional spring outflow).
- 26 • South Delta operating restrictions of the BDCP (the current NMFS 2009 and USFWS 2008 BiOps
 27 plus Scenario 6 operations).
- 28 • Tidal natural community restoration consistent with the USFWS 2008 BiOp.
- 29 • Implementation of some floodplain restoration in the Yolo Bypass consistent with the NMFS
 30 2009 BiOp.
- 31 • Installation of one non-physical barrier consistent with the NMFS 2009 BiOp.

32 Details of the cost estimates are presented below. A similar scenario is also introduced that is the
 33 same as described above but that applies the BDCP low-outflow points on the decision tree (no Fall
 34 X2 and no additional spring outflow). This scenario is called the **Existing Conveyance Low-Outflow**
 35 **Scenario**. These scenarios are used only in this chapter and only to provide a reasonable
 36 comparison point for the cost practicability analysis.

37 To be practicable on cost, the economic benefits of the take alternative must exceed the costs by a
 38 certain margin to compensate for cost uncertainty (Chapter 8, *Implementation Costs and Funding*
 39 *Sources*), the uncertainty in the economic benefits (Appendix 9.A, *Economic Benefits of the BDCP and*
 40 *Take Alternatives*), and the relatively low rate of discount. The margin by which benefits exceed

1 costs, called the *hurdle rate*, is defined for the purposes of the cost practicability analysis as 20%. An
2 optimal hurdle rate is in the range of 20% for projects with a relatively high volatility of benefits and
3 a relatively low rate of discount¹².

4 This chapter presents the water supply, water quality, and seismic risk reduction benefits of the
5 BDCP Proposed Action and take alternatives, as well as the associated cost, as compared to the
6 Existing Conveyance High-Outflow Scenario. This type of incremental analysis is standard in welfare
7 economics, and is applied consistently across the Plan and all the take alternatives: each case is
8 compared to the same Existing Conveyance High-Outflow Scenario. As explained below, the baseline
9 costs of the comparison scenario are netted out by the incremental cost calculation. Thus, the cost
10 practicability test compares the incremental benefits of a scenario to its incremental cost to
11 determine whether it is economically feasible.

12 The cost and benefits of BDCP Proposed Action and the take alternatives are expressed in
13 discounted 2012 dollars. Present value calculations are performed using a 3% real discount rate.
14 This rate is reflective of recent capital market conditions; indeed, it is well above the current real
15 rate of interest. The 3% real rate of discount is one of the rates authorized by the White House Office
16 of Management and Budget for federal agencies evaluating capital investments (Circular A-94), and
17 has wide acceptance among economists. The chosen discount rate is above the 2.275% real rate
18 mandated by the U.S. Army Corps of Engineers for use in evaluating water infrastructure projects.
19 Choosing a higher rate of discount leads to smaller present value benefits because benefits in the
20 distant future are discounted by a larger factor when converting to present value. Thus, relative to
21 the U.S. Army Corps of Engineer guidelines, this choice of a discount rate is conservative.

22 Cost and benefits are evaluated from 2015 through 2075. Conveyance changes in the BDCP
23 Proposed Action and the take alternatives are assumed to become operational in 2025 and are
24 evaluated over a 50-year period from 2025 to 2075. This period is chosen to correspond to the
25 assumed design life of the conveyance facility as described in Chapter 8, *Implementation Costs and*
26 *Funding Sources*. The following sections describe the computation of incremental economic benefits
27 and cost relative to the Existing Conveyance High-Outflow Scenario.

28 **9.3.4.1.2 Cost Estimation**

29 Costs for each take alternative were developed from information taken from Delta Habitat
30 Conservation and Conveyance Program (DHCCP) Conceptual Engineering Reports (CER) and the
31 Plan implementation cost estimates in Chapter 8, *Implementation Costs and Funding Sources*. The
32 take alternative cost estimates used for the practicability analysis are net of cost anticipated in the
33 Existing Conveyance High-Outflow Scenario. In this respect they differ from the cost estimates in
34 Chapter 8, *Implementation Costs and Funding Sources*, which provides estimates of the total capital
35 cost of Plan implementation, including costs that are expected to occur in the Existing Conveyance
36 High-Outflow Scenario.

37 To account for differences between the BDCP Proposed Action and each take alternative,
38 adjustments were made to cost estimates developed for the BDCP Proposed Action as described
39 below.

¹² The concept of a hurdle rate is described by McDonald (1998). He also shows that simple “rules of thumb” like hurdle rates can serve as effective proxies for more sophisticated investment criteria such as real options valuation which are beyond the scope of this study.

- 1 ● **Water facilities construction.** Water facilities construction costs were adjusted to reflect the
 2 physical differences in the type (e.g., pipelines and tunnels alignment, canal, or through-Delta)
 3 and diversion capacity (e.g., 3,000 cfs to 15,000 cfs) of conveyance included in each take
 4 alternative. The basis for construction costs used for each take alternative is as follows.
 - 5 ○ **Take Alternative A.** Dual conveyance with west canal and up to 15,000 cfs diversion
 6 capacity. Water facility construction costs are taken from CER ICF West Revision 1, updated
 7 to 2012 dollars.
 - 8 ○ **Take Alternative F.** Through-Delta conveyance with Delta channel modifications and
 9 different intake locations. Water facility construction costs are taken from CER Revision 0
 10 Separate Corridors Option, updated to 2012 dollars.
 - 11 ○ **Take Alternatives B through E and G through I.** Pipelines and tunnels alignment with
 12 diversion capacities ranging from 3,000 cfs to 15,000 cfs. Water facility construction costs
 13 are based on the *Modified Pipeline/Tunnel Option (MPTO) 2013 Conceptual Engineering*
 14 *Report* (MPTO CER 2013), which also provided the basis for the proposed facility cost
 15 estimate in Chapter 8, *Implementation Costs and Funding Sources*. Water facility construction
 16 costs for pipelines and tunnels alignment with diversion capacity different from the facilities
 17 in the BDCP Proposed Action were rescaled using cost information from the CER. A detailed
 18 explanation of the procedure used to rescale pipelines and tunnels alignment costs can be
 19 found in Appendix 9.B, *Take Alternative Cost Estimation*.
- 20 ● **Water facilities operation.** In Chapter 8, *Implementation Costs and Funding Sources*, water
 21 facilities operation costs consist of three components.
 - 22 ○ Labor and equipment costs for operations and maintenance.
 - 23 ○ Power costs for conveyance pumping.
 - 24 ○ Capital replacement costs.

25 Cost estimates for labor and equipment prepared in 2010 by DHCCP for **Take Alternatives A, C,**
 26 **and F** (west canal, through Delta, and 15,000 cfs pipelines and tunnels alignment) were updated
 27 to be consistent with the current estimate for the BDCP Proposed Action. Similarly, new
 28 estimates for labor and equipment costs for **Take Alternatives B and D** (6,000 cfs and 3,000 cfs
 29 pipelines and tunnels alignment) were developed based on the current estimate for the BDCP
 30 Proposed Action. Power costs for take alternatives with pipelines and tunnels alignment are
 31 scaled to the power cost estimate for the BDCP Proposed Action in proportion to the expected
 32 volume of north Delta pumping. Power costs for take alternatives with west canal conveyance
 33 are based on estimates prepared in 2009 by DHCCP, updated to 2012 dollars. Pumping costs for
 34 through-Delta conveyance have not been estimated by DHCCP. For the practicability analysis,
 35 half the cost for the BDCP Proposed Action is assumed. Capital replacement costs are scaled to
 36 the capital replacement cost estimate for the BDCP Proposed Action in proportion to the initial
 37 capital cost of the conveyance alternative. A detailed explanation of the procedure used to
 38 estimate the water facilities operation costs for each take alternative can be found in Appendix
 39 9.B, *Take Alternative Cost Estimation*.
- 40 ● **Natural community restoration and protection.** As discussed in Section 9.2, *Descriptions of*
 41 *Take Alternatives*, some of the take alternatives include different targets for acres of restoration
 42 (CM4 and CM5) or linear miles of channel margin habitat enhancement (CM6). It was assumed
 43 that costs would change proportional to the change in total acreage. This may result in a slight

1 underestimation of cost for **Take Alternative H** because the higher restoration targets
 2 associated with this take alternative could result in higher per-acre costs for more expensive
 3 and/or less suitable land, which would incur higher restoration or enhancement costs.

- 4 ● **Other stressors** costs are assumed to be the same as the BDCP Proposed Action for all take
 5 alternatives.
- 6 ● **Monitoring and adaptive management, changed circumstances, and program**
 7 **administration** are assumed to be the same as the BDCP Proposed Action for each of the take
 8 alternatives (see Chapter 8, *Implementation Costs and Funding Sources*, for a description of each
 9 component and the methods used to estimate this cost.

10 **Existing Conveyance High-Outflow Scenario Cost.** Certain restoration costs resulting from
 11 implementation of the NMFS 2009 BiOp and the USFWS 2008 BiOp are anticipated under the
 12 Existing Conveyance High-Outflow Scenario. These costs were deducted from the costs for each take
 13 alternative and include:

- 14 ● **Cost for 8,000 acres of tidal habitat restoration.** The NMFS 2009 BiOp and the USFWS 2008
 15 BiOp call for 8,000 acres of Delta tidal habitat restoration. The CM4 cost estimate was reduced to
 16 12.3% (= 8,000/65,000) to account for this requirement.
- 17 ● **Cost for Yolo Bypass floodplain restoration.** There is significant overlap in Yolo Bypass
 18 improvements between the NMFS 2009 BiOp and the USFWS 2008 BiOp and CM2. The CM2
 19 estimate was reduced to 75% to account for this overlap.
- 20 ● **Cost for Nonphysical Barriers.** The NMFS 2009 BiOp and the USFWS 2008 BiOp call for
 21 implementation of measures to redirect migrating salmonids from the interior and southern
 22 Delta, including a nonphysical barrier for Georgiana Slough. The CM16 cost estimate was
 23 reduced 14.3% (= 1/7) to account for this requirement.

24 **9.3.4.1.3 Urban Water Supply Benefits**

25 Urban water supply benefits are measured as customers’ willingness to pay to avoid future water
 26 shortages. Avoided shortages, defined as the difference between demand and available supply, are
 27 calculated on an annual basis for the period 2025 to 2075.

28 Projections of urban water shortages under each take alternative are calculated using the Supply-
 29 Demand Balance Simulation Model (SDBSIM), developed by The Brattle Group and the Metropolitan
 30 Water District of Southern California (MWD). The model accounts for uncertainty in future supplies
 31 by considering 83 sequenced hydrologic years, one for each water year in the 83-year hydrologic
 32 record. Each hydrologic year generates a different level of shortages over the study period. The
 33 model accounts for current supply alternatives, including groundwater, recycling, stormwater
 34 capture, and other imported supplies. The model also accounts for storage such as local
 35 groundwater aquifers, and surface storage facilities. Each of MWD’s 26 member agencies is included
 36 in the SDBSIM model as well as 9 other non-MWD contractors (e.g., Castaic Lake, Mojave, San
 37 Bernardino, Santa Maria, Antelope Valley-East Kern, San Gorgonio, Zone 7, Alameda County Water
 38 Agency, and Palmdale). Separate shortage projections were provided by the Santa Clara Valley
 39 Water District for its service territory.

40 Future water demands in the MWD service territory are calculated using the IWR-MAIN model. The
 41 demands used in the SDBSIM are somewhat lower than those detailed in MWD’s *Integrated Regional*
 42 *Water Management Plan* (2010). They have been updated to reflect the most recent (2010)

1 projections of the Southern California Association of Governments regarding population, income and
2 other factors. They have also been updated to reflect the development of desalinated water supplies
3 in the San Diego County Water Authority. Both changes have the effect of reducing long-run
4 demands for imported water in southern California. Long-run water demand projections for other
5 agencies in SDBSIM were provided by the agencies themselves, and are usually consistent with data
6 contained in their urban water management plans.

7 Once avoided shortages are calculated for each alternative for all 83 hydrologic years, welfare
8 analysis is performed to compute the economic value to urban users of avoiding the calculated
9 shortage in each scenario. Specifically, the value of avoiding a given shortage is calculated as the
10 difference between what the ratepayer would be willing to pay minus the marginal cost of supplying
11 the water. Thus, the welfare losses during a shortage are calculated using data on price, the price
12 elasticity of demand, the avoided marginal water supply costs during a shortage, the size of the
13 shortage, and the forecasted level of demand.

14 Data on retailer-level water rates is used to generate a price index for each of the agencies included
15 in the welfare analysis. Estimates of the price elasticity of demand are generated using a statistical
16 model employing the most comprehensive set of water price and consumption data available in
17 California, using existing rate structures to calculate effects and to econometrically estimate the
18 price elasticity of demand based on actual historical price-consumption trends. The avoided
19 marginal maintenance and delivery costs during a shortage are based on engineering estimates.
20 Once again, the forecasted shortage and demand data is derived from SDBSIM. Further, because the
21 SDBSIM generates shortage and demand data for 83 hydrologic scenarios, the welfare analysis
22 produces a range of likely benefits that reflect differences in the assumed hydrologic scenarios.

23 **9.3.4.1.4 Agricultural Water Supply Benefits**

24 Agricultural water supply benefits are measured using the Statewide Agricultural Production
25 (SWAP) model, a regional agricultural production model developed specifically for large-scale
26 analysis of agricultural water supply and cost changes (a detailed explanation of the SWAP model
27 can be found in Appendix 9.A, *Economic Benefits of the BDCP and Take Alternatives*). Developed by
28 the University of California at Davis and the California Department of Water Resources (DWR), the
29 SWAP model simulates the profit-maximizing decisions of agricultural producers in California
30 subject to resource, technical, and market constraints (Howitt et al. 2010). The model accounts for
31 SWP and CVP water supplies, other local water supplies, and groundwater. As the availability or cost
32 of these water supplies changes within a SWAP region, the model optimizes production by adjusting
33 the crop mix, water sources and quantities used, and other inputs, or even by fallowing land if that is
34 the most cost-effective response. The model assumes a competitive market for farmers such that no
35 single producer can affect or control the price of any commodity, and includes four inputs to
36 production—land, water, labor, and other inputs. The SWAP model includes all SWP and CVP
37 agricultural water contractors in the Central Valley.

38 Agricultural benefits from changes in water supply from the Delta include reductions in
39 groundwater pumping and cost, increases in net returns from crop production, and increases in
40 benefits to consumers of agricultural products. The SWAP model produces estimates of average
41 annual benefits in the years 2025 to 2075.

1 **9.3.4.1.5 Benefits from Improved Water Quality**

2 Water quality benefits are modeled for the urban and agricultural agencies receiving Delta water
 3 exports using previously developed water quality models. The Lower Colorado River Basin Water
 4 Quality Model, developed by the U.S. Department of the Interior, Bureau of Reclamation
 5 (Reclamation) in conjunction with MWD, estimates salinity-related benefits for the MWD service
 6 area. The South Bay Water Quality Model, originally developed for the economic evaluation of a
 7 proposed expansion of Los Vaqueros Reservoir, estimates salinity-related benefits for the Contra
 8 Costa Water District and Santa Clara Valley Water District service areas.

9 The Lower Colorado River Basin Water Quality Model uses data on demographic characteristics,
 10 water deliveries, total dissolved solids concentration, and costs for typical water uses by sector for
 11 15 subareas covering the MWD service area. The model assesses the average annual economic
 12 impacts of SWP and Colorado River salinity changes using mathematical relationships between total
 13 dissolved solids and important characteristics in each affected category of water use, such as the
 14 useful life of appliances, specific crop yields, and costs to industrial and commercial customers. For
 15 this analysis, a routine was developed to estimate salinity of urban water based on timing of urban
 16 deliveries, mixing in San Luis Reservoir and salinity estimates at Edmonston Pumping Plant. The
 17 South Bay Water Quality Model uses estimates of relationships between salinity and damages to
 18 residential appliances and fixtures to estimate the impacts of changes in salinity. For the Contra
 19 Costa Water District, water quality estimates are based on diversion volume and water quality at
 20 Old River and Rock Slough. For the Alameda County Water District, Zone 7, and the Santa Clara
 21 Valley Water District, water quality is based on diversion volume and salinity at Harvey O. Banks
 22 Pumping Plant. Changes in water quality at the City of Antioch’s diversion are used to estimate the
 23 additional cost of treatment or replacement supply. Annual benefits depend on both the salinity
 24 improvement and the total delivered water to which the improvement applies.

25 Near-term agricultural water quality impacts are also estimated. Salinity, measured as electrical
 26 conductivity is the single best indicator of the effect of changes in water quality on agricultural
 27 production. In the short term, an improvement in salinity can spur reduced leaching fraction and
 28 irrigation costs, lower soil salinity, improved crop yields, and greater crop selection. In the Delta in
 29 particular, which has areas of shallow, saline groundwater, a reduction in the salinity of applied
 30 irrigation water can keep lands productive for longer while reducing the cost of drainage treatment
 31 and disposal. The short-term benefit of the BDCP on agricultural water quality is quantified as the
 32 value of changes in leaching requirement; that is, the value of reduced irrigation water required to
 33 maintain root zone salt balance.

34 Estimates of the value of changes in leaching requirement are based on accepted methods for
 35 calculating leaching fraction for irrigated crops. This analysis is based on the assumption that
 36 growers can reduce the irrigation water applied to maintain root zone salt balance. The reduced
 37 salinity of irrigation water results in economic benefits through savings on irrigation water used by
 38 growers. For the purposes of this analysis, this saved water is valued at the avoided cost of
 39 additional water supply, which is assumed to come from groundwater pumping. The salt leaching
 40 benefit from improved project delivered water quality is calculated in two parts. For the portion of
 41 SWP and CVP water that replaces groundwater pumping, the benefit is calculated relative to the
 42 applied groundwater quality. For all other applied project water, the benefit is calculated relative to
 43 water quality under the Existing Conveyance High-Outflow Scenario The calculations account for the
 44 variation in crops across affected delivery areas. Estimating the long-run effects on salt load in

1 shallow groundwater, drainage conditions, and drainage-related costs would require a more
 2 complex analysis of groundwater conditions over time.

3 **9.3.4.1.6 Benefits of Reduced Seismic Risk**

4 An important benefit of the BDCP Proposed Action is that construction of the water conveyance
 5 facility, under *CM1 Water Facilities and Operation*, will reduce the risks to the state’s water system
 6 from earthquake-induced supply disruptions. With the current water supply infrastructure, large
 7 earthquakes in and around the Delta region may cause numerous levees to fail, with the result that
 8 some number of islands will flood. As a result, seawater will be pulled into the Delta, potentially
 9 reducing SWP/CVP water deliveries for some period of time. During this recovery period, urban and
 10 agricultural water consumers may experience incremental water shortages if agencies are unable to
 11 replace lost Delta supplies.

12 Benefits associated with reduced vulnerability of the water export system to seismic events in the
 13 Delta region are calculated by observing differences in water supplies under no-earthquake and
 14 post-earthquake conditions across the urban and agricultural sectors for the BDCP and the Existing
 15 Conveyance Scenario. The difference in supplies under each scenario between the two conditions is
 16 considered to be the earthquake-induced shortage. Some level of shortage is inevitable; however,
 17 the mitigation of these shortages is important. The marginal value of water is used to value the
 18 economic loss associated with these earthquake-induced shortages under each scenario. The
 19 marginal value of water is estimated using the SDBSIM for urban and the SWAP for agriculture.
 20 Benefits of reduced seismic risk are derived from the abatement of this economic loss, and are
 21 therefore calculated as the difference in earthquake-induced economic losses under the BDCP and
 22 the corresponding Existing Conveyance Scenario.

23 **9.3.4.1.7 Practicability of the BDCP Proposed Action Relative to the Existing**
 24 **Conveyance High-Outflow and Low-Outflow Scenarios**

25 Funding for the BDCP from the state and federal water contractors is ultimately based on the direct
 26 economic benefits of the BDCP Proposed Action to their customers. There is no inducement for
 27 water purveyors to participate in a conservation plan where the cost exceeds the benefits in
 28 relationship to conditions as they would likely exist without the BDCP. As described in Section
 29 9.3.4.1, *Cost*, the cost of the BDCP Proposed Action High-Outflow Scenario is evaluated in relation to
 30 the cost of the Existing Conveyance High-Outflow Scenario and likewise, the cost of the BDCP
 31 Proposed Action Low-Outflow Scenario is evaluated in relation to the cost of the Existing
 32 Conveyance Low-Outflow Scenario.

33 State and federal project deliveries under the BDCP Proposed Action High-Outflow and Low-Outflow
 34 scenarios would have a mean of 4.71 MAF and 5.59 MAF, respectively, in the early long-term.
 35 Deliveries in the corresponding Existing Conveyance High-Outflow and Low-Outflow Scenarios
 36 would be approximately 3.45 MAF and 3.89 MAF, respectively, considered in the early long-term.

37 The practicability of the BDCP Proposed Action may be verified by comparing its high-outflow and
 38 low-outflow scenarios to the Existing Conveyance High-Outflow and Low-Outflow Scenarios,
 39 respectively. These two comparisons bracket the range of incremental impacts of the BDCP across
 40 the outcomes specified by the decision tree component of CM1.

41 With respect to the water supply benefits of the BDCP Proposed Action, urban demand is projected
 42 to be 5.64 MAF in 2025 (the year CM1 would become operational) and is estimated to grow to 6.18

1 MAF by 2050. Using the SDBSIM modeling framework, by 2025, under the Existing Conveyance
 2 High-Outflow and Low-Outflow Scenarios, shortages in the urban agencies receiving SWP deliveries
 3 are predicted to average 0.50 MAF and 0.31 MAF, respectively. By 2050, these mean shortages are
 4 projected to be 0.84 MAF and 0.63 MAF, respectively. The BDCP Proposed Action high-outflow and
 5 low-outflow scenarios would mitigate these losses by lessening the frequency and magnitude of
 6 water supply shortages. With BDCP implementation, in 2025, mean shortages would drop to 0.37
 7 MAF and 0.20 MAF, respectively. By 2050, they would average 0.57 MAF and 0.33 MAF, respectively.

8 As presently configured, the Delta’s water export infrastructure is vulnerable to earthquake-induced
 9 outages in which SWP deliveries will be drastically reduced, resulting in a potential shortage to
 10 urban and agricultural consumers. Through the construction of an isolated conveyance facility, the
 11 BDCP Proposed Action high-outflow and low-outflow scenarios would reduce the vulnerability of
 12 the Delta’s water export infrastructure to seismic events. With a 9,000-cfs isolated conveyance
 13 facility, post-earthquake water supplies could be maintained at a level of 3.8 MAF under each of the
 14 BDCP Proposed Action scenarios. Mean water supplies following an earthquake in the Existing
 15 Conveyance High-Outflow and Low-Outflow Scenarios would be 1.0 MAF.¹³

16 The water conveyance facilities and operating criteria implemented as part of the BDCP Proposed
 17 Action high-outflow and low-outflow scenarios would improve the quality of Delta exports to
 18 agricultural and municipal water users. Under the BDCP Proposed Action high-outflow scenario,
 19 49% of state and federal project supplies would originate in the north Delta as opposed to the
 20 Existing Conveyance High-Outflow Scenario, which would provide 100% of supplies from the south
 21 Delta. Similarly, under the BDCP Proposed Action low-outflow scenario, 48% of state and federal
 22 project supplies would originate in the north Delta, while the Existing Conveyance Low-Outflow
 23 Scenario would provide 100% of supplies from the south Delta. As a result, project water deliveries
 24 would be less saline under the BDCP Proposed Action high-outflow and low-outflow scenarios,
 25 relative to the Existing Conveyance High-Outflow and Low-Outflow Scenarios.

26 The economic benefits of the BDCP to the state and federal water contractors that will be funding
 27 CM1 and other conservation measures specified as part of the BDCP Proposed Action would \$18.0
 28 billion for the BDCP Proposed Action high-outflow scenario and \$18.8 billion for the BDCP Proposed
 29 Action low-outflow scenario. These outcomes are presented in Table 9-32, which, for convenience,
 30 also displays cost practicability results for the take alternatives.

31 As described in *Appendix 9.B, Take Alternative Cost Estimation*, the present value of the cost of the
 32 BDCP Proposed Action (including construction, habitat restoration, and operations & maintenance
 33 costs) that would be assigned to the contractors is \$13.5 billion. The BDCP Proposed Action high-
 34 outflow and low-outflow scenarios would thus result in a net benefit of \$4.5 billion and \$5.3 billion,
 35 relative to the Existing Conveyance High-Outflow and Low-Outflow Scenarios, respectively.
 36 Comparing these cost figures to the benefits described in the previous paragraph, it follows that the
 37 BDCP Proposed Action would be practicable from a cost standpoint.

38 **9.3.4.2 Logistics**

39 To be logistically practicable, a take alternative must meet three logistical criteria:

- 40
 - Access to conveyance facility and restoration construction sites.

¹³ MWD Board Meeting (Neudeck pers. comm.)

1 • Availability of resources necessary for construction, operation, and maintenance of facilities and
2 restoration sites.

3 • Availability of sufficient land suitable for conveyance facilities and habitat restoration.

4 All of the take alternatives meet the first two criteria. That is, all sites are sufficiently accessible to
5 allow for all necessary construction, operation, and maintenance actions. Also, all sites have
6 sufficient access to resources such as electric power, sources of fill, and materials disposal sites.
7 However, not all take alternatives meet the criterion of having availability of sufficient and suitable
8 land for conveyance facilities and restoration.

9 The analysis of the availability of sufficient and suitable lands for constructing the conveyance
10 facilities and habitat restoration considered the availability of appropriate types of land, conflicting
11 land uses, physical characteristics such as elevation, and ability to assemble necessary parcels.
12 Conceptual engineering reports prepared by DWR (California Department of Water Resources
13 2009) and information contained in the EIR/EIS Appendix 3A, *Identification of Water Conveyance*
14 *Alternatives Conservation Measure 1*, were reviewed to identify potential issues associated with
15 availability of suitable land for conveyance facilities. None of the take alternatives failed the
16 practicability test for availability of sufficient areas of suitable lands for conveyance facilities.

17 Assessment of the availability of sufficient areas of suitable lands for restoration was based on
18 information contained in conceptual engineering reports prepared by DWR, the DHCCP (2012)
19 technical memorandum on creation of up to 100,000 acres of intertidal habitat and HCP Appendix
20 3.A, *Background on the Process of Developing the BDCP Conservation Measures*. A take alternative was
21 deemed impracticable if either of the following circumstances were determined to be likely to occur.

22 • A take alternative would require assembly of conservation reserves at a spatial scale that would
23 not be feasible within Plan implementation timelines except by the use of urban or industrial
24 lands.

25 • A take alternative would require a suite of conservation lands that cannot be supported with
26 existing and foreseeable climate, streamflow and land suitability constraints in the Plan Area.

27 As detailed in Section 9.5, *Assessment of Take Alternatives*, not all take alternatives passed the
28 practicability test for availability of sufficient areas of suitable lands for restoration.

29 **9.3.4.3 Technology**

30 For a take alternative to be technologically practicable, it must use existing, proven technology that
31 can be implemented with a high level of certainty. Untried or untested designs constitute a
32 technological problem because they entail a significant risk that a critical facility component may fail
33 or not perform as intended. The *all known, available, and reasonable technology* (AKART) standard
34 was applied to test whether the take alternative uses existing, proven technology. Technology
35 considerations were deemed to render a take alternative impracticable in cases when an alternative
36 would require the use of untested technologies; i.e., technologies that do not meet the AKART
37 standard.

38 The assessment of technology relies on information contained in conceptual engineering reports
39 prepared by DWR. Technological considerations related to the expense and complexity of water
40 facilities construction were also considered, but these considerations are incorporated in the
41 analysis of economic costs described above and do not present an independent basis for a
42 practicability determination.

1 9.3.5 Other Environmental Consequences

2 Although the EIR/EIS alternatives are not equivalent to the take alternatives, there are nonetheless
 3 sufficient similarities to identify with high confidence those resource areas where significant and
 4 unavoidable adverse effects would likely result if a take alternative were to be implemented. For
 5 example, alternatives that entail extensive areas of construction-related disturbance generally also
 6 entail significant and unavoidable adverse effects on air quality and greenhouse gases. Such impacts
 7 would result from all take alternatives in equal measure, but for four resource areas (air quality,
 8 water quality, land use, and noncovered special-status species), impacts would vary in magnitude
 9 between take alternatives, as shown in Table 9-9. Section 9.5, *Assessment of Take Alternatives*,
 10 discusses the other environmental consequences for each take alternative that are different from the
 11 BDCP Proposed Action. Each other environmental consequence that would occur under a take
 12 alternative but not under the BDCP Proposed Action is briefly described.

13 **Table 9-9. Other Environmental Consequences that Vary Between Take Alternatives**

Resource Impacts	BDCP Proposed Action 9,000 cfs	Take Alternative with Adverse, Significant and Unavoidable Effects								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Air Quality and Greenhouse Gas										
Generation of criteria pollutants in excess of the Yolo-Solano Air Quality Management District thresholds during construction of the proposed water conveyance facility (CM1)		X								
Generation of criteria pollutants in excess of the Sacramento Metropolitan Air Quality Management District thresholds during construction of the proposed water conveyance facility.							X			
Generation of criteria pollutants in excess of the Bay Area Air Quality Management District thresholds during construction of the proposed water conveyance facility		X								
Generation of criteria pollutants in the excess of federal de minimis thresholds from construction and operation and maintenance of the proposed water conveyance facility		X								
Exposure of Sensitive Receptors to Health Risks in Excess of SMAQMD's Health-Risk Assessment Thresholds							X			
Land Use										
Create physical structures adjacent to and through a portion of an existing community as a result of constructing the proposed water conveyance facility (CM1)	X	X	X		X	X	X	X	X	X
Recreation										
Permanent displacement of existing well-established public use or private commercial recreation facility available for							X			

Resource Impacts	BDCP Proposed Action 9,000 cfs	Take Alternative with Adverse, Significant and Unavoidable Effects								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
public access as a result of the location of the proposed water conveyance facilities										
Cause a change in reservoir or lake elevations resulting in substantial reductions in water-based recreation opportunities and experiences at reservoirs outside the Plan Area										X
Water Quality										
Effects on mercury concentrations resulting from facilities operations and maintenance (CM1)						X	X		X	
Effects on organic carbon concentrations resulting from facilities operations and maintenance (CM1)						X	X		X	
Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1)						X	X		X	
Effects on water quality conditions outside of the Plan Area from facilities operations and maintenance (CM1).										X
Effects on selenium concentrations resulting from facilities operations and maintenance (CM1)							X			
Other Species										
Effects of water operations on rearing habitat for non-covered aquatic species of primary management concern ¹⁴		X	X							
Effects on noncovered species from facilities operations and maintenance (CM1)										X

1

2 9.4 Level of Incidental Take and Conservation Benefit 3 by Species Group

4 This section summarizes how the level of take would differ for all covered fish and wildlife species
5 for each take alternative. The same take alternative may eliminate, reduce, not change, or increase
6 take of any particular covered species. For each species group, the take alternatives that would

¹⁴ *Noncovered aquatic species of primary management concern* is the terminology used in the ESI/EIR to describe fish and aquatic species identified by state or federal agencies as special status or of particular ecological, recreational, or commercial importance.

1 avoid or reduce take are identified, and measures to avoid or reduce take are described. Variations
2 in the level of take for each covered fish species are based on the primary mechanisms of effect
3 (stressors) during three project stages (construction, maintenance, and operations). Variations in
4 the level of take for each covered wildlife species are based on permanent, temporary, direct,
5 indirect, and periodic effects from project construction and project operations and maintenance.

6 These assessments were based on quantitative data described in Chapter 5, *Effects Analysis*, and on
7 similar data developed for the EIR/EIS and applied, as appropriate, to the take alternatives.

8 Examples of such quantitative data include geographic information system (GIS) overlays of species
9 habitat distribution models (fish and wildlife) and modeling results of operational scenarios on key
10 stressors of covered fish. Best professional judgment was used for all covered fish and wildlife
11 species to reach conclusions about differences in the level of take. The expected effects were based
12 on the likelihood of the species occurring in the area influenced by the effect or stressor, the degree
13 of overlap between the species and stressor occurrences, the relative intensity and duration of the
14 stressor, and the expected effect of the stressor.

15 **9.4.1 Fish**

16 This section summarizes the potential effect mechanisms for fish described in detail in Chapter 5,
17 *Effects Analysis*. It describes the likely effects of the BDCP Proposed Action and focuses on those
18 potential effect mechanisms (stressors) during construction, maintenance, and operations. As such,
19 it provides a basis for comparison of the potential effects of the take alternatives on the covered fish
20 species, and focuses on those take alternatives that would result in measurable effects on one or
21 more fish species. A relative ranking was assigned to each take alternative, indicating whether take
22 potential was lower, higher, or similar to that which would occur under the BDCP Proposed Action.
23 This ranking was based on the combination of all the stressors, with particular emphasis on
24 stressors likely to elicit measurable effects on that species.

25 **9.4.1.1 Delta Smelt**

26 The geographic distribution of delta smelt is primarily downstream of Isleton on the Sacramento
27 River, downstream of Mossdale on the San Joaquin River, and in Suisun Bay and Suisun Marsh. Delta
28 smelt adults occur primarily in the tidally influenced low-salinity zone of Suisun Bay and the
29 freshwater regions of the Delta and the lower Sacramento and San Joaquin Rivers (Moyle 2002).
30 However, spawning occurs in the Sacramento River as far upstream as Sacramento, the Mokelumne
31 River, and Cache Slough from February to July (Moyle 2002). Thus, adult and larval delta smelt could
32 occur near the intake, fish diversion, conservation hatchery, and nonphysical barrier construction
33 areas early in the in-water construction window (June and July). All life stages are expected to occur
34 near most of the habitat restoration areas in the Delta and lower river areas throughout the
35 construction window. The comparison of take alternatives is summarized in Table 9-10.

1 **Table 9-10. Expected Changes in Incidental Take of Delta Smelt and Conservation Benefits by Take**
 2 **Alternative, Ranked Relative to the BDCP Proposed Action**

Stage	Mechanism of Effect	Take Alternatives								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Construction										
	Underwater sound	+	-	+	-	+	+	○	○	○
	Fish stranding and handling	○	○	○	○	○	+	○	○	○
	Water quality	○	○	○	-	○	+	-	○	○
	Dredging	+	-	+	-	+	+	○	○	○
	Habitat alteration	+	-	+	-	+	+	○	○	○
	Habitat restoration	○	○	○	-	○	○	-	+	○
Maintenance										
	Dredging	+	-	+	-	+	+	○	○	○
	Water quality	○	○	○	○	○	○	○	○	○
	Habitat loss and condition	○	○	○	○	○	○	○	○	○
	Predation and competition	○	○	○	○	○	○	○	○	○
Operations										
	Entrainment and impingement	+	○	+	+	○	+	○	○	○ ^a
	Water quality	○	○	○	○	○	○	○	○	○ ^a
	Flow	○	○	○	○	○	○	○	○	○ ^a
	Habitat	○	○	○	+	○	○	+	-	○
	Predation and competition	○	○	○	○	○	-	○	○	○
	Foodweb	○	○	○	+	○	○	+	-	○
	Conservation measures	○	○	○	○	○	○	○	○	○
<p>A three-point scale indicates how the level of take or conservation benefit is expected to change relative to the BDCP Proposed Action.</p> <ul style="list-style-type: none"> - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action. <p>Note:</p> <p>^a While there is no expected change in the level of take, this species is expected to have greater conservation benefit from this take alternative.</p>										

3

1 **9.4.1.1.1 Construction**

2 Construction at the north Delta intakes, fish diversion structures, restoration sites, conservation
3 hatcheries, and nonphysical barriers may result in a number of adverse effects on delta smelt and
4 other covered species, including disturbance from in-water construction activity and hydrodynamic
5 changes, physical injury from pile-driving sound and vibration levels, exposure to contaminants, and
6 elevated turbidity levels (Appendix 5.H, *Aquatic Construction and Maintenance Effects*).

7 The effects of construction activities would be temporary and are unlikely to have a considerable
8 effect on delta smelt that occur well downstream of the area where the north Delta in-water
9 facilities would be located (downstream of Isleton) (Chapter 5, Section 5.5.1.2.5, *Exposure to In-*
10 *Water Construction and Maintenance Activities*). The BDCP Proposed Action includes measures to
11 minimize effects, including timing of in-water work. As a result, there would be minimal effect on
12 take from these activities.

13 Although the potential for construction effects at the north Delta intakes is expected to be
14 proportional to the number of intakes and total area of intake screen, delta smelt may occur more
15 frequently at the intakes located furthest downstream, particularly during low-flow years, when
16 their distribution may extend further upstream. A greater potential for take of delta smelt is
17 expected to occur from construction of the water conveyance facility with **Take Alternative F** as
18 compared to the BDCP Proposed Action because the Delta Cross Channel and Georgiana Slough
19 diversion structures are about 10 miles further downstream than Intake 5 (Table 9-10), and delta
20 smelt is more likely to occur further downstream.

21 Construction at the restoration sites, conservation hatcheries, and the nonphysical barriers would
22 result in potential effects of short-term and temporary increases in turbidity, exposure to
23 methylmercury, accidental spills, disturbance of contaminated sediments, construction-related
24 disturbance, and predation. For the most part, these activities can be located in areas that avoid or
25 minimize effects on sensitive habitats. However, these effects would be similar for most of the take
26 alternatives, as the type and location of the restoration actions would be similar. The magnitude of
27 effects would vary somewhat based on the overall amount of restoration provided by the various
28 take alternatives, and, as a result, some of the restoration locations would differ (Table 9-10).

29 **Underwater Sound**

30 The primary source of underwater sound that could affect delta smelt and other covered fish species
31 would be from impact pile driving during the construction of the intakes, fish diversion structures,
32 and temporary barge landings. Although vibratory pile driving would be the primary method of
33 installing the cofferdam sheet piles, some impact pile driving (up to 30% of the time) is expected
34 (Appendix 5.H, *Aquatic Construction and Maintenance Effects*). Under all take alternatives, sound
35 minimization measures would be used to minimize the risk of incidental take attributable to sound
36 exposure associated with impact pile driving. The amount of impact pile-driving would be
37 proportional to the overall size of the in-water structures and the number of barge landings. The
38 take alternatives with five new intakes (**Take Alternatives A, C, and E**) would require up to 80%
39 more pile driving to install the cofferdams, compared with the BDCP Proposed Action (three
40 intakes), resulting in substantially greater potential effects. However, take alternatives that include
41 Intakes 4 and/or 5, or that include new structures farther into the south and east Delta (**Take**
42 **Alternative F**) have an increased potential to affect delta smelt and other covered species that have
43 a longer residence time in the lower river reaches (Table 9-10). Incidental take associated with
44 **Take Alternatives G, H, and I** would be similar to the BDCP Proposed Action, as each include the

1 same three intakes, while **Take Alternatives B and D** would likely result in less take because of the
2 fewer intakes constructed.

3 Similar differences in the number of foundation piles, installed in the cofferdams, would occur. As
4 described above, however, the timing of pile driving, the limited use of the construction areas by
5 delta smelt and some other covered species and the primary use of vibratory pile-driving methods
6 would minimize potential effects. **Take Alternative F** would have two primary diversion screen
7 structures (at Georgiana Slough and the Delta Cross Channel), and a number of operable barriers on
8 various sloughs. The overall length of in-water structures would be greater than under the BDCP
9 Proposed Action, and the structures would be widely distributed, resulting in a larger area of
10 exposure to pile driving sound, and thus an increased risk of incidental take (Table 9-10).

11 **Fish Stranding and Handling**

12 As with other construction activities, the potential for take resulting from stranding delta smelt and
13 other covered fish species in cofferdam structures, and the handling associated with their
14 subsequent rescue and removal would be proportional to the number and size of in-water
15 structures built. However, potential effects on delta smelt in the vicinity of the proposed north Delta
16 intakes are expected to be limited because smelt have a low probability of occurrence in the area
17 during the in-water construction period (Chapter 5, *Effects Analysis*). As with pile driving, the take
18 alternatives with five intakes (**Take Alternatives A, C, and E**) would have a greater potential for
19 effects than the BDCP Proposed Action, and the take alternatives with fewer in-water structures
20 would have less potential for effects. These activities would typically occur only once at each site
21 during the construction phase, so the overall effects would be limited, and no substantial differences
22 between take alternatives relying on new north Delta intakes are expected (Table 9-10). The
23 diversion structures built under **Take Alternative F** have a smaller footprint, but the structures are
24 numerous, widely distributed, and more are located within the smelt's range than with the BDCP
25 Proposed Action; thus this construction would likely result in greater stranding and handling effects
26 than work at the north Delta intakes under the other take alternatives.

27 **Water Quality**

28 The implementation of appropriate construction best management practices, as described in
29 Appendix 3.C, *Avoidance and Minimization Measures*, would minimize the potential take of delta
30 smelt and other covered species resulting from changes in water quality. The expected limited
31 occurrence of delta smelt in the project construction areas for alternatives relying on new north
32 Delta intakes, and the isolation of most construction activities within the cofferdams, would also
33 minimize the potential for effects. As a result, no measurable differences are expected between these
34 take alternatives, although the limited footprint for **Take Alternative D** and the reduced tidal
35 habitat restoration under **Take Alternatives D and G** could result in a lower potential for effects.
36 **Take Alternative F**, however, includes numerous new in-water structures built within portions of
37 the range of the delta smelt located in the west, central, and south Delta, and thus has greater
38 potential for water quality changes to affect this species (Table 9-10).

39 **Dredging**

40 Dredging effects would include increased turbidity, potential suspension of contaminated
41 sediments, and decreased dissolved oxygen levels (Appendix 5.D, *Contaminants*). Some dredging
42 would occur outside of the cofferdams to recontour the substrate adjacent to the intakes (Appendix
43 5.H, *Aquatic Construction and Maintenance Effects*). The amount of dredging typically would vary in

1 proportion to the number and size of in-water structures, similar to the other construction effects.
 2 The five-intake take alternatives (**Take Alternatives A, C, and E**) would require 54 to 68% more
 3 acres of construction area requiring dredging than the BDCP Proposed Action, while **Take**
 4 **Alternative D** (one intake) would require about 73% fewer acres (Table 9-11). Similar acreages
 5 would be dredged periodically for maintenance purposes. While **Take Alternative F** would likely
 6 require little or no dredging associated with construction of the diversion structures, dredging is
 7 expected to occur in some of the sloughs in the interior Delta where delta smelt and some other
 8 covered species may be more likely to occur, in order to increase channel flow capacity or extend
 9 their length to redirect flows or fish. Although it is assumed that dredging these interior channels
 10 would not occur until after the diversion structures are completed, **Take Alternative F** would have
 11 a greater potential for take from dredging than the BDCP Proposed Action because nearly four times
 12 the area would be dredged (Table 9-11).

13 **Table 9-11. Number of Barge Landings and Habitat Affected by Construction Activities by Take**
 14 **Alternatives**

Take Alternatives	Intakes	Barge Landings	Total Shoreline Habitat Affected (feet)	Total Intake Footprint (acres)	Total Habitat Dredged (acres)
BDCP Proposed Action	2, 3, and 5	6	6,360	5.0	14.6
A: W Canal 15,000 cfs	W1-W5	2	10,100 (+59%)	8.4 (+68%)	24.6 (+68%)
B: Tunnels 6,000 cfs	1 and 2	6	4,060 (-36%)	3.4 (-32%)	9.4 (-36%)
C: Tunnels 15,000 cfs	1-5	6	9,780 (+54%)	7.9 (+58%)	22.6 (+54%)
D: Tunnels 3,000 cfs	1	6	1,660 (-74%)	1.3 (-74%)	3.9 (-73%)
E: Isolated 15,000 cfs	1-5	6	9,780 (+54%)	7.9 (+58%)	22.6 (+54%)
F: Through Delta	N/A ^a	5	4,800 (-24%)	15.5 (+310%)	56.9 (+389%)
G: Less Tidal Restoration	2, 3, and 5	6	6,360 (0%)	5.0 (0%)	14.6 (0%)
H: More Restoration	2, 3, and 5	6	6,360 (0%)	5.0 (0%)	14.6 (0%)
I: Modified Spring Outflow	2, 3, and 5	6	6,360 (0%)	5.0 (0%)	14.6 (0%)

^a Consists of a series of fish screens to limit fish access to existing channels, instead of typical intake structures.

15
 16 While dredging has the potential to injure or kill fish that come in contact with the dredge, limited
 17 occurrences of delta smelt are expected during the in-water construction window. Dredging would
 18 also result in the loss of benthic and epibenthic organisms, which would affect the localized food
 19 resources, until the area is recolonized. However, the limited extent of dredging areas, compared to
 20 the amount of overall habitat in the Delta, the relatively quick recolonization expected
 21 (National Marine Fisheries Service 2005), and the limited use of the construction areas by delta

1 smelt (Baxter et al. 2008; Nobriga and Herbold 2009; Sommer et al. 2011) would limit the overall
2 effects of any of the take alternatives (Table 9-10).

3 **Habitat Alteration**

4 As with other construction activities, the potential for take from the loss or alteration of nearshore
5 habitat would vary by the number and size of the in-water structures and the number of barge
6 landings. However, compared to the amount of habitat available to delta smelt in the Plan Area, the
7 condition of the lost habitat, and the overall limited use of the affected habitat by delta smelt, the
8 overall potential for take would be limited. Nevertheless, the take alternatives with five intakes
9 (**Take Alternatives A, C, and E**) would have substantially greater (58 to 68%) habitat loss,
10 compared with the BDCP Proposed Action, while **Take Alternative B** (two intakes) and **Take**
11 **Alternative D** (one intake) would have 32 and 74% less habitat loss than the BDCP Proposed
12 Action, respectively (Table 9-11). **Take Alternative F** would likely affect less nearshore habitat than
13 other take alternatives, but the overall aquatic habitat effects are likely to be greater than the BDCP
14 Proposed Action and the other three-intake take alternatives, based on the numerous and widely
15 distributed in-water structures constructed within the range of delta smelt habitat, as well as the
16 associated dredging effects (Table 9-10).

17 The potential effects of the barge landings on delta smelt habitat would be similar for most take
18 alternatives (typically six barge landings each) and temporary. However, **Take Alternative A** would
19 have only two landings (67% fewer than the BDCP Proposed Action), and **Take Alternative F** would
20 have one less landing (17% less), compared to the BDCP Proposed Action (Table 9-11).

21 **Habitat Restoration**

22 The construction of habitat restoration projects may temporarily disturb or displace covered fish
23 species and their habitat, as well as affect water quality, particularly turbidity, dissolved oxygen, and
24 suspended contaminated sediments (Appendix 5.E, *Habitat Restoration*). However, most of the
25 restoration construction activities would be conducted in the dry, and any in-water work would
26 occur during the approved in-water construction window (typically June 1 through October 31),
27 when fewer numbers of delta smelt are expected to occur in the Plan Area. Some restoration
28 construction could occur during periods when delta smelt may be present, depending on the specific
29 location. Any potential effects would be localized, temporary, and infrequent.

30 The BDCP Proposed Action and most of the take alternatives would have comparable amounts of
31 restoration construction activity. **Take Alternatives D and G**, would restore about 61 and 23%
32 fewer acres of tidal habitat respectively, and would cause less disturbance (take) than the BDCP
33 Proposed Action. In contrast, **Take Alternative H** would restore 15% more tidal habitat (from
34 65,000 to 75,000 acres), 100% more seasonally inundated floodplain acreage (from 10,000 to
35 20,000 acres), and 100% more channel margin enhancement area (from 10 to 20 linear miles).
36 Therefore, **Take Alternative H** would result in greater potential for take than the BDCP Proposed
37 Action. Overall, the differences in the amount of habitat restored are not expected to substantially
38 affect the take of delta smelt, but would likely result in substantial differences in the long-term
39 benefits to the species. For example, tidal natural communities restoration under CM4 will
40 considerably increase the amount of potentially suitable delta smelt spawning habitat. These areas
41 include the Cache Slough ROA (doubling the habitat units for the egg stage) but also in the West
42 Delta and Suisun Marsh ROAs (orders of magnitude more spawning habitat). There may also be a
43 beneficial effect due to reduced contaminant runoff from restoration areas previously used for
44 agriculture (Chapter 5, Section 5.5.1.2.4, *Exposure to Contaminants*).

1 **9.4.1.1.2 Maintenance**

2 As with construction, the potential for take resulting from maintenance activities would be
3 proportional to the number of in-water structures. However, maintenance activities would be
4 temporary, localized, and infrequent. Substantial effects on delta smelt would be unlikely because
5 the species typically occurs well downstream of the primary maintenance areas (north Delta intake
6 sites). A number of measures would minimize effects (Appendix 3.C, *Avoidance and Minimization*
7 *Measures*), including timing of in-water work. As a result, take from these activities would be
8 minimal. The maintenance activity most likely to affect aquatic species is dredging required to
9 maintain appropriate hydrodynamics and to minimize sediment entering the intakes.

10 **Dredging**

11 Dredging would be required to maintain the efficiency of the intakes. This maintenance dredging
12 would occur relatively infrequently, typically during the approved in-water work windows, and
13 would be unlikely to occur at more than one intake at any one time. The frequency of maintenance
14 dredging would be proportional to the number and size of intakes (Table 9-11). Maintenance
15 dredging for **Take Alternative F** would be similar to existing conditions at the south Delta facilities,
16 although extensive maintenance dredging may be required in some of the interior Delta sloughs to
17 maintain sufficient water transport capacity. While it is unknown how frequently maintenance
18 dredging would be required to maintain these flow routes, and the diversion structures would
19 reduce delta smelt access to some of these dredging areas, it is assumed that dredging requirements
20 of **Take Alternative F** would be similar to the five-intake take alternatives, and thus would be
21 substantially greater than requirements for the three-intake take alternatives, including the BDCP
22 Proposed Action.

23 Dredging can result in take through a number of mechanisms, including physical injury or mortality
24 and habitat alterations. The habitat alterations would include the removal of substrate-based food
25 resources and changes in water quality, although such effects would typically be localized,
26 temporary, and infrequent. These changes could result in direct or indirect effects on delta smelt,
27 particularly in downstream areas, where the fish occur more frequently. In addition, few delta smelt
28 would be expected to occur in the dredging areas during the approved in-water work window.
29 Although the take alternatives with the greatest number of in-water structures would likely require
30 the most dredging, the limited use of these areas by delta smelt would reduce the magnitude of
31 effects.

32 **Water Quality**

33 Dredging and other maintenance activities could result in temporary changes in water quality, as
34 described above under construction effects. However, these effects would be temporary, periodic,
35 and of limited extent. Few delta smelt would likely occur in areas affected by these water quality
36 conditions, and dredging would likely occur at only one site at a time. Any take associated with these
37 activities would be negligible, and the expected difference in take between take alternatives would
38 likely be small (Table 9-10).

39 **Habitat Loss and Condition**

40 The removal of substrate during dredging operations would result in the removal of benthic and
41 epibenthic organisms, which provide direct or indirect food resources for other aquatic species,
42 including most of the covered fish species. Although delta smelt are typically pelagic feeders, they

1 could be somewhat affected by changes in substrate-oriented (epibenthic) food resources. Any take
 2 associated with these activities would likely be negligible, and the expected difference in take
 3 between take alternatives would likely be small.

4 **Predation and Competition**

5 Any effects of maintenance activities on predation of delta smelt or competition with other species
 6 would be infrequent, temporary, and localized. Any take associated with these activities would likely
 7 be negligible, and the expected difference in take between take alternatives would likely be small.

8 **9.4.1.1.3 Operations**

9 In addition to the diversion of water into the north Delta intakes, operations would include long-
 10 term habitat restoration and enhancement activities, as well as predator reduction and invasive
 11 aquatic vegetation control measures. Entrainment and impingement represent the primary
 12 mechanisms for take of delta smelt. Other potential mechanisms for take would include changes in
 13 water quality (particularly turbidity), changes in flow management, alteration (restoration) of
 14 habitat, changes to predator habitat or predator numbers, alteration of competitive interactions
 15 with other species, and the long-term implementation of other conservation measures.

16 Delta smelt is one of two species (the other is longfin smelt) for which the BDCP includes a decision
 17 tree to determine initial operations of CM1 using the best available science (Chapter 3, Section
 18 3.4.1.4.4, *Decision Trees*). For delta smelt, the decision tree is focused on the need for fall outflow to
 19 be implemented per the USFWS 2008 BiOp. The BDCP’s fall outflow decision-tree process is
 20 conceptually similar to the BiOp’s Fall X2 requirement, and expected to provide the same level of
 21 protection for delta smelt. However, the BDCP Proposed Action may provide substantial additional
 22 habitat (up to 50% more than existing conditions) from restoration in low-salinity areas, and will
 23 restore almost seven times more tidal natural communities (55,000 acres) than are included in the
 24 BiOp, providing the potential for greater restoration of foodweb productivity. For these reasons, the
 25 BDCP Proposed Action is consistent with and expected to exceed the benefits to delta smelt
 26 provided under the USFWS 2008 BiOp.

27 **Entrainment and Impingement**

28 With regard to the BDCP Proposed Action and all take alternatives, some entrainment and
 29 impingement risks to delta smelt would arise in the north Delta with the addition of the new in-
 30 water intake structures, compared to existing conditions. These alternatives would include fish
 31 screens designed to meet NMFS, USFWS, and CDFW criteria regarding sweep and approach
 32 velocities, while minimizing the overall size of the intakes. Although sweep- and approach-velocity
 33 criteria for the north Delta intake screens have not been finalized, the approach velocity will be less
 34 than 0.33 foot per second foot per second (the criterion for salmonid fry) and may be limited to 0.2
 35 foot per second when monitoring shows presence of delta smelt (the existing criterion for juvenile
 36 delta smelt) (Chapter 5, Section 5.5.1.2.2, *North Delta Intakes Entrainment and Impingement*). These
 37 design criteria will minimize entrainment, impingement and mortality of all delta smelt life stages.
 38 Monitoring programs will be implemented to confirm their effectiveness, and adaptive management
 39 procedures will be used to correct unforeseen deficiencies in the screening system. However, there
 40 would be some differences in effectiveness between intakes, based on specific characteristics at the
 41 various intake sites. For example, sites located on the outside of a river bend, or in a narrower
 42 portion of the river, would tend to have greater water velocities than wider and straighter river
 43 sections.

1 At the same time, an intake on the outside of a river bend may result in a greater proportion of the
 2 fish exposed to the intake screen, because the river flow is directed toward the intake. For an intake
 3 on the inside of a bend, the river flow would generally be moving away from the intake, potentially
 4 reducing the proportion of fish encountering the screens. However, inside bend locations are
 5 typically avoided because of sedimentation problems and difficulties maintaining sweep velocities.
 6 As a result, most of the intakes are on relatively straight reaches of the river, except for Intake 3
 7 (outside bend) and Intake 1 (just downstream of an outside bend).

8 Increased water velocities at the intake sites would increase the sweep velocity parallel to the
 9 screen face, which is also expected to increase the velocity of fish passing the screens. This would
 10 decrease the time that fish are exposed to potential entrainment or impingement, thereby
 11 potentially improving overall screen effectiveness. However, there are indications of increased delta
 12 smelt mortality with higher sweep velocities and also at night. Once the design criteria are finalized,
 13 monitoring and adaptive management procedures will inform subsequent adjustments, as
 14 necessary.

15 Water depth could also affect screen effectiveness, as water velocities tend to be slower in deeper
 16 reaches, decreasing the sweep velocity and slowing the movement of fish past the site. Despite these
 17 variables, the overall rate of entrainment and impingement would tend to increase proportionally
 18 with the length of an intake screen, or the combined length of multiple intakes (Table 9-12). A take
 19 alternative with a greater number and size of intakes would typically have a greater overall
 20 incidence of entrainment or impingement, based on the overall length of the combined screens
 21 (Appendix 5.B, *Entrainment*).

22 **Table 9-12. Intake Numbers, Intake Capacity, and Total Screen Length by Take Alternatives**

Take Alternatives	Intakes	Diversion Capacity (cfs)	Total Screen Length (feet)	Difference in Total Screen Length Compared with the BDCP Proposed Action ^a
BDCP Proposed Action	2, 3, and 5	9,000	4,400	0
A: W Canal 15,000 cfs	1 through 5 ^b	15,000	7,300	+66%
B: Tunnels 6,000 cfs	1 and 2	6,000	2,900	-34%
C: Tunnels 15,000 cfs	1 through 5	15,000	6,800	+54%
D: Tunnels 3,000 cfs	1	3,000	1,100	-75%
E: Isolated 15,000 cfs	1 through 5	15,000	6,800	+54%
F: Through Delta	None ^c	15,000	5,600	+27%
G: Less Tidal Restoration	2, 3, and 5	9,000	4,400	0
H: More Restoration	2, 3, and 5	9,000	4,400	0
I: Modified Spring Outflow	2, 3, and 5	9,000	4,400	0

^a Estimated differences in total intake screen length indicate potential differences in operational effects, although other factors (e.g., intake location, configuration, or water velocity across the screens) substantially influence actual effects.

^b These five intakes are located on the west (opposite) side of the river from those of the other take alternatives.

^c Two screened diversions would be constructed, one each at the Delta Cross Channel and one at Georgiana Slough. Each diversion would be 7,500 cfs.

23

1 In addition to the number and location of the proposed north Delta intakes, the take alternatives
2 also vary in the use of the existing south Delta facilities. With the exception of **Take Alternative E**,
3 which would have no south Delta diversions, all take alternatives include some continued use of the
4 south Delta facilities. Fish losses from entrainment and predation would be greater at the south
5 Delta facilities than the north Delta facilities, so the benefits of the take alternatives would vary with
6 the proportion of the mean total project water deliveries provided through the south Delta facilities.
7 The take alternatives with a greater number of north Delta intakes would also increase operational
8 flexibility to reduce the use of the south Delta facilities.

9 At the north Delta diversions, the risk of delta smelt entrainment would increase compared to
10 existing conditions (with no north Delta facilities), but the overall risks would be relatively low
11 because delta smelt occur infrequently in the area. Delta smelt are typically found downstream of
12 Isleton (about 19 miles downstream of Intake 5, which is the most downstream intake), and the
13 center of their distribution is typically near Decker Island (about 27 miles downstream of Intake 5)
14 (Moyle 2002). However, some portion of the delta smelt population would pass the intake area
15 during upstream spawning migrations, and subsequent downstream larval movement.

16 Based on lower entrainment estimated for the delta smelt population under the BDCP Proposed
17 Action compared to existing conditions, the reduction in take of delta smelt at the south Delta
18 facilities may provide a minor benefit at the population level for delta smelt (Chapter 5, Section
19 5.5.1.1, *Beneficial Effects*). Take of delta smelt at the south Delta facilities could increase in the future
20 if the population increases as a result of the BDCP or other actions; however, this would not
21 represent an increase in loss as a proportion of the population. As with the construction effects, the
22 potential for entrainment and impingement effects is expected to be proportional to the number of
23 intakes and total area of intake screen (Table 9-12), although delta smelt are more likely to occur at
24 the intakes located furthest downstream, particularly during low-flow years. The potential for
25 greater effects at the downstream intakes is expected to occur in the long term, as a result of sea
26 level rise and increased intrusion of saltwater up the river, and the proposed habitat restoration in
27 Cache Slough. These conditions are expected to increase the range distribution of delta smelt,
28 potentially increasing their exposure to north Delta intakes, particularly the ones that would be
29 located furthest downstream. Similar effects could occur with **Take Alternative F**, as the Delta
30 Cross Channel and Georgiana Slough diversion structures are about 10 miles further downstream
31 than Intake 5.

32 The BDCP Proposed Action would have three new north Delta intakes (Intakes 2, 3, and 5), with a
33 total screen length of about 4,400 feet, which is the same as **Take Alternatives G, H, and I** (Table
34 9-12). By comparison, **Take Alternatives A, C, and E** would have substantially greater potential for
35 entrainment and impingement, because each would have five intakes, with a total screen length
36 between 54 and 66% greater than the BDCP Proposed Action. **Take Alternative B** would have two
37 intakes, with about 34% less overall screen length than the BDCP Proposed Action. While the one
38 intake for **Take Alternative D** would have a screen length about 75% less than the BDCP Proposed
39 Action, the greater proportion of south Delta exports (72% vs. 51%) would offset the entrainment
40 reductions resulting from the shorter north Delta intake screens. This increased entrainment
41 potential under **Take Alternative D** would be magnified in dry years by the more upstream
42 distribution of estuarine fishes.

43 The cumulative length of the diversion screens constructed under **Take Alternative F** will be 27%
44 greater than the BDCP Proposed Action. Each screen under **Take Alternative F** will be almost twice
45 the length of those proposed under the BDCP Proposed Action, and located in waters farther

1 downstream where delta smelt are more likely to occur. **Take Alternative F** also includes 14
2 operable gates in the interior Delta. There is substantial uncertainty regarding the effectiveness of
3 the screens used in **Take Alternative F**. There are no screens of this size currently in use and it is
4 possible that fish would experience impingement due to the high energetic costs of having to swim
5 past such a long barrier without access to any flow refugia. There are also uncertainties about the
6 effects of tidal flow reversals on the behavior and impingement risks for fish swimming past these
7 long barriers. The proportional change in impacts on delta smelt from the intakes might not be the
8 same as the change in total screen length because of other differences among take alternatives at the
9 screens (e.g., screen location on a river bend, water velocity across the screens), as discussed above.
10 However, these differences serve as a guide to the potential magnitude of differences in screen
11 effects among take alternatives. **Take Alternative F** would also limit the number of fish
12 encountering the south Delta pumping facility screens by blocking their access to the Delta Cross
13 Channel and Georgiana Slough. For this reason, entrainment would likely be reduced compared to
14 the BDCP Proposed Action, but impingement rates and other screen-related effects would likely be
15 substantially greater. Therefore, the overall level of take is expected to be somewhat higher under
16 **Take Alternative F** than the BDCP Proposed Action (Table 9-12).

17 In addition to the size and number of north Delta intakes, the changes in the south Delta exports
18 could affect the overall entrainment rates of delta smelt (Chapter 5, Section 5.5.1.1.3, *Reduced*
19 *Entrainment*). As a result, **Take Alternatives B** and **D**, with fewer north Delta intakes could still
20 have similar or greater entrainment levels as the BDCP Proposed Action, because of greater south
21 Delta exports. Similarly, **Take Alternative E** would have no south Delta exports, which could
22 partially offset having a greater number of north Delta intakes than the BDCP Proposed Action. The
23 fish screens at the proposed north Delta intakes would meet or exceed the current agency-
24 recommended sweep- and approach-velocity criteria, while minimizing the overall size of the
25 intakes, which are expected to result in lower entrainment and impingement rates than the existing
26 south Delta facilities (Appendix 5.B, *Entrainment*). Therefore, while the take alternatives with the
27 largest number of intakes (and longest overall screen length) would have a greater potential to
28 increase entrainment and impingement rates at the north Delta intakes, and any corresponding
29 reductions in water diversions at the existing SWP and CVP facilities, are expected to result in an
30 overall reduction in entrainment losses of most covered fish species, including delta smelt (Chapter
31 5, Section 5.5.1.1.3, *Reduced Entrainment*).

32 During some water years, exports from the north and south Delta facilities could be substantially
33 reduced to help meet the spring outflow target level under **Take Alternative I**, thereby reducing
34 entrainment and impingement potential. Spring entrainment of larval and juvenile delta smelt at the
35 south Delta export facilities would be less because the greater Delta outflow would result in
36 distribution further downstream and less south Delta exports would result in less hydrodynamic
37 influence of the south Delta export facilities in reversing net flows in Old and Middle Rivers
38 (Appendix 5.B, *Entrainment*, Section 5.B.6.1.5.1, *Larva/Juvenile [Proportional Entrainment Loss*
39 *Regression]*). Therefore, **Take Alternative I** would likely result in lower entrainment and
40 impingement rates of delta smelt, compared to the BDCP Proposed Action, despite having the same
41 water export facilities (Table 9-10).

42 **Water Quality**

43 With the possible exception of changes in turbidity, operations under the BDCP Proposed Action and
44 most take alternatives, are not expected to substantially affect water quality in the Plan Area.

1 However, **Take Alternative I** might have a greater potential to affect water quality conditions in the
 2 spring, due to the increased outflow target, compared to the BDCP Proposed Action (Table 9-10).

3 Effects from restoration associated with CM4, CM5, CM6, and CM7 may result in more substantial
 4 changes in water quality (Appendix 5.E, *Habitat Restoration*). Restored areas will be closer to the
 5 primary range of delta smelt, increasing the potential for effects from water quality changes. Such
 6 changes could include increases in turbidity, temperature, and contaminant levels resulting from the
 7 inundation of restored floodplain and tidal habitat area.

8 Turbidity is a particularly important habitat characteristic for delta smelt and is a significant
 9 predictor of occurrence (Nobriga et al. 2008; Feyrer et al. 2011). Cloern et al. (2011) noted the
 10 uncertainty regarding the continuation of a 40-year average decline in turbidity, of 1.6% per year.
 11 Should such a trend continue, it would further decrease delta smelt habitat value in the Plan Area.
 12 Restored habitat has the potential to increase turbidity through runoff from inundated and natural
 13 shoreline areas, although sediment removal by the north Delta intakes and upstream ROAs is
 14 expected to reduce the amount of sediment available for resuspension (i.e., reduced turbidity
 15 potential) in downstream areas typically occupied by delta smelt. Implementation of dual
 16 conveyance under CM1 could result in around 8 to 9% less sediment entering the Plan Area from the
 17 Sacramento River, the main source of sediment for the Delta and downstream subregions, because
 18 of the north Delta intakes (Chapter 5, Section 5.5.1.2.1, *Increased Water Clarity*). However, the
 19 overall effects of sediment removal on water clarity are uncertain.

20 While the take alternatives that provide the most habitat restoration could cause greater changes in
 21 corresponding water quality, they are also expected to provide offsetting benefits, by increasing the
 22 quantity and value of available habitat. As a result, changes in water quality resulting from the
 23 various take alternatives are not expected to differentially affect delta smelt.

24 **Flow**

25 Prior to 2004, intermediate outflow years tended to produce the greatest abundance of delta smelt,
 26 although production was highly variable among years in response to overall environmental
 27 conditions (Moyle 2002; Bennett 2005). For delta smelt, the decision tree is focused on whether fall
 28 outflow will be consistent with requirements of the USFWS 2008 BiOp. The monitoring and
 29 decision-tree process for Fall X2 will provide more guidance for meeting the goals and objectives of
 30 Fall X2, as well as the spring outflow goals. The process is also focused on developing more accurate
 31 estimates of the outflows necessary to maintain the X2 position with future sea level rise (Chapter 3,
 32 Section 3.4.1.4.4, *Decision Trees*).

33 Delta smelt inhabit the low-salinity zone (brackish water/freshwater interface) in the upper Bay-
 34 Delta estuary. Because the location of the low-salinity zone is determined by the interaction of river
 35 outflow and tidal inflow of marine water from San Francisco Bay, the daily distribution of adult delta
 36 smelt can vary by many kilometers in response to tidal dynamics (Bennett 2005). The location of X2
 37 during the fall, has been used as an indicator of habitat conditions for delta smelt and other
 38 estuarine fish and macroinvertebrates. The location of X2, which varies seasonally and
 39 interannually, is used as one of the parameters in assessing the effects of changes in freshwater
 40 outflow on estuarine habitat conditions.

41 The BDCP Proposed Action could reduce the movement of water from the north Delta (Sacramento
 42 River) to the south Delta for export, restoring a more natural pattern of flow through the Delta. This
 43 would include improving normative flows east to west (outflow to the bay) by shifting a larger

1 portion of the total exports to the north Delta facilities. Additionally, the timing of Delta exports and
2 outflows would be adjusted to specifically benefit the aquatic ecosystem and covered fish species.
3 While this may also reduce some Sacramento River flows, the frequency and magnitude of reverse
4 flows in Old and Middle River will be substantially reduced because of the reduced use of the south
5 Delta export facilities in most water-year types.

6 Fall outflow under the BDCP Proposed Action would increase the index of abiotic habitat, which
7 incorporates salinity and water clarity factors, relative to existing conditions. The effect that fall
8 outflow has on the delta smelt population—including such characteristics as abundance, body size,
9 and health—will be tested through the decision-tree process. Initial operations under the BDCP
10 Proposed Actions would be adjusted on the basis of the scientific information developed up to CM1
11 implementation. The BDCP contemplates two different fall outflow scenarios to ensure positive
12 effects on delta smelt habitat, and restoration activities conducted throughout the Plan Area will
13 provide additional rearing habitat. The decision tree is designed to provide the information
14 necessary to achieve the biological goals and objectives for delta smelt relative to outflow, and
15 therefore the fall outflow outcome under the BDCP Proposed Action would be positive for delta
16 smelt (Chapter 3, Section 3.4.1.4.4, *Decision Trees*). Low outflow may increase exposure of delta
17 smelt to less desirable environmental conditions, such as toxicity from microcystis blooms or
18 increased abundance of the invasive overbite clam (*Potamocorbula amurensis*), as a result of greater
19 areas of suitable salinity (greater than 2 parts per thousand [ppt]). Analyses indicate that the
20 centroid of the delta smelt geographic distribution moves upstream and downstream in relationship
21 to Fall X2 location (Sommer et al. 2011), although the relationship between the location of Fall X2
22 and population-level responses (health, survival, and abundance) of delta smelt is not known (Mac
23 Nally et al. 2010; Miller et al. 2012). However, the lowest population indices coincide with the lowest
24 values of habitat index in the fall (Feyrer et al. 2011) (Chapter 5, Section 5.5.1.1.2, *Fall X2 Decision*
25 *Tree Process*).

26 The decline in fall abiotic habitat in the open estuary would also be largely offset by tidal marsh
27 habitat restoration when considered across all water year types. However, even with this habitat
28 restoration, the decrease in the fall abiotic habitat index would still be a potential adverse effect on
29 the portion of the delta smelt population that rears near the confluence of the Sacramento and San
30 Joaquin Rivers in the west Delta and Suisun Bay subregions, depending on which baseline is used for
31 comparison. Delta outflows under the BDCP Proposed Action, would be slightly higher than existing
32 conditions. The BDCP Proposed Action would also have greater fall outflows compared to **Take**
33 **Alternatives A, B, and C**; less than **Take Alternatives D, E, and F**; and similar to **Take Alternatives**
34 **G, H, and I**. However, the seasonality of these outflows, and the influence of other flow-related
35 survival factors (i.e., increased predation potential with reduced flows) reduce the ability to discern
36 differences in flow effects between take alternatives. **Take Alternative I** would provide fixed spring
37 flows in some water years to specifically benefit delta smelt and potentially other species occurring
38 in the Plan Area in the spring.

39 **Habitat**

40 Tidal wetland restoration may provide significant benefits to covered species, particularly delta
41 smelt; however, it is not possible to predict the level of benefit because of uncertainties related to
42 the specifics of the restoration sites. Adaptive management during implementation will aim to
43 maximize benefits to delta smelt. Take alternatives that provide greater amounts of habitat
44 restoration have the most potential to benefit delta smelt, particularly from increased nutrients
45 provided by periodic inundation of restored habitat. **Take Alternative H** has the most potential to

1 benefit delta smelt, as it would provide 15% (10,000 acres) more tidal habitat and 100% (20 miles)
2 more channel margin than other take alternatives. Some additional benefits might also occur from
3 the additional 10,000 acres of seasonal inundated floodplain restored under **Take Alternative H**,
4 depending on where this restoration occurs, particularly if it occurs outside of the south Delta. **Take**
5 **Alternatives G** and **D** would provide 23% (15,000 acres) and 38% (25,000 acres) less tidal habitat
6 than most other take alternatives (**Take Alternatives A, B, C, E, F, and I**), respectively. Reduced
7 habitat restoration would result in fewer benefits to delta smelt (Table 9-10).

8 **Predation and Competition**

9 Although predation is a natural part of aquatic community dynamics, excessive predation is a
10 stressor for covered fish species, especially delta smelt (Baxter et al. 2008). Predators are believed
11 to aggregate in areas around intake screens (Vogel 2008), and the number of predators is expected
12 to be proportional to the size (length) of the screen facility. Therefore, the five-intake take
13 alternatives (**Take Alternatives A, C, and E**) would provide the most potential predator habitat and
14 corresponding predation pressure, compared to the take alternatives with smaller or fewer in-water
15 facilities. However, as described above for entrainment and impingement, other site characteristics
16 (water velocities, water depth, and cover habitat) are important variables affecting predation and
17 competition.

18 While in-water and overwater structures can provide habitat for delta smelt predators, the amount
19 of such habitat produced during construction, compared to the overall availability of predator
20 habitat in the Plan Area, would be small. In addition, delta smelt generally occur more frequently
21 away from shore and are not typically associated with structures (Nobriga and Herbold 2009).
22 Therefore, the potential differences in predation risks between take alternatives would likely be
23 negligible (Table 9-10).

24 Any increases in predation pressure at the proposed north Delta diversions would also likely be
25 small because the diversions are upstream of much of the range of delta smelt, although delta smelt
26 moving to and from upstream spawning areas would be exposed to these predators. The
27 implementation of CM15 may reduce predation pressure at key locations in the Plan Area, and
28 would apply to all the take alternatives.

29 Water operations under CM1 would change the proportions of delta smelt entrained at the south
30 Delta export facilities, which in turn would affect their exposure to predation. Although delta smelt
31 typically occur downstream of the proposed north Delta intakes (downstream of Isleton), **Take**
32 **Alternative F** would result in the fewest fish diverted to the interior Delta and the lowest predation
33 levels, as fish would be blocked from entering the interior Delta channels. While the other take
34 alternatives would change the amount of water, and presumably a similar proportion of fish
35 diverted to the interior Delta, they would not prevent fish from entering these areas. Of these, **Take**
36 **Alternative E** would not include south Delta exports, and could result in a reduction in the number
37 of delta smelt entering the interior Delta and exposed to predators along this route (Table 9-13).
38 However, the overall differences are expected to be small, because of the typical distribution of delta
39 smelt, and the other flow-related effects of north Delta exports (i.e., reduced mainstem Sacramento
40 River flows) (Table 9-10). Delta smelt typically occur well downstream of proposed diversion
41 facilities (downstream of Isleton) Flow reductions and increased in-water structures could increase
42 habitat suitability for predatory fish such as largemouth bass and could increase predation on delta
43 smelt and other species (Appendix 5.F, *Biological Stressors on Covered Fish*, Section 5.F.4.2.4,
44 *Predation Risk in Restored Habitats*).

1 **Table 9-13. Mean Annual Project Water Deliveries in Million Acre-Feet and Total Delta Outflow by**
 2 **Take Alternatives at Early Long-Term**

Take Alternatives	Mean Annual Total Project Water Deliveries	Mean North Delta Deliveries	Mean South Delta Deliveries	Total Mean Annual Delta Outflow
BDCP Proposed Action High-Outflow Scenario	4.71 – 5.59	2.31–2.74 (49%)	2.40–2.85 (51%)	16.14
A: W Canal 15,000 cfs	5.01	2.60 (52%)	2.40 (48%)	15.81
B: Tunnels 6,000 cfs	4.49	1.83 (41%)	2.66 (59%)	15.92
C: Tunnels 15,000 cfs	5.01	2.60 (52%)	2.40 (48%)	15.81
D: Tunnels 3,000 cfs	4.19	1.19 (28%)	3.00 (72%)	16.19
E: Isolated 15,000 cfs	3.40	3.40 (100%)	0	17.45
F: Through Delta	4.17	0	4.17 (100%)	16.68
G: Less Tidal Restoration	4.71 – 5.59	2.31–2.74 (49%)	2.40–2.85 (51%)	16.14
H: More Restoration	4.71 – 5.59	2.31–2.74 (49%)	2.40–2.85 (51%)	16.14
I: Modified Spring Outflow	4.34	2.21 (51%)	2.13 (49%)	NA
Notes: NA = not analyzed				

3

4 **Foodweb**

5 Natural communities restoration would substantially increase the amount of tidal and floodplain
 6 habitat in the Plan Area to benefit delta smelt, mostly in the Cache Slough and Suisun Marsh
 7 subregions. This restoration could increase food for local consumption and export to open-estuary
 8 areas (in tidal natural communities and seasonally inundated floodplains). Habitat restoration is
 9 expected to increase primary productivity, which would result in a corresponding increase in higher
 10 trophic level prey resources important to delta smelt. Previous studies have found positive
 11 correlations between prey resources and juvenile survival and abundance (Chapter 5, *Effects*
 12 *Analysis*).

13 **Take Alternative H** would provide the most potential benefits to the foodweb (e.g., primary
 14 productivity) from habitat restoration, followed by **Take Alternatives A, B, C, E** and **I**. In contrast,
 15 **Take Alternative G** would have slightly lower potential benefits, and **Take Alternative D** would
 16 likely provide the least benefits of the take alternatives (Table 9-10).

17 While habitat restoration is expected to provide the most direct foodweb benefits, additional flows
 18 provided by meeting the high-outflow scenario and/or Fall X2 commitments under most take
 19 alternatives could also provide additional foodweb benefits from increased seasonal floodplain
 20 habitat inundation. The additional spring flows provided by **Take Alternative I** would also likely
 21 provide greater inundation-related foodweb benefits.

22 **Conservation Measures**

23 The conservation measures will benefit delta smelt by restoring habitat, reducing predation, and
 24 controlling invasive aquatic vegetation. The loss of tidal wetlands in the Delta is the most obvious
 25 and pervasive change that has occurred as a result of development (Kimmerer 2004; BDCP Science
 26 Advisors 2007). CM4 requires restoration of 65,000 acres of tidal natural communities, which

1 includes a target of 55,000 acres of intertidal and subtidal habitat, plus up to 10,000 acres (15%) of
2 transitional uplands to accommodate future sea level rise. This 65,000 acres of restoration would
3 result in a substantial increase in the total Delta tidal habitat, although how much the current lack of
4 tidal habitat limits the delta smelt population is uncertain. Except for the differences identified
5 above, in *Habitat*, there would be no difference in the beneficial effects of the other take alternatives
6 (Table 9-10).

7 In-water activities associated with CM14, CM15, CM16, and CM21 would have little to no effect on
8 delta smelt because of the small scale of the work and limited influence on delta smelt or their
9 habitat. These conservation measures are primarily intended to benefit salmonids. In-water
10 activities associated with CM2, CM13, and CM18 would have a greater potential to benefit delta
11 smelt and other covered fish species, as they would increase or improve habitat and enhance their
12 population levels.

13 **9.4.1.2 Longfin Smelt**

14 Similar to delta smelt, longfin smelt occur primarily downstream of where the north Delta diversion
15 facilities would be located. As a result, intake construction and maintenance activities would have
16 limited effects on longfin smelt. However, because longfin smelt have an extensive presence in the
17 Delta, they are at risk of effects from construction activities for habitat restoration in the lower river
18 reaches and in the Delta. In addition, long-term climate change, sea level rise, increased saltwater
19 intrusion, and habitat restoration activities could increase the range distribution of longfin smelt,
20 potentially increasing their exposure to the north Delta facilities. The comparison of take
21 alternatives is summarized in Table 9-14.

1 **Table 9-14. Expected Changes in Incidental Take of Longfin Smelt and Conservation Benefits by**
 2 **Take Alternative, Relative to the BDCP Proposed Action**

Stage	Mechanism of Effect	Take Alternatives								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Construction										
	Underwater sound	+	-	+	-	+	+	○	○	○
	Fish stranding and handling	○	○	○	○	○	+	○	○	○
	Water quality	○	○	○	-	○	+	-	+	○
	Dredging	+	-	+	-	+	+	○	○	○
	Habitat alteration	+	-	+	-	+	+	○	○	○
	Habitat restoration	○	○	○	-	○	○	-	+	○
Maintenance										
	Dredging	+	-	+	-	+	+	○	○	○
	Water quality	○	○	○	○	○	○	○	○	○
	Habitat loss and condition	○	○	○	○	○	○	○	○	○
	Predation and competition	○	○	○	○	○	○	○	○	○
Operations										
	Entrainment and impingement	+	+	+	+	○	+	○	○	○ ^a
	Water quality	○	○	○	○	○	○	○	○	○ ^a
	Flow	○	○	○	○	○	○	○	○	○ ^a
	Habitat	○	○	○	+	○	○	+	-	○ ^a
	Predation and competition	○	○	○	○	○	-	○	○	○ ^a
	Foodweb	○	○	○	+	○	○	+	-	○ ^a
	Conservation measures	○	○	○	○	○	○	○	○	○
<p>A three-point scale indicates how the level of take or conservation benefit is expected to change compared with the BDCP Proposed Action.</p> <ul style="list-style-type: none"> - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action. <p>Note:</p> <p>^a While there is no expected change in the level of take, this species is expected to have greater conservation benefit from this take alternative.</p>										

3

1 **9.4.1.2.1 Construction**

2 The mechanisms of effects of construction activities on longfin smelt would be the same as those
3 described for delta smelt. Construction effects would be temporary, localized, and would occur
4 during the approved in-water work window. Although some individual fish may occur in the vicinity
5 of the intakes, longfin smelt generally occur well downstream of the construction area (downstream
6 of Rio Vista), particularly during the in-water construction window (Chapter 5, Section 5.5.2.2.3,
7 *Exposure to In-Water Construction and Maintenance Activities*).

8 **Underwater Sound**

9 The take alternatives with five new intakes (**Take Alternatives A, C, and E**) would require up to
10 80% more pile driving to install the cofferdams, compared with the BDCP Proposed Action, resulting
11 in substantially greater potential for effects than those with fewer in-water structures (Table 9-11).
12 Similar differences in the number of foundation piles, installed within the cofferdams, would also
13 occur. Under all take alternatives, sound minimization measures would be used to minimize the risk
14 of incidental take attributable to sound exposure associated with pile driving. The take associated
15 with **Take Alternatives G, H, and I** would be similar to the BDCP Proposed Action, as each include
16 the same three intakes, while **Take Alternatives B and D** would likely result in less take because of
17 the fewer intakes constructed. **Take Alternative F** would have two primary diversion screen
18 structures (at Georgiana Slough and the Delta Cross Channel), and a number of operable barriers on
19 various sloughs. The overall length of in-water structures under **Take Alternative F** would be
20 greater than the other take alternatives; however, the structures would also be smaller overall. In
21 addition, the operable barriers would be constructed on waterways that are smaller than the
22 Sacramento River. This is expected to reduce the area affected by increased pile-driving sound levels
23 in the Sacramento River. However, the barriers would also be more widely distributed than the
24 north Delta intakes for the other take alternatives, resulting in a larger overall area affected by
25 increased sound levels. These diversions would also be constructed farther into the south and east
26 Delta regions, where longfin smelt may have a longer residence time. These factors may result in a
27 greater potential for increased risk of incidental take (Table 9-14).

28 **Fish Stranding and Handling**

29 As with other construction activities, the potential for take resulting from stranding longfin smelt
30 within cofferdams, handling during subsequent rescue and removal operations, and dredging
31 activities would be proportional to the number and size of in-water structures (cofferdams)
32 constructed. Take would likely be low for most take alternatives because of the limited occurrence
33 of longfin smelt expected during the in-water construction period (Chapter 5, *Effects Analysis*).
34 However, the greater number, and wider distribution, of the in-water structures under **Take**
35 **Alternative F**, is expected to result in greater overlap with the typical distribution of longfin smelt.
36 This increased overlap would increase the potential for increased take from fish stranding and
37 handling activities during construction. Overall, except for **Take Alternative F**, no measurable
38 differences between take alternatives are expected (Table 9-14).

39 **Water Quality**

40 As described under delta smelt, the implementation of appropriate construction best management
41 practices, as described in *Appendix 3.C, Avoidance and Minimization Measures*, would minimize the
42 potential take of longfin smelt and other covered species resulting from changes in water quality. As
43 a result, no measurable differences are expected between the take alternatives, although the limited

1 footprint for **Take Alternative D** and the reduced tidal habitat restoration under **Take**
2 **Alternatives D and G** could result in a lower potential for effects. **Take Alternative F**, however,
3 includes numerous new structures build in-water within portions of the range of the longfin smelt
4 located in the east and south Delta, and thus has greater potential for water quality changes to affect
5 this species (Table 9-14).

6 **Dredging**

7 Dredged areas would be 54 to 68% greater for the five-intake take alternatives (**Take Alternatives**
8 **A, C, and E**), compared to the BDCP Proposed Action, and about 73% less for **Take Alternative D**
9 (one intake) (Table 9-11). Similar acreages would be dredged periodically for maintenance
10 purposes. For **Take Alternative F**, substantial dredging activity would occur in some of the sloughs
11 in the interior Delta where longfin smelt are more likely to occur, to increase their flow capacity or
12 extend their length to redirect flows or fish. Although the diversion structures would reduce longfin
13 smelt access to some of these dredging areas, the dredging effects of **Take Alternative F** could still
14 be greater than under the BDCP Proposed Action (Table 9-14).

15 **Habitat Alteration**

16 The potential for take resulting from the loss or alteration of nearshore habitat would vary by the
17 number and size of the in-water structures and the number of barge landings. The take alternatives
18 with five intakes (**Take Alternatives A, C, and E**) would result in greater (58 to 68%) habitat loss
19 compared to the BDCP Proposed Action, while **Take Alternative B** (two intakes) and **Take**
20 **Alternative D** (one intake) would result in 32 and 74% less habitat loss than the BDCP Proposed
21 Action, respectively (Table 9-11). For **Take Alternative F**, the overall level of habitat alterations are
22 expected to be greater than the BDCP Proposed Action and the other three-intake take alternatives
23 due to the numerous and widely distributed in-water structures constructed within longfin smelt
24 habitat, as well as the associated dredging effects. The potential effects of barge landing construction
25 on longfin smelt habitat would be similar for most take alternatives (typically six barge landings
26 each) and temporary. However, **Take Alternative A** would have only two landings (67% less than
27 the BDCP Proposed Action), and **Take Alternative F** would have five(17% less) landings (Table
28 9-11).

29 **Habitat Restoration**

30 The differences between take alternatives would be similar to those discussed under delta smelt,
31 and based on the acres of habitat restored. However, the restoration of tidal habitat is expected to be
32 the primary source of benefits to longfin smelt, compared with restoration of seasonally inundated
33 floodplain or channel margin (Chapter 5, *Effects Analysis*). While restoration will typically occur
34 during the approved in-water work window, some restoration construction could occur when
35 longfin smelt may be present, depending on the specific location of the restoration.

36 Tidal natural community restoration will substantially increase the amount of tidal habitat for
37 longfin smelt in the Plan Area, mostly in the Cache Slough and Suisun Marsh subregions. A habitat
38 suitability index analysis suggested considerably more (at least 45%) tidal habitat units would be
39 available for longfin smelt larvae under the BDCP Proposed Action in the late long-term, compared
40 with existing conditions (Appendix 5.E, *Habitat Restoration*). With sea level rise and increasing
41 salinity, habitat restoration in the Cache Slough and West Delta subregions will become more
42 important to the species. Conservation of adjacent upland areas under the BDCP Proposed Action

1 would allow expansion of aquatic habitat as sea level rises, maintaining or increasing the extent of
 2 tidal habitat for longfin smelt (Chapter 5, Section 5.5.2.1.1, *Spring Outflow Decision-Tree Process*).

3 Take alternatives with the most habitat restoration acreage would have proportionally greater
 4 potential for take during construction, although the long-term benefits of this habitat restoration
 5 would also be greater. **Take Alternative H** would have about a 15% greater potential for take,
 6 based on the amount of tidal natural communities and upland transitional habitat restoration, and a
 7 100% greater potential from seasonally inundated floodplain habitat construction, compared with
 8 the BDCP Proposed Action. In contrast, **Take Alternatives D** and **G** would have about 61 and 23%
 9 less potential for take than the BDCP Proposed Action, respectively, due the corresponding
 10 decreases in restoration acreage (Table 9-14).

11 **9.4.1.2.2 Maintenance**

12 As with construction activities, the potential for take resulting from maintenance activities would be
 13 proportional to the number and size of in-water structures. However, maintenance activities would
 14 be temporary, localized, and infrequent. Substantial effects on longfin smelt would be unlikely
 15 because the species typically occurs well downstream of most in-water maintenance activities,
 16 particularly maintenance dredging. The expected difference in take between take alternatives would
 17 likely be small.

18 **Dredging**

19 The overall effects of dredging would be limited for all take alternatives because few longfin smelt
 20 are expected to occur in the dredging areas, particularly during the approved in-water work
 21 window. Any take associated with these activities would likely be negligible, and the expected
 22 difference in take between take alternatives would likely be small. Take is expected to be
 23 proportional to the number of intakes and the associated dredging (Table 9-11). Similarly, while the
 24 diversion structures would reduce longfin smelt access to some of these dredging areas, the
 25 dredging effects are still expected to be somewhat greater for **Take Alternative F** than for the BDCP
 26 Proposed Action (Table 9-14).

27 **Water Quality**

28 Dredging and other maintenance activities could result in temporary and limited changes in water
 29 quality. Dredging would typically only occur at one site at any one time. Few longfin smelt would
 30 likely occur in areas affected by these water quality conditions. Any take associated with these
 31 activities would likely be negligible, and the expected difference in take between take alternatives
 32 would likely be small (Table 9-14).

33 **Habitat Loss and Condition**

34 The removal of substrate during dredging operations would result in the removal of benthic and
 35 epibenthic organisms, which provide direct or indirect food resources for other aquatic species,
 36 including most of the covered fish species. Although published scientific literature strongly supports
 37 the conclusion that longfin smelt are food-limited (Durand 2008), longfin smelt are pelagic feeders
 38 and would not be directly affected by changes in substrate conditions. However, to the extent that
 39 substrate conditions affect primary productivity, some indirect effects could occur. Any take
 40 associated with these activities would likely be negligible, and the expected difference in take
 41 between take alternatives would likely be small (Table 9-14).

1 **Predation and Competition**

2 Any effects of maintenance activities on predation of longfin smelt or competition with other species
 3 would be infrequent, temporary, and localized. Any take associated with these activities would likely
 4 be negligible, and the expected difference in take between take alternatives would likely be small
 5 (Table 9-14).

6 **9.4.1.2.3 Operations**

7 The BDCP includes a decision-tree process for longfin smelt. This process would use the best
 8 available science to determine operations that result in levels of spring Delta outflow necessary to
 9 meet longfin smelt biological goals and objectives (Chapter 3, Section 3.4.1.4.4, *Decision Trees*). For
 10 longfin smelt, the decision tree is focused on the need for spring outflow above existing conditions.
 11 In addition to the diversion of water through the proposed north Delta intakes and Delta outflows,
 12 operations would include long-term habitat restoration and enhancement activities, as well as
 13 predator reduction and invasive aquatic vegetation control measures. Entrainment and
 14 impingement represent the primary mechanisms for take of longfin smelt. Other potential
 15 mechanisms for take would include changes in water quality, flow, habitat and predation. While the
 16 conservation measures would also affect these mechanisms, the effects would be largely beneficial.

17 **Entrainment and Impingement**

18 With regard to the BDCP Proposed Action and all take alternatives except **Take Alternative F**, some
 19 entrainment and/or impingement risks to longfin smelt would arise in the north Delta with the
 20 addition of the new in-water intake structures, compared to existing conditions. However, the
 21 reduction in overall south Delta exports, when combined with operational changes at the south
 22 Delta export facilities, is expected to provide a moderate reduction in entrainment-related losses of
 23 longfin smelt in the south Delta (Appendix 5.B, *Entrainment*, Section 5.B.6.1.6, *Longfin Smelt*). The
 24 salvage-density method of entrainment analysis suggests that there would be up to about 50% less
 25 adult longfin smelt entrainment, and 40% less juvenile entrainment under the BDCP Proposed
 26 Action compared to existing conditions, averaged across all water years in the late long-term.
 27 However, the high-outflow scenario would result in somewhat lower entrainment during the spring
 28 because of higher Delta outflow (Chapter 5, Section 5.5.2.1.2, *Reduced Entrainment*).

29 As with delta smelt, the potential for entrainment and impingement effects are expected to be
 30 limited because the north Delta intakes are well upstream of the typical distribution of longfin smelt
 31 in the Plan Area (Chapter 5, Section 5.5.2.1.2, *Reduced Entrainment*). However, any entrainment
 32 would be proportional to the number of intakes, total area of intake screen, and the proportional use
 33 of the south Delta facilities, although other site-specific variables (water velocity, depth, and
 34 orientation of the river flow relative to the screens) may also influence these effects. The BDCP
 35 Proposed Action, with three intakes, would likely result in less take from entrainment or
 36 impingement than **Take Alternatives A, C, and E**, which each have five intakes and total screen
 37 lengths between 54 and 66% greater than the BDCP Proposed Action (Table 9-14).

38 Fish losses from entrainment would also vary with the proportion of the mean total project water
 39 deliveries provided through the south Delta facilities (Table 9-13). Although operational changes
 40 associated with the USFWS 2008 BiOp have reduced longfin smelt losses at these facilities,
 41 additional benefits would be provided by reductions in south Delta exports under the BDCP
 42 Proposed Action and most take alternatives. In particular, **Take Alternative E** would not export
 43 water from the south Delta facilities, which is expected to offset potential increases in take

1 associated with the greater number of north Delta intakes, compared to the BDCP Proposed Action.
 2 However, **Take Alternatives B and D** would have greater south Delta exports than the BDCP
 3 Proposed Action, particularly in dry years because of the more upstream distribution of longfin
 4 smelt expected, resulting in potentially greater take.

5 The cumulative length of the diversion screens constructed under **Take Alternative F** will be 27%
 6 greater than those of the BDCP Proposed Action. Furthermore, each screen under **Take Alternative**
 7 **F** is nearly twice as long as the average screen length of those proposed under the BDCP Proposed
 8 Action, and are located in waters farther downstream where longfin smelt are more likely to occur.
 9 **Take Alternative F** also includes 14 operable gates in the interior Delta. There is substantial
 10 uncertainty regarding the effectiveness of the screens used in **Take Alternative F**. There are no
 11 screens of this size currently in use and it is possible that fish would experience impingement due to
 12 the high energetic costs of having to swim past such a long barrier without access to any flow
 13 refugia. There are also uncertainties about the effects of tidal flow reversals on the behavior and
 14 impingement risks for fish swimming past these long barriers. The proportional change in impacts
 15 on longfin smelt from the intakes might not be the same as the change in total screen length because
 16 of other differences among take alternatives at the screens (e.g., screen location on a river bend,
 17 water velocity across the screens). **Take Alternative F** would also limit the number of fish
 18 encountering the south Delta pumping facility screens by blocking their access to the Delta Cross
 19 Channel and Georgiana Slough. For this reason, entrainment would likely be reduced compared to
 20 the BDCP Proposed Action, but impingement rates and other screen-related effects would likely be
 21 substantially greater. Therefore, the overall level of take is expected to be somewhat higher under
 22 **Take Alternative F** than the BDCP Proposed Action (Table 9-14).

23 **Take Alternatives G, and H** would likely have similar entrainment effects as the BDCP Proposed
 24 Action (Table 9-14). The modified spring outflows provided by **Take Alternative I** are expected to
 25 result in increased conservation benefit relative to the BDCP Proposed Action.

26 **Water Quality**

27 Turbid water conditions benefit longfin smelt by providing cover from predators and improving
 28 foraging effectiveness (Chapter 5, Section 5.5.2.2.1, *Increased Water Clarity*). As described for delta
 29 smelt, it is uncertain if the long-term trend of decreasing turbidity would continue under the BDCP
 30 Proposed Action, although implementation of CM13 could improve localized conditions. Overall, the
 31 potential effects of the BDCP Proposed Action and take alternatives would likely be limited, although
 32 **Take Alternative I** would provide substantially greater outflows. These additional flows could
 33 improve rearing conditions in the spring by transporting suspended sediments downstream (Table
 34 9-14).

35 Exposure of longfin smelt to contaminants may occur from converting upland habitat to tidal or
 36 seasonally inundated habitat. However, exposure to these agriculture-related contaminants would
 37 likely decline over time as these areas are removed from active agricultural production
 38 (Appendix 5.D, *Contaminants*). As discussed in Chapter 5, *Effects Analysis*, any population-level
 39 effects of contaminant exposure would likely be low, and no substantial differences are expected
 40 between take alternatives (Table 9-14).

41 **Flow**

42 Based on positive correlations between longfin smelt abundance and winter/spring Delta outflow,
 43 high spring outflows would provide similar benefits to longfin smelt across alternatives. These

1 higher flows, provided under **Take Alternatives A, B, C, D, E, and F** would be similar to those
2 provided by the BDCP Proposed Action under the high-outflow scenario (Table 9-13). An additional
3 increase in spring flows is provided during wet and above normal flow years under **Take**
4 **Alternative I**, which could potentially provide some additional benefits to longfin smelt. However,
5 the BDCP Proposed Action also include the decision-tree process for longfin smelt, which would use
6 the best available science to determine operations that result in levels of spring Delta outflow
7 necessary to meet longfin smelt biological goals and objectives (Chapter 3, Section 3.4.1.4.4, *Decision*
8 *Trees*).

9 **Habitat**

10 Habitat restoration under **Take Alternative H** has the most potential to benefit longfin smelt, as it
11 would provide 15% (10,000 acres) more of tidal habitat than the other action take alternatives. In
12 contrast, **Take Alternatives G and D** would provide less tidal habitat (15,000 and 25,000 less acres,
13 respectively). The increased spring flows provided by the high-outflow scenario under the BDCP
14 Proposed Action and **Take Alternatives A, B, C, D, E, and F** would provide additional and improved
15 habitat for longfin smelt (Table 9-14). The fixed spring flows during 50% of years under **Take**
16 **Alternative I**, would likely provide greater habitat improvement benefits than the other take
17 alternatives.

18 **Predation and Competition**

19 Any increases in predation pressure at the north Delta facilities would be small, as these intakes
20 would be upstream of much of the typical range of longfin smelt. The differences between take
21 alternatives would typically be small, but generally proportional to the number and size of in-water
22 structures and any associated predator habitat (Table 9-14). **Take Alternative F** would restrict the
23 movement of longfin smelt from the Sacramento River into the interior Delta, which would reduce
24 predation and improve survival rates, although some increased predation would likely occur at the
25 diversion screens and operable gates.

26 **Foodweb**

27 As indicated above, scientific literature strongly supports the conclusion that longfin smelt are food-
28 limited (Durand 2008). The BDCP is expected to improve conditions, such zooplankton abundance,
29 for larval and juvenile longfin smelt. Tidal natural communities restoration would increase the
30 amount of suitable longfin smelt habitat in the Plan Area, potentially increasing food for local
31 consumption and export to open-estuary areas. Analyses suggest an increase of 60% in primary
32 productivity over the Plan Area, based on the production-acres metric, which may translate into
33 increased food resources for larval and juvenile longfin smelt in the ROAs (Chapter 5, Section
34 5.5.2.1.1, *Spring Outflow Decision-Tree Process*).

35 The primary mechanism for differences in foodweb effects is the amount of habitat restoration
36 provided. Habitat restoration is expected to increase primary productivity, which would result in a
37 corresponding increase in higher trophic level prey resources important to longfin smelt. **Take**
38 **Alternative H** would provide the most potential benefits to primary productivity from habitat
39 restoration, followed by the BDCP Proposed Action and **Take Alternatives A, B, C, E, and I**. In
40 contrast, **Take Alternative G** would have slightly lower potential benefits and **Take Alternative D**
41 would provide the least benefits (Table 9-14).

1 While habitat restoration is expected to provide the most direct foodweb benefits, due to the
2 increased habitat compared to existing conditions. Additional flows provided by meeting high-
3 outflow scenario commitments under most take alternatives are also likely to provide additional
4 foodweb benefits from increased seasonal floodplain habitat inundation. The additional spring flows
5 provided by **Take Alternative I** would also provide some additional inundation-related foodweb
6 benefits.

7 **Conservation Measures**

8 The conservation measures will benefit longfin smelt by restoring habitat, reducing predation, and
9 controlling invasive aquatic vegetation. Except for the differences identified above under *Habitat*,
10 there would be no difference in the effects of the take alternatives.

11 **9.4.1.3 Chinook Salmon, Sacramento River Winter-Run**

12 The entire population of the Sacramento River winter-run Chinook salmon must pass through the
13 Plan Area as migrating adults and emigrating juveniles. Because winter-run Chinook salmon use
14 only the Sacramento River system for spawning, it has been hypothesized that adults are attracted
15 to, and migrate upstream primarily along, the western edge of the Delta through the Sacramento
16 River corridor. Because juvenile winter-run salmon have been collected at various locations in the
17 Delta (including the south Delta export facilities), it is assumed that juveniles use a larger area of the
18 Delta for migration and rearing than adults (Lindley et al. 2008; MacFarlane et al. 2008; Michel et al.
19 2008; Perry et al. 2008). Juvenile winter-run Chinook salmon likely inhabit Suisun Marsh for rearing
20 and may inhabit the Yolo Bypass when flooded, as winter-run Chinook salmon smolts tend to occur
21 in the Delta later, in years when the Yolo Bypass floods (del Rosario et al. unpublished). The
22 comparison of take alternatives is summarized in Table 9-15.

23 **9.4.1.3.1 Construction**

24 Construction would be temporary, localized, and would occur during the approved in-water work
25 window. Winter-run Chinook salmon typically occur in the north Delta as they migrate upstream to
26 spawn and downstream as smolts (migrants) or rearing fry (foragers). Adhering to the approved in-
27 water construction window (June through October) would protect a substantial portion of the
28 population, although some juveniles could occur in the area in October. The magnitude of effects
29 would vary somewhat based on the overall amount of habitat restoration provided by the various
30 take alternatives and as a result of the different restoration locations.

31 **Underwater Sound**

32 The primary source of underwater sound that could affect winter-run Chinook salmon would be
33 from impact pile driving during construction. Such effects would be in proportion to the number and
34 size of the intakes constructed (Table 9-11). However, sound minimization measures would be used
35 to minimize the risk of incidental take attributable to sound exposure associated with impact pile
36 driving, under all take alternatives. The take alternatives with five new intakes (**Take Alternatives**
37 **A, C, and E**) would require up to 80% more pile driving to install the cofferdams, compared to the
38 BDCP Proposed Action (three intakes), resulting in substantially greater potential effects (take) than
39 those with fewer intakes. The take associated with **Take Alternatives G, H, and I** would be similar
40 to the BDCP Proposed Action, as each includes the same three intakes. **Take Alternatives B and D**
41 would likely result in less take because of the fewer intakes constructed. **Take Alternative F** would
42 likely have greater pile-driving effects than the BDCP Proposed Action, based on the greater number

1 and wider distribution of in-water diversion structures (Table 9-15). Although the sizes of the
 2 diversions structures would be small relative to the water intake structures of the other take
 3 alternatives, the wider distribution of construction sites will result in a larger area exposed to pile
 4 driving sound effects, and an increased risk of incidental take.

5 **Table 9-15. Expected Changes in Incidental Take of Sacramento River Winter-Run Chinook Salmon**
 6 **and Conservation Benefits by Take Alternative, Relative to the BDCP Proposed Action**

Stage	Mechanism of Effect	Take Alternatives								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Construction										
	Underwater sound	+	-	+	-	+	+	○	○	○
	Fish stranding and handling	+	-	+	-	+	+	○	○	○
	Water quality	+	-	+	-	+	+	-	+	○
	Dredging	+	-	+	-	+	+	○	○	○
	Habitat alteration	+	-	+	-	+	+	○	○	○
	Habitat restoration	○	○	○	-	○	○	-	+	○
Maintenance										
	Dredging	+	-	+	-	+	○	○	○	○
	Water quality	○	○	○	○	○	○	○	○	○
	Habitat loss and condition	○	○	○	○	○	○	○	○	○
	Predation and competition	○	○	○	○	○	○	○	○	○
Operations										
	Entrainment and impingement	+	-	+	+	-	○	○	○	○
	Water quality	○	○	○	○	○	○	○	○	+
	Flow	○	○	○	○	-	+	○	○	+
	Habitat	○	○	○	+	○	○	+	-	○
	Predation and competition	○	○	○	○	-	+	○	○	+
	Foodweb	○	○	○	+	○	○	+	-	○
	Conservation measures	○	○	○	○	○	○	○	○	○
<p>A three-point scale indicates how the level of take or conservation benefit is expected to change compared with the BDCP Proposed Action.</p> <ul style="list-style-type: none"> - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + 										

7

1 **Fish Stranding and Handling**

2 Winter-run Chinook salmon juveniles entering the Plan Area use the nearshore habitat for rearing
3 and for protection from predators during their outmigration, making them particularly susceptible
4 to entrapment in the project cofferdams, which may require rescue and handling. The take
5 alternatives with the most intakes (**Take Alternatives A, C, and E**) would have a greater potential
6 for stranding winter-run Chinook salmon than the BDCP Proposed Action (Table 9-15). **Take**
7 **Alternatives B and D** would have less potential to strand fish, while **Take Alternatives G, H, and I**
8 would be similar to the BDCP Proposed Action. **Take Alternative F** would need smaller cofferdams,
9 as the structures would generally have smaller in-water footprints than the proposed north Delta
10 intakes for the other take alternatives, which would reduce the potential for stranding. However, the
11 cumulative stranding and handling levels are expected to be greater than the BDCP Proposed Action,
12 due to the increased number of in-water work sites under **Take Alternative F** (Table 9-15).

13 **Water Quality**

14 Few winter-run Chinook are expected to occur in the area during the construction window, although
15 some juveniles could occur in October. As a result, the potential for take is limited, and only minor
16 differences between take alternatives are expected. However, as with the other construction effect
17 mechanisms, take alternatives with five intakes (**Take Alternatives A, C, and E**) would likely have
18 greater potential for effects than the BDCP Proposed Action and the other three-intake alternatives
19 (**Take Alternatives G, H, and I**). However, **Take Alternative F** includes a number of new and
20 widely distributed in-water structures in habitat areas used by winter-run Chinook salmon, and thus
21 is expected to have a greater potential for water quality effects on this species, compared to the
22 BDCP Proposed Action. **Take Alternative H** provides the most extensive habitat restoration of all
23 the take alternatives, and would have the most potential to temporarily alter water quality during
24 that construction process at these restoration sites. In contrast, **Take Alternatives D and G** would
25 have lower risks of water quality effects from restoration than the other take alternatives, including
26 the BDCP Proposed Action (Table 9-15). While habitat restoration activities would occur in areas
27 frequently used by Chinook salmon, any associated changes in water quality would be temporary
28 and localized, and would occur during the approved in-water work window.

29 **Dredging**

30 The amount of dredging would vary in proportion to the number and size of in-water structures,
31 similar to the other construction effects. While **Take Alternative F** would likely require little or no
32 dredging associated with the diversion structures, dredging activity would occur in some of the
33 interior Delta sloughs. However, it is assumed that this dredging would not occur until after the
34 diversion structures are constructed, which would reduce the number of Chinook salmon entering
35 into the interior Delta. However, **Take Alternative F** is expected to result in greater dredging effects
36 on winter-run Chinook salmon than the BDCP Proposed Action (Table 9-15).

37 **Habitat Alteration**

38 The potential for take from the loss or alteration of nearshore habitat would vary by the number and
39 size of in-water structures built and the number of barge landings, and would give similar
40 differences between take alternatives as described above for other construction-related effects
41 (Table 9-9). However, compared to the amount of habitat available to winter-run Chinook salmon in
42 the Plan Area and the degraded condition of the affected habitat, the overall potential for take would
43 be limited. **Take Alternative F** would have limited effects on nearshore habitat, as the majority of

1 the diversion structures would be in offshore areas at existing channel junctions. However, the
2 cumulative effects of the wide distribution and number of these diversions structures are likely to be
3 greater under **Take Alternative F** than the BDCP Proposed Action. The temporary effects of the
4 barge landings on winter-run Chinook salmon habitat would be limited and similar for most take
5 alternatives, although **Take Alternative F** would have one less barge landing than most other take
6 alternatives (Table 9-15).

7 **Habitat Restoration**

8 The construction of habitat restoration projects may temporarily disturb or displace covered fish
9 species and their habitat, as well as affect water quality, particularly turbidity, dissolved oxygen, and
10 suspended contaminated sediments. However, most of the construction activities would be
11 conducted in the dry, and any in-water work would occur during the approved in-water
12 construction window, when few winter-run Chinook salmon are expected to occur in the Plan Area.
13 Some restoration construction could occur during periods when Chinook salmon may be present,
14 depending on the specific location of the restoration. Any negative effects would be localized,
15 temporary, and infrequent.

16 All of the take alternatives would provide substantially more habitat, compared to existing
17 conditions. Given the relatively small size of winter-run Chinook salmon fry that rear in the Delta for
18 several months, and their use of the shallow and nearshore habitat, the take alternative with the
19 greatest amount of habitat restoration (**Take Alternative H**) would have an increased risk of
20 affecting Chinook salmon fry during construction, compared to the other take alternatives (including
21 the BDCP Proposed Action). In contrast, **Take Alternatives D** and **G** would likely have a fewer
22 effects, based on less habitat restoration construction (Table 9-15).

23 **9.4.1.3.2 Maintenance**

24 Potential effects of maintenance activities would be proportional to the number of in-water
25 structures. However, maintenance activities would be temporary and unlikely to have a measurable
26 effect on winter-run Chinook salmon. Any effects would also be localized and infrequent.

27 **Dredging**

28 The amount of maintenance dredging would be proportional to the number and size of in-water
29 facilities (Table 9-11). Take alternatives with five intakes (**Take Alternatives A, C, and E**) would
30 require more maintenance dredging than the BDCP Proposed Action, and **Take Alternative D** (one
31 intake) and **Take Alternative B** (two intakes) would require less. As indicated for the construction
32 phase, **Take Alternative F** would include limited dredging at the in-water facility sites, but would
33 require dredging or excavation in some sloughs to maintain water transport capacity. However, the
34 diversion structures would restrict the access of Chinook salmon to these channels, minimizing the
35 potential for take, particularly during the approved in-water work window. As a result, the effects
36 would likely be similar to the BDCP Proposed Action, based on the size of the in-water structures
37 (Table 9-15).

38 Periodic channel maintenance excavation and dredging would also occur in the Yolo Bypass under
39 all the take alternatives, to enhance the habitat and reduce stranding. While the take alternatives
40 would result in potential effects, this dredging would occur during low water and in the approved
41 in-water work window, when few winter-run Chinook salmon are expected to occur in the area.

1 **Water Quality**

2 Dredging is the primary maintenance activity that could affect water quality. Dredging could result
 3 in temporary increases in turbidity and suspended contaminated sediments, as well as decreases in
 4 dissolved oxygen levels. However, these effects would be temporary, periodic, of relatively limited
 5 extent, and would typically occur at only one site at a time. Few winter-run Chinook salmon would
 6 likely occur in the areas affected by these water quality conditions, particularly during the approved
 7 in-water construction window. Any take associated with these activities would likely be negligible,
 8 and the expected difference in take between take alternatives would likely be small (Table 9-15).

9 **Habitat Loss and Condition**

10 Substrate removal during dredging operations would result in the removal of benthic and
 11 epibenthic organisms, which provide direct or indirect food resources for aquatic species. However,
 12 winter-run Chinook salmon are expected to spend limited time in the relatively small dredged areas,
 13 and would be unlikely to be substantially affected by changes in substrate conditions near the intake
 14 sites. Any take associated with these activities would likely be negligible, and the expected
 15 difference in take between take alternatives would likely be small (Table 9-15).

16 **Predation and Competition**

17 Any effects of maintenance activities on the predation of winter-run Chinook salmon, or competition
 18 with other species, would likely be temporary, infrequent, and localized. In-water maintenance
 19 would also occur during the approved in-water construction window, when few winter-run Chinook
 20 would be present. Any take associated with these activities would likely be negligible, and the
 21 expected difference in take between take alternatives would likely be small (Table 9-15).

22 **9.4.1.3.3 Operations**

23 In addition to the diversion of water through the proposed north Delta intakes, operations would
 24 include conservation measures providing long-term habitat restoration and enhancement activities,
 25 as well as predator and invasive aquatic vegetation control measures.

26 **Entrainment and Impingement**

27 With regard to the BDCP Proposed Action and all take alternatives, some entrainment and
 28 impingement risks to winter-run Chinook salmon would arise in the north Delta with the addition of
 29 the new in-water intake structures, compared to existing conditions. These take alternatives would
 30 include screens designed to meet and exceed current NMFS criteria for approach and sweep
 31 velocities for salmonids, while minimizing the overall size of the north Delta intakes or diversion
 32 screens. Operations of the north Delta facilities would also include bypass flow criteria managed in
 33 real time to minimize adverse effects of north Delta intake diversions on downstream-migrating
 34 salmonids. A major component of the BDCP is a switch from export pumping solely in the south
 35 Delta to dual conveyance, including both north and south Delta diversions. It is anticipated that this
 36 will result in appreciably lower entrainment levels of juvenile salmonids, compared to existing
 37 conditions from reduced exports at the existing south Delta facilities, where entrainment rates
 38 would likely be greater than the proposed north Delta facilities (Appendix 5.B, *Entrainment*, Section
 39 5.B.5.4, *Salvage-Density Method*). Estimates of wild-origin winter-run Chinook salmon take at the
 40 south Delta export facilities as a percentage of the juveniles entering the Delta have ranged from less
 41 than 0.1% in 2007 to over 5% in 2001 (Chapter 5, *Effects Analysis*).

1 Entrainment of winter-run Chinook salmon at the north Delta intakes is expected to be limited, but
2 generally in proportion to the number and size of intakes, and the proportion of mean total project
3 water deliveries exported from the north Delta (Table 9-13). Thus, the BDCP Proposed Action would
4 be similar to **Take Alternatives G, H, and I** (each with three new north Delta intakes). **Take**
5 **Alternatives A, C, and E** would have substantially greater entrainment and impingement potential
6 (each with five intakes), while **Take Alternative B** (two intakes) would have a lower potential
7 (Table 9-15). Although **Take Alternative D** would also have a lower potential, based on having only
8 one north Delta intake, the increased proportion of south Delta exports would likely result in greater
9 entrainment effects than the BDCP Proposed Action. Although **Take Alternative E** would have a
10 higher potential for entrainment and impingement effects than the BDCP Proposed Action, based on
11 the number of intakes, it would also eliminate exports from the south Delta facilities. Therefore, the
12 take associated with **Take Alternative E** would likely be lower than with the BDCP Proposed
13 Action.

14 **Take Alternative F** (with no new north Delta intakes) would reduce the overall entrainment of
15 winter-run Chinook salmon by blocking Sacramento River fish from entering the interior Delta,
16 thereby avoiding entrainment effects at the south Delta intakes. While some entrainment would
17 occur at the fish diversion structures, the flow velocities through these screens is expected to be less
18 than through the north Delta water intake screens. However, there is some uncertainty regarding
19 the effectiveness of these screens to minimize impingement rates, as there are no screens of this size
20 currently in use. Despite these uncertainties, the overall effects are expected to be similar under
21 **Take Alternative F** to that of the BDCP Proposed Action (Table 9-12).

22 **Water Quality**

23 Limited water quality effects are expected from operations and the potential differences between
24 take alternatives would likely be negligible, except for potential water temperature effects under
25 **Take Alternative I** (Table 9-15). **Take Alternative I** would affect the operations of upstream water
26 storage reservoirs by increasing spring flows to benefit longfin smelt, which would also reduce
27 reservoir storage levels and reduce late summer and fall flows, which would negatively affect
28 juvenile winter-run Chinook salmon.

29 **Flow**

30 The primary effects of flow changes on winter-run Chinook salmon are changes in flow-related
31 survival in the Sacramento River mainstem, downstream of the north Delta intakes, the diversion of
32 smolts into channels leading to the south Delta export facilities, the associated relatively high
33 predation rates in the interior Delta, and as a mechanism to trigger adult upstream spawning
34 migrations. The BDCP Proposed Action and the take alternatives, which include changes in flows and
35 tidal area from restoration, generally would reduce the diversion of flow to the south Delta export
36 facilities to existing conditions. Take alternatives with lower exports from the south Delta facilities
37 could potentially have proportionally greater benefits to Chinook salmon (Table 9-13), depending
38 on the level of exports from the north Delta export facilities. These benefits would include reduced
39 losses of juvenile Chinook from predation in the interior Delta because of more favorable south
40 Delta hydrodynamics (e.g., less time with reversed flows), and less entrainment and predation at the
41 south Delta facilities (Chapter 5, Section 5.5.3.1.3, *Reduced Entry into Interior Delta*). Operations of
42 the north Delta facilities also include bypass flow criteria that will be managed in real time to
43 minimize adverse effects of north Delta intake diversions on downstream-migrating salmonids. The
44 Sacramento River criteria are expected to limit the potential for increased frequency of reversed

1 flow in the Sacramento River below Georgiana Slough, thereby reducing the probability of juvenile
 2 Chinook salmon entry into the interior Delta (Appendix 5.C, *Flow, Passage, Salinity, and Turbidity*).

3 With the exception of **Take Alternative F**, all the take alternatives would alter the flow
 4 characteristics in the Plan Area by reducing exports from the south Delta and increasing north Delta
 5 exports. These changes would potentially provide some benefits, although the magnitude or
 6 differences in benefits between take alternatives may be difficult to discern. While **Take**
 7 **Alternative E** would have the most effects on flow in the Delta because all of the project water
 8 deliveries would occur through the north Delta facilities (no south Delta exports), the corresponding
 9 flow reductions in the Sacramento River could offset these potential benefits due to other flow-
 10 related survival factors (e.g., greater susceptibility to predation) (Chapter 5, *Effects Analysis*).

11 The modified spring outflows provided by **Take Alternative I** could improve migration and rearing
 12 conditions for some juvenile Chinook salmon, although the subsequent lower flows in the fall would
 13 negatively affect juvenile winter-run Chinook salmon in the Plan Area.

14 In addition to potential changes in overall juvenile survival, reduced Sacramento River flows
 15 (downstream of the north Delta intakes) could also negatively affect the upstream migration of adult
 16 winter-run Chinook salmon by changing attraction flows and olfactory cues, although these changes
 17 are not readily quantifiable in terms of take. The uncertainty in overall effects will be informed by
 18 monitoring and targeted research under the BDCP (e.g., examining migration success of tagged adult
 19 Chinook salmon under different flow regimes), with any adverse effects being addressed by adaptive
 20 management (Chapter 5, Section 5.5.3.2.2, *Reduced Attraction to Flows in the Sacramento River*).

21 **Habitat**

22 For winter-run Chinook salmon, the take alternatives could result in appreciable changes in
 23 upstream spawning and rearing habitat. The changes to flow and temperature may add to the
 24 overall climate change-related effects on this species, while adaptive management could address the
 25 contribution of the BDCP Proposed Action.

26 Habitat restoration activities associated with the conservation measures would benefit rearing
 27 juvenile salmonids, including winter-run Chinook salmon, which rear for several months in the
 28 lower river and Delta. While the BDCP Proposed Action and all take alternatives would result in
 29 considerable increases in the amount of shallow-water tidal habitat that benefits foraging winter-
 30 run Chinook salmon, **Take Alternative H** would have the most potential benefits because it would
 31 result in more inundated floodplain and restored tidal and channel margin habitat than all take
 32 alternatives (Table 9-15). In contrast, **Take Alternatives D** and **G** would have less habitat
 33 restoration than the BDCP Proposed Action, resulting in greater take potential. Less channel margin
 34 habitat would be replaced by in-water structures under **Take Alternative F** than by the other take
 35 alternatives, but **Take Alternative F** would also eliminate access to many miles of existing habitat.

36 **Predation and Competition**

37 The north Delta diversions would have gradual shoreline transitions, which would substantially
 38 reduce the potential for producing predator habitat, but the magnitude of change in predation is
 39 uncertain. Additionally, implementation of CM15 is expected to reduce predation pressure at key
 40 locations in the Plan Area, including the north Delta intakes, and would apply to all the take
 41 alternatives. The effectiveness of predation reduction efforts will be assessed with targeted research
 42 and monitoring, and adaptive management will be applied as necessary to modify the conservation
 43 measure. As a result, the differences between the take alternatives would be likely negligible, except

1 for **Take Alternatives E, F, and I**, which could divert fewer Sacramento River fish into the interior
 2 or south Delta regions than any of the other take alternatives (Table 9-15). The elimination of south
 3 Delta exports under **Take Alternative E** could result in fewer fish diverted into the interior Delta,
 4 and **Take Alternative F** would block fish from entering the high-predation route through the
 5 interior Delta (Table 9-15). However, the longer cumulative length of in-water structures
 6 constructed under **Take Alternative F**, is expected to increase structure-related predation levels,
 7 compared to the BDCP Proposed Action. **Take Alternative I** would result in lower late summer and
 8 fall flows, while still providing relatively large exports from the south Delta facilities, resulting in
 9 greater predation risks.

10 **Foodweb**

11 Restored tidal wetland and floodplain habitat, and to a lesser extent channel margin and riparian
 12 habitat, would likely provide increased foodweb resources for juvenile salmonids throughout the
 13 Plan Area (Chapter 5, *Effects Analysis*). In particular, tidal habitat restoration is expected to augment
 14 the Delta foodweb and potentially enhance pelagic food supply. This will benefit both foraging and
 15 migrating juvenile winter-run Chinook salmon. Production of phytoplankton is greatest in shallow-
 16 water areas, and restored shallow-water habitats have been shown to enhance phytoplankton
 17 production in many cases (Jassby and Cloern 2000). The expected benefits of the take alternatives
 18 on Chinook salmon food resources would generally be in proportion to the amount of floodplain,
 19 tidal wetland, and channel margin habitat restored. **Take Alternative H** would provide the most
 20 foodweb benefits from habitat restoration, such as increased primary productivity, followed by the
 21 BDCP Proposed Action and **Take Alternatives A, B, C, E, and I**. In contrast, **Take Alternatives D**
 22 and **G** would likely have lower potential benefits than the other take alternatives (Table 9-15).

23 While habitat restoration is expected to provide the most direct foodweb benefits, due to the
 24 increased habitat compared to existing conditions. Additional flows provided by meeting high-
 25 outflow scenario and/or Fall X2 commitments under most take alternatives could add foodweb
 26 benefits from increased seasonal floodplain habitat inundation and the downstream transport of
 27 associated nutrients. The additional spring flows of **Take Alternative I** would also provide more
 28 inundation-related foodweb benefits.

29 **Conservation Measures**

30 The conservation measures will benefit winter-run Chinook salmon by restoring habitat, reducing
 31 predation, improving migratory corridor conditions, and controlling invasive aquatic vegetation.
 32 Except for the differences identified above, in *Habitat*, there would be no difference in the beneficial
 33 effects of the take alternatives (Table 9-15).

34 **9.4.1.4 Chinook Salmon, Central Valley Spring-Run**

35 As with the other salmonids, the entire population of the Central Valley spring-run Chinook salmon
 36 evolutionarily significant unit must pass through the Plan Area as migrating adults and emigrating
 37 juveniles. Adult Central Valley spring-run Chinook salmon migrate primarily along the western edge
 38 of the Delta through the Sacramento River corridor, and juvenile spring-run Chinook salmon use the
 39 Delta, Suisun Marsh, and Yolo Bypass for migration and rearing (National Marine Fisheries Service
 40 2009). With the goal of returning spring-run Chinook salmon to the San Joaquin River, the San
 41 Joaquin corridor will presumably become an important migration route, with juveniles also using
 42 the south, central and west Delta areas as migration and rearing corridors. The comparison of take
 43 alternatives is summarized in Table 9-16.

1 **Table 9-16. Expected Changes in Incidental Take of Sacramento River Spring-Run Chinook Salmon**
 2 **and Conservation Benefits by Take Alternative, Relative to the BDCP Proposed Action**

Stage	Mechanism of Effect	Take Alternatives								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Construction										
	Underwater sound	+	-	+	-	+	+	○	○	○
	Fish stranding and handling	+	-	+	-	+	+	○	○	○
	Water quality	+	-	+	-	+	+	-	+	○
	Dredging	+	-	+	-	+	+	○	○	○
	Habitat alteration	+	-	+	-	+	+	○	○	○
	Habitat restoration	○	○	○	-	○	○	-	+	○
Maintenance										
	Dredging	+	-	+	-	+	○	○	○	○
	Water quality	○	○	○	○	○	○	○	○	○
	Habitat loss and condition	○	○	○	○	○	○	○	○	○
	Predation and competition	○	○	○	○	○	○	○	○	○
Operations										
	Entrainment and impingement	+	-	+	+	-	○	○	○	○ ^a
	Water quality	○	○	○	○	○	○	○	○	○
	Flow	○	○	○	○	-	-	○	○	○ ^a
	Habitat	○	○	○	+	○	-	+	-	○
	Predation and competition	○	○	○	○	-	○	○	○	○
	Foodweb	○	○	○	+	○	○	+	-	○
	Conservation measures	○	○	○	○	○	○	○	○	○
<p>A three-point scale indicates how the level of take or conservation benefit is expected to change compared with the BDCP Proposed Action.</p> <ul style="list-style-type: none"> - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action. <p>Note: ^a While there is no expected change in the level of take, this species is expected to have greater conservation benefit from this take alternative.</p>										

3

1 **9.4.1.4.1 Construction**

2 Construction would be temporary, localized, and would occur during the approved in-water work
3 window. Spring-run Chinook salmon typically occur in the north Delta as they migrate upstream as
4 adults to spawn and downstream as smolts (migrants) or rearing juveniles (foragers). It is assumed
5 that the juvenile spring-run Chinook entering the Plan Area consist of 10% foragers and up to 90%
6 migrant smolts. Adhering to the approved in-water construction window (June through October)
7 would protect a substantial portion of the juvenile population, although some juveniles could occur
8 in the area in June. Adult spring-run Chinook salmon would also likely occur in the area throughout
9 much of the typical in-water construction window. The magnitude of effects would be in proportion
10 to the amount of in-water construction activity (Table 9-11).

11 **Underwater Sound**

12 The primary source of underwater sound that could affect spring-run Chinook salmon would be
13 from impact pile driving. Such effects would be in proportion to the number and size of the intakes
14 constructed (Table 9-12). Individual fish are expected to migrate through each of the north Delta
15 construction areas relatively quickly, typically in a matter of a few hours, thereby minimizing the
16 potential pile-driving effects at any one site. In addition, sound minimization measures would be
17 used to minimize the risk of incidental take attributable to sound exposure associated with impact
18 pile driving. However, the take alternatives with five intakes (**Take Alternatives A, C, and E**) would
19 increase the potential for individual fish to be affected by pile driving at more than one facility as
20 they migrate either upstream or downstream through the north Delta (Table 9-16). The take
21 associated with **Take Alternatives G, H, and I** would be similar to the BDCP Proposed Action, as
22 each would include the same three intakes, while **Take Alternatives B and D** would likely result in
23 less take because of the fewer intakes constructed. The overall length of in-water structures under
24 **Take Alternative F** would be greater than the BDCP Proposed Action, but the in-water diversion
25 structures would have a smaller footprint. However, the widely distributed diversion screens in the
26 Delta would result in a larger area of exposure to pile driving sound, and thus an increased risk of
27 incidental take.

28 **Fish Stranding and Handling**

29 Juvenile spring-run Chinook salmon entering the Plan Area are expected to use the nearshore
30 habitat for rearing and for protection from predators during their outmigration, making them
31 particularly susceptible to entrapment in the project cofferdams, and may require rescue and
32 subsequent handling, although juveniles are only expected to occur during the early portion (June)
33 of the in-water construction window. The take alternatives with the most intakes (**Take**
34 **Alternatives A, C, and E**) would have a greater stranding potential than the BDCP Proposed Action,
35 while **Take Alternatives B and D** would have less potential, and **Take Alternatives G, H, and I**
36 would be similar to the BDCP Proposed Action (Table 9-16). The diversion structures built under
37 **Take Alternative F** have a smaller footprint, but the greater number of structures and their wide
38 distribution through the Delta would likely result in greater stranding and handling effects than
39 work at the north Delta intakes under the other take alternatives (Table 9-16).

40 **Water Quality**

41 The potential for take is limited, and only minor differences are expected between take alternatives
42 (Table 9-16). However, the potential for take would typically be proportional to the number and size
43 of the intake structures and the extent of the required construction phase (Table 9-11). Therefore,

1 **Take Alternatives A, C, and E** would have a greater potential for take than the BDCP Proposed
2 Action, while **Take Alternatives B and D** would have less potential, and **Take Alternatives G, H,**
3 and **I** would be similar to the BDCP Proposed Action from intake construction (Table 9-16).
4 However, **Take Alternative H** would also include the most extensive habitat restoration of all the
5 take alternatives, and would have the most potential to temporarily alter water quality during that
6 construction process. In contrast, **Take Alternatives D and G** would have lower risks of water
7 quality effects from restoration construction than the other take alternatives, including the BDCP
8 Proposed Action. **Take Alternative F** includes numerous new in-water structures throughout the
9 Delta, and thus has greater potential for water quality changes to affect this species. While habitat
10 restoration activities would occur in areas frequently used by Chinook salmon, any associated
11 changes in water quality would be temporary, localized, and would occur during the approved in-
12 water work window.

13 **Dredging**

14 The amount of dredging would vary in proportion to the number and size of in-water structures,
15 similar to the other construction effects (Table 9-11). Therefore, **Take Alternatives A, C, and E**
16 would require more dredging, **Take Alternatives B and D** would need less dredging, and **Take**
17 **Alternatives G, H, and I** about the same amount of dredging as the BDCP Proposed Action (Table
18 9-16). While **Take Alternative F** would likely require little or no dredging associated with the
19 diversion structures, dredging would occur in some of the interior Delta sloughs. While it is assumed
20 that this dredging would not occur until after the diversion structures are constructed, which would
21 reduce the number of Chinook salmon entering into the interior Delta, the dredging effects could
22 still be greater than the BDCP Proposed Action (Table 9-16).

23 **Habitat Alteration**

24 The potential for take from the loss or alteration of nearshore habitat would vary by the number and
25 size of in-water structures and the number of barge landings (Table 9-11). Juvenile spring-run
26 Chinook salmon typically migrate as young-of-the-year fry, and extensively use the shoreline habitat
27 in the lower river and Delta for rearing. These fry would be susceptible to the alteration of this
28 habitat during construction. However, compared to the amount of habitat available in the Plan Area
29 and the existing degraded condition of the affected habitat, the overall potential for take would be
30 limited. **Take Alternative F** would result in less overall nearshore habitat losses than the BDCP
31 Proposed Action, based on the size of the in-water structures and the limited effects on nearshore
32 habitat from construction. However, the increased number and distribution of in-water construction
33 sites, and the associated dredging, would likely result in greater overall aquatic habitat effects. The
34 effects of constructing barge landings on spring-run Chinook salmon habitat would be limited and
35 similar for most take alternatives, although **Take Alternative F** would have one less barge landing
36 than the other take alternatives (Table 9-11).

37 **Habitat Restoration**

38 The construction of habitat restoration projects may temporarily disturb or displace covered fish
39 species (including spring-run Chinook salmon), as well as affect water quality, particularly turbidity,
40 dissolved oxygen, and suspended contaminated sediments. However, most of the restoration
41 activities would be conducted in the dry, and any in-water work would occur during the approved
42 in-water construction window, when few juvenile spring-run Chinook salmon are expected to occur
43 in the Plan Area. However, some restoration construction could occur when Chinook salmon may be
44 present, depending on the specific location of the restoration. Any negative effects would be

1 localized, temporary, and infrequent; effects would also be similar for all the take alternatives,
2 although the magnitude would vary based on the amount of habitat restored (Table 9-6). Therefore,
3 **Take Alternatives D** and **G** would have less potential for effects, while **Take Alternative H** would
4 have a greater potential, compared to the BDCP Proposed Action or the other take alternatives.

5 **9.4.1.4.2 Maintenance**

6 Potential effects of maintenance activities would be proportional to the number of in-water
7 structures (Table 9-11). However, maintenance activities would be temporary and unlikely to have a
8 measurable effect on spring-run Chinook salmon. Any effects would be localized and infrequent.
9 These activities would also occur during the approved in-water construction window, when few
10 spring-run Chinook salmon are in the area.

11 **Dredging**

12 The maintenance dredging and potential take would be proportional to the number and size of in-
13 water facilities (Table 9-11). The take alternatives with five intakes (**Take Alternatives A, C, and E**)
14 would require more maintenance dredging than the BDCP Proposed Action, and **Take Alternative**
15 **D** (one intake) and **Take Alternative B** (two intakes) would require less. **Take Alternative F** would
16 include limited dredging at the in-water facility sites, but would require dredging in some sloughs to
17 maintain water transport capacity. However, Chinook salmon would be restricted from the interior
18 Delta by the diversion structure constructed under **Take Alternative F**, minimizing potential for
19 take. As a result, the level of take would likely be similar to the BDCP Proposed Action, based on the
20 size of the in-water structures (Table 9-16).

21 While few juvenile spring-run Chinook salmon would likely occur in the dredging areas, particularly
22 during the approved in-water work window, adult Chinook salmon would be migrating through the
23 lower river during much of the work window. However, adult Chinook salmon are expected to
24 migrate through the area relatively quickly, and would likely avoid areas where dredging would
25 occur. Therefore, the amount of take associated with these activities would likely be relatively small.

26 Periodic channel maintenance excavation and dredging to enhance the habitat and reduce stranding
27 would also occur in the Yolo Bypass for most of the take alternatives. While this dredging could have
28 more effects, it would occur during low water and in the approved in-water work window, when few
29 spring-run Chinook salmon are expected to occur in the area.

30 **Water Quality**

31 Dredging would be the primary maintenance activity that could affect water quality. Dredging could
32 result in temporary increases in turbidity and suspended contaminated sediments, as well as
33 potential decreases in dissolved oxygen levels. However, these effects would be temporary and
34 periodic, of relatively limited extent, and would be unlikely to occur at more than one site at a time.
35 Any take associated with these activities would likely be negligible, and the expected difference in
36 take between take alternatives would likely be small (Table 9-16).

37 **Habitat Loss and Condition**

38 The removal of substrate during dredging operations would result in the removal of benthic and
39 epibenthic organisms, which provide direct or indirect food resources for other aquatic species,
40 including most of the covered fish species. However, spring-run Chinook salmon are expected to
41 occur primarily along the shoreline, or near the surface in deeper water areas, and would be

1 unlikely to be substantially affected by changes in substrate conditions near the intake sites. Any
 2 take associated with these activities would likely be negligible, and the expected difference in take
 3 between take alternatives would likely be small (Table 9-16).

4 **Predation and Competition**

5 Any effects of maintenance activities on the predation of spring-run Chinook salmon, or competition
 6 with other species, would likely be temporary, infrequent, and localized. In-water maintenance work
 7 would occur during the approved in-water construction window, when few spring-run Chinook
 8 would be present. Any take associated with these activities would likely be negligible, and the
 9 expected difference in take between take alternatives would likely be small (Table 9-16).

10 **9.4.1.4.3 Operations**

11 In addition to the diversion of water through the proposed north Delta intakes, operations would
 12 include long-term habitat restoration and enhancement activities, as well as predator reduction and
 13 invasive aquatic vegetation control measures. These effects would be largely beneficial to spring-run
 14 Chinook salmon. However, the Delta Passage Model results, which do not account for habitat
 15 restoration, suggested that overall through-Delta survival of spring-run Chinook salmon smolts
 16 would be similar under the BDCP compared to existing biological conditions (Appendix 5.C, *Flow,*
 17 *Passage, Salinity, and Turbidity*). This assessment is based on tradeoffs between the positive effect of
 18 greater Yolo Bypass entry (with relatively high survival) and reduced interior Delta mortality
 19 because of lower entrainment loss from the south Delta export facilities, versus less survival through
 20 the Sacramento River and Steamboat/Sutter Slough pathways because of lower flows on the
 21 Sacramento River.

22 **Entrainment and Impingement**

23 With regard to the BDCP Proposed Action and all take alternatives, some entrainment and
 24 impingement risks to spring-run Chinook salmon would arise in the north Delta with the addition of
 25 the new in-water intake structures. However, entrainment of juvenile spring-run Chinook salmon
 26 would be lower under the BDCP Proposed Action than under existing conditions, when averaged
 27 across all water years and across the Plan Area. The Delta Passage Model estimate of spring-run
 28 Chinook salmon smolts (greater than 70-mm fork length) salvaged at the south Delta export
 29 facilities (as an index of entrainment) was 56% lower under the BDCP than existing conditions
 30 (Appendix 5.B, *Entrainment*, Section 5.B.6.1.2.2, *Delta Passage Model Salvage Estimates*).

31 All of the take alternatives would include screens at the north Delta facilities designed to meet and
 32 exceed current NMFS criteria for salmonids. The north Delta intake operations also include bypass
 33 flow criteria that will be managed in real time to minimize adverse effects of north Delta intake
 34 diversions on downstream-migrating salmonids. Thus, the overall entrainment and impingement
 35 risks would generally be lower than under existing conditions. In addition, reduced exports at the
 36 south Delta facilities, from greater spring (March to May) Delta outflows provided during a portion
 37 of the juvenile spring-run Chinook salmon outmigration period, are expected to further minimize
 38 overall entrainment and impingement effects (Appendix 5.B, *Entrainment*).

39 Entrainment of spring-run Chinook salmon at the new north Delta intakes is expected to be limited,
 40 but generally in proportion to the number and size of intakes and the proportion of mean total
 41 project water deliveries exported from the north Delta. Thus, the BDCP Proposed Action, **Take**
 42 **Alternatives G, H, and I** (each with three new north Delta intakes) would have a comparable

1 potential, **Take Alternatives A, C, and E** (each with five intakes) would have greater potential, while
 2 **Take Alternatives B** (two intakes) would have a lower potential for entrainment and impingement
 3 (Table 9-16). Although **Take Alternative D** would also tend have a lower potential, with only one
 4 north Delta intake, the increased proportion of south Delta exports would likely result in greater
 5 entrainment effects than the BDCP Proposed Action. Although **Take Alternative E** would have a
 6 higher potential for entrainment and impingement effects than the BDCP Proposed Action, it would
 7 also eliminate exports from the south Delta facilities and associated take could be lower than the
 8 BDCP Proposed Action. Entrainment and impingement rates could also be further reduced under
 9 **Take Alternative I** due to the even higher spring flows provided in some (wet and above normal)
 10 years (Table 9-13). These higher flows would also have other beneficial effects, such as improved
 11 access to and increased use of the Yolo Bypass. **Take Alternative I** is expected to result in increased
 12 conservation benefit relative to the BDCP Proposed Action. As with the other species, the
 13 entrainment rates are expected to be lower under **Take Alternative F** than the BDCP Proposed
 14 Action, although impingement rates and other screen-related effects would likely be somewhat
 15 greater due to the overall length of the diversion screens and operable gates. Therefore, the overall
 16 level of take is expected to be similar for **Take Alternative F** and the BDCP Proposed Action.

17 **Water Quality**

18 Limited water quality effects are expected from operations and the potential differences between
 19 take alternatives would likely be negligible (Table 9-16).

20 **Flow**

21 The primary effects of flow changes on spring-run Chinook salmon are related to changes in flow-
 22 related survival in the Sacramento River mainstem, downstream of the north Delta intakes, the
 23 diversion of smolts into channels leading to the south Delta export facilities, the associated relatively
 24 high predation rates in the interior Delta, and as a mechanism to trigger adult upstream spawning
 25 migrations. The BDCP Proposed Action and the take alternatives, which would include changes in
 26 flows and tidal area restoration, generally would reduce the diversion of flow to the south Delta
 27 export facilities. Take alternatives with lower exports from the south Delta facilities could
 28 potentially have proportionally greater benefits to Chinook salmon (Table 9-13), depending on the
 29 extent to which the north Delta facilities are used. These benefits would include less predation in the
 30 interior Delta, because of more favorable south Delta hydrodynamics (e.g., less percentage of time
 31 with reversed flows) and reduced entrainment and predation at the south Delta facilities. While
 32 juvenile salmonids passing the north Delta diversions would generally experience lower migration
 33 flows compared to existing conditions, operations of the north Delta facilities would include bypass
 34 flow criteria managed in real time to minimize adverse effects on downstream migrating salmonids.

35 With the exception of **Take Alternative F**, all the take alternatives would alter the flow
 36 characteristics in the Plan Area by reducing exports from the south Delta and increasing north Delta
 37 exports. These changes could provide some benefits, although the magnitude or differences in
 38 benefits between take alternatives may be negligible. **Take Alternative E** would have the most
 39 effects on flow below the north Delta intakes, because all of the project water deliveries would occur
 40 through the north Delta facilities (no south Delta exports). As a result, the corresponding flow
 41 reductions in the Sacramento River could offset potential benefits due to other flow-related survival
 42 factors (e.g., greater susceptibility to predation) (Chapter 5, *Effects Analysis*).

43 In contrast, **Take Alternative F** would have the least effects on Sacramento River flows downstream
 44 of where the north Delta intakes would be placed under the other take alternatives. **Take**

1 **Alternative F** generally would maintain existing flow patterns, although blocking juvenile Chinook
 2 salmon from entering the interior Delta and encountering the south Delta intakes is expected to
 3 reduce juvenile Chinook salmon losses, compared to existing conditions (Table 9-16). The modified
 4 spring outflows provided by **Take Alternative I** may improve migration and rearing conditions for
 5 juvenile spring-run Chinook salmon, based on the overlap between the species’ occurrence and the
 6 higher flows under **Take Alternative I**.

7 In addition to potential changes in overall juvenile survival, reduced Sacramento River flows could
 8 also negatively affect the upstream migration of adult spring-run Chinook salmon by changing
 9 attraction flows and olfactory cues, although these changes are not readily quantifiable in terms of
 10 take. The uncertainty in overall effects will be informed by monitoring and targeted research under
 11 the BDCP (e.g., examining migration success of tagged adult Chinook salmon under different flow
 12 regimes), with any adverse effects being addressed by adaptive management (Chapter 5, Section
 13 5.5.4.2.2, *Reduced Attraction to Flows in the Sacramento River*).

14 **Habitat**

15 The BDCP will change the configuration and operation of Fremont Weir and the Yolo Bypass, which
 16 will increase floodplain availability and usage, and improve conditions for migrating juvenile and
 17 adult spring-run Chinook salmon, compared to existing conditions (Chapter 5, Section 5.5.4.1.1,
 18 *Restored Floodplain, Tidal, and Channel Margin Habitat*). Habitat restoration activities associated
 19 with the conservation measures would benefit rearing salmonids, including spring-run Chinook
 20 salmon, which can rear for several months in the lower river and Delta. However, the majority of
 21 juveniles entering the Plan Area are assumed to be migrant smolts rather than foraging juveniles.

22 Overall, **Take Alternative H** would have the most potential to benefit spring-run Chinook salmon
 23 because it would result in more inundated floodplain and restored tidal and channel margin,
 24 compared to the other take alternatives (including the BDCP Proposed Action). **Take Alternatives**
 25 **D** and **G** would restore less habitat than the BDCP Proposed Action and the other take alternatives.
 26 Less channel margin habitat would be replaced by in-water structures under **Take Alternative F**
 27 than the other take alternatives, resulting in a greater net increase (including restored habitat) in
 28 this type of habitat in the north Delta (Table 9-16). The other take alternatives would have similar
 29 effects on habitat as the BDCP Proposed Action. Similarly, the implementation of CM2 would
 30 improve passage for adult fish, including spring-run Chinook salmon.

31 **Predation and Competition**

32 The north Delta diversions would have gradual shoreline transitions, which would substantially
 33 reduce the potential for producing predator habitat, but the magnitude of change in predation is
 34 uncertain. Additionally, implementation of CM15 is expected to reduce predation pressure at key
 35 locations in the Plan Area, including the north Delta intakes, and would apply to all of the take
 36 alternatives. The effectiveness of predation reduction efforts will be assessed with targeted research
 37 and monitoring, and adaptive management will be applied as necessary to modify the conservation
 38 measure. As a result, the differences between the take alternatives would be likely negligible, except
 39 for **Take Alternatives E, F, and I**, which could divert fewer Sacramento River fish into the interior
 40 or south Delta regions than any of the other take alternatives (Table 9-15). The elimination of south
 41 Delta exports under **Take Alternative E** could result in fewer fish diverted into the interior Delta,
 42 and **Take Alternative F** would block fish from entering the high-predation route through the
 43 interior Delta (Table 9-15). However, the longer cumulative length of in-water structures
 44 constructed under **Take Alternative F**, is expected to increase structure-related predation levels,

1 compared to the BDCP Proposed Action. **Take Alternative I** would result in lower late summer and
 2 fall flows, while still providing relatively large exports from the south Delta facilities, resulting in
 3 greater predation risks.

4 **Foodweb**

5 Restored tidal wetland and floodplain habitat, and to a lesser extent channel margin and riparian
 6 habitat, would provide increased foodweb resources for juvenile salmonids throughout the Plan
 7 Area, although few juvenile spring-run Chinook salmon actively forage in the Plan Area (Chapter 5,
 8 *Effects Analysis*). Habitat restoration would increase primary productivity, which is expected to
 9 cause a corresponding increase in higher trophic-level prey resources important to spring-run
 10 Chinook salmon and other juvenile salmonids. The take alternatives providing the most habitat
 11 restoration, particularly tidal and inundated floodplain habitat, would have the most potential
 12 benefits on foodweb conditions for Chinook salmon. Therefore, **Take Alternative H** would have the
 13 most potential benefits, while **Take Alternatives A, B, C, E, and I** would provide similar benefits as
 14 the BDCP Proposed Action. In contrast, **Take Alternatives D and G** would have fewer potential
 15 benefits than the BDCP Proposed Action (Table 9-16).

16 While habitat restoration is expected to provide the most direct foodweb benefits, additional flows
 17 provided by meeting high-outflow scenario and/or Fall X2 commitments under most take
 18 alternatives would also provide additional foodweb benefits from increased seasonal floodplain
 19 habitat inundation. The additional spring flows provided by **Take Alternative I**, would provide
 20 some more inundation-related foodweb benefits.

21 **Conservation Measures**

22 The conservation measures will benefit covered fish species, including spring-run Chinook salmon,
 23 by restoring habitat, reducing predation, improving migration corridor conditions, and controlling
 24 invasive aquatic vegetation. Except for the differences identified above, in *Habitat*, there would be
 25 no substantial difference in the beneficial effects of the take alternatives (Table 9-16).

26 **9.4.1.5 Chinook Salmon, Central Valley Fall- and Late Fall–Run**

27 As with the other salmonids, the entire population of the Central Valley fall- and late fall–run
 28 Chinook salmon evolutionarily significant unit must pass through the Plan Area as adults migrating
 29 upstream and as juveniles emigrating downstream. Adult Central Valley fall- and late fall–run
 30 Chinook salmon migrating into the Sacramento River and its tributaries primarily use the west and
 31 north Delta, whereas adults entering the San Joaquin River system to spawn use the west, central,
 32 and south Delta as a migration pathway. Young fall- and late fall–run Chinook salmon must migrate
 33 through the Delta toward the Pacific Ocean and use the Delta, Suisun Marsh, and the Yolo Bypass for
 34 rearing to varying degrees, depending on their life stage (fry versus juvenile) and size, river flows,
 35 and time of year. The comparison of take alternatives is summarized in Table 9-17.

36 **9.4.1.5.1 Construction**

37 Construction would be temporary, localized, and would occur during the approved in-water work
 38 window. Fall- and late fall–run Chinook salmon typically occur in the north Delta as they migrate
 39 upstream to spawn and downstream as smolts (migrants) or rearing fry (foragers). For this
 40 assessment, it was assumed that 95% of the fall-run juveniles, but only 25% of late fall–run juveniles
 41 enter the Plan Area as foragers. Adhering to the approved in-water construction window (June

1 through October) would protect a substantial portion of the populations, although October coincides
2 with the peak fall-run Chinook salmon adult upstream migration and the start of the late fall-run
3 juvenile migration. Chinook salmon occurring in the Plan Area during this overlap period could be
4 adversely affected by construction activities, although implementation of CM22 will reduce the
5 likelihood of adverse effects. Overall, the magnitude of potential effects would be in proportion to
6 the amount of in-water construction activity occurring under the various take alternatives.

1
2

Table 9-17. Expected Changes in Incidental Take of Central Valley Fall- and Late Fall–Run Chinook Salmon and Conservation Benefits by Take Alternative, Relative to the BDCP Proposed Action

Stage	Mechanism of Effect	Take Alternatives								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Construction										
	Underwater sound	+	-	+	-	+	+	○	○	○
	Fish stranding and handling	+	-	+	-	+	+	○	○	○
	Water quality	+	-	+	-	+	+	-	+	○
	Dredging	+	-	+	-	+	+	○	○	○
	Habitat alteration	+	-	+	-	+	+	○	○	○
	Habitat restoration	○	○	○	-	○	○	-	+	○
Maintenance										
	Dredging	+	-	+	-	+	○	○	○	○
	Water quality	○	○	○	○	○	○	○	○	○
	Habitat loss and condition	○	○	○	○	○	○	○	○	○
	Predation and competition	○	○	○	○	○	○	○	○	○
Operations										
	Entrainment and impingement	+	-	+	+	-	○	○	○	○
	Water quality	○	○	○	○	○	○	○	○	○
	Flow	○	○	○	○	-	○	○	○	○ ^a
	Habitat	○	○	○	+	○	-	+	-	○
	Predation and competition	○	○	○	○	-	-	○	○	○
	Foodweb	○	○	○	+	○	○	+	-	○
	Conservation measures	○	○	○	○	○	○	○	○	○
<p>A three-point scale indicates how the level of take or conservation benefit is expected to change compared with the BDCP Proposed Action.</p> <ul style="list-style-type: none"> - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action. <p>Note:</p> <p>^a While there is no expected change in the level of take, this species is expected to have greater conservation benefit from this take alternative.</p>										

3
4

1 Underwater Sound

2 The primary source of underwater sound that could affect Chinook salmon would be from impact
3 pile driving. Such effects would be in proportion to the number and size of the intakes constructed,
4 although sound minimization measures would be used under all take alternatives to minimize the
5 risk of incidental take attributable to impact pile driving. The take alternatives with five-intakes
6 (**Take Alternatives A, C, and E**) would have a greater potential for take from pile driving than those
7 with fewer intakes, including the BDCP Proposed Action (three intakes). The five-intake take
8 alternatives would have a shoreline footprint up to 59% larger than the BDCP Proposed Action
9 footprint, with a corresponding greater amount of pile driving (Table 9-11). The take associated
10 with **Take Alternatives G, H, and I** would be similar to the BDCP Proposed Action, as each would
11 include the same three intakes, while **Take Alternatives B and D** would likely result in less take
12 because of the fewer intakes constructed. **Take Alternative F** would also likely have less pile
13 driving activity than the BDCP Proposed Action, as the in-water diversion structures would have a
14 smaller footprint than the structures constructed for the BDCP Proposed Action (Table 9-17).
15 However, the wider distribution of the diversions screens constructed in the Delta would result in a
16 larger overall area of exposure to pile driving sound effects, and thus an increased risk of incidental
17 take.

18 Fish Stranding and Handling

19 Fall-run Chinook salmon migrate primarily as foraging fry. Smaller individuals tend to occupy
20 nearshore habitat for rearing and protection from predators, while larger fish tend to move offshore
21 to inhabit deeper water habitat (U.S. Fish and Wildlife Service 1997). As a result, the smaller fish
22 may be particularly susceptible to entrapment in cofferdams, and may require rescue and
23 subsequent handling. Therefore, the take alternatives with the most intakes (**Take Alternatives A,**
24 **C, and E**) would have a greater potential for stranding fall- and late fall-run Chinook salmon than the
25 BDCP Proposed Action (Table 9-17). **Take Alternatives B and D** would have less potential to strand
26 fish, while **Take Alternatives G, H, and I** would have a similar potential as the BDCP Proposed
27 Action. Similarly, the amount of dredging required during construction would be proportional to the
28 number of facilities constructed (Table 9-11). **Take Alternative F** could potentially result in lower
29 levels of entrapment and stranding than the BDCP Proposed Action, as a substantial portion of the
30 fish diversion structures would occur in offshore habitat areas where subyearling fish infrequently
31 occur. The diversion structures constructed under **Take Alternative F** would also be smaller than
32 the intakes for the BDCP Proposed Action and other take alternatives, but the greater number of
33 these in-water structures and the wider distribution through the Delta, would likely result in greater
34 stranding and handling effects than the other take alternatives (Table 9-17).

35 Water Quality

36 Although few juvenile Chinook salmon are expected to occur in the area during much of the in-water
37 construction window, some could occur in late spring or early fall. The potential for take is limited,
38 and only minor differences are expected between take alternatives. However, as with the other
39 construction effect mechanisms, take alternatives with five intakes (**Take Alternatives A, C, and E**)
40 would likely have greater potential for effects than the BDCP Proposed Action and the other three-
41 intake alternatives (**Take Alternatives G, H, and I**). **Take Alternative F** includes a greater number
42 of in-water construction sites than the other take alternatives, and thus has greater potential for
43 water quality changes to affect this species. **Take Alternative H** would include the most extensive
44 habitat restoration, and would have the most potential to temporarily alter water quality during

1 restoration construction. In contrast, **Take Alternatives D and G** would have lower risks of
2 restoration-related water quality effects than the other take alternatives or the BDCP Proposed
3 Action (Table 9-17). While habitat restoration activities would occur in areas frequently used by
4 Chinook salmon, any associated changes in water quality would be temporary, localized, and would
5 occur during the approved in-water work window.

6 **Dredging**

7 The amount of dredging would vary in proportion to the number and size of in-water structures,
8 similar to the other construction effects (Table 9-11). While **Take Alternative F** would likely
9 require little or no dredging associated with the diversion structures, dredging activity would
10 increase their flow capacity or extend the length of some of the sloughs in order to redirect flows or
11 fish. While it is assumed that the diversion structures would be constructed prior to dredging,
12 thereby restricting Chinook salmon access to these dredging areas, the effects would likely be
13 greater than the BDCP Proposed Action (Table 9-17).

14 **Habitat Alteration**

15 The potential for take from the loss or alteration of nearshore habitat would vary according to the
16 number and size of in-water structures and barge landings, and differences between take
17 alternatives would be similar, as described above for other construction-related effects. Juvenile fall-
18 and late fall–run Chinook salmon typically migrate as young-of-the-year fry, are expected to use the
19 shoreline habitat in the lower river and Delta for rearing and migrating, and would be susceptible to
20 the alteration of this habitat during construction. However, compared to the amount of habitat
21 available to Chinook salmon in the Plan Area and the degraded condition of the affected habitat, the
22 overall potential for take would be limited (Table 9-17).

23 **Habitat Restoration**

24 The construction of habitat restoration projects may temporarily disturb or displace covered fish
25 species and their habitat, as well as affect water quality, particularly turbidity, dissolved oxygen, and
26 suspended contaminated sediments. However, most of the construction activities would be
27 conducted in the dry, and any in-water work would occur during the approved in-water
28 construction window, when limited numbers of fall- and late fall–run Chinook salmon are expected
29 to occur in the Plan Area. Some restoration construction could occur when Chinook salmon may be
30 present, depending on the specific location of the restoration.

31 All of the take alternatives would provide substantially more habitat, compared to existing
32 conditions, through the implementation of conservation measures (Table 9-6). Given the relatively
33 small size of fall- and late fall–run Chinook salmon fry that rear in the Delta for several months, and
34 their extensive use of the shallow and nearshore habitat, the take alternative with the greatest
35 amount of habitat restoration (**Take Alternative H**) would have an increased risk of affecting
36 Chinook salmon fry during construction, compared to the other take alternatives (including the
37 BDCP Proposed Action) (Table 9-17). In contrast, **Take Alternatives D and G** would likely have
38 fewer effects, based on less habitat restoration.

39 **9.4.1.5.2 Maintenance**

40 Potential effects of maintenance activities would be proportional to the number of in-water
41 structures. However, maintenance activities would be temporary and unlikely to have a measurable

1 effect on fall- and late fall–run Chinook salmon. These activities would also occur during the
2 approved in-water construction window, although fall- or late fall-run Chinook salmon are expected
3 to occur in the area during portions of the construction window, and could be affected by
4 maintenance activities. However, the potential for effects would be limited and negligibly different
5 between take alternatives (Table 9-17).

6 **Dredging**

7 The amount of maintenance dredging, and potential take, would be proportional to the number and
8 size of in-water facilities, although the extent, frequency, and duration of any maintenance dredging
9 would likely be limited (Table 9-11). Dredging would also occur during low water and the approved
10 in-water work window, when few fall- or late fall-run Chinook salmon are expected to occur in the
11 area. Therefore, the amount of take associated with these activities would likely be small.

12 As indicated for the construction phase, **Take Alternative F** would include limited dredging at the
13 in-water facility sites, but would require dredging or excavation in some sloughs to maintain water
14 transport capacity. However, the diversion structures would restrict the access of Chinook salmon to
15 these channels, minimizing the potential for take, particularly during the approved in-water work
16 window. As a result, the effects would likely be similar to the BDCP Proposed Action, based on the
17 size of the in-water structures (Table 9-17).

18 Periodic channel maintenance excavation and dredging would also occur in the Yolo Bypass under
19 all the take alternatives, to enhance the habitat and reduce stranding. While the take alternatives
20 would result in greater potential effects, this dredging would occur during low water and in the
21 approved in-water work window, when few fall- or late fall-run Chinook salmon are expected to
22 occur in the area

23 **Water Quality**

24 Dredging would be the primary maintenance activity that could affect water quality. Dredging would
25 result in temporary increases in turbidity and suspended contaminated sediments, as well as
26 potential decreases in dissolved oxygen levels. However, these effects would be temporary and
27 periodic, of relatively limited extent, and would be unlikely to occur at more than one site at a time.
28 Any take associated with these activities would likely be negligible, and the expected difference in
29 take between take alternatives would likely be small (Table 9-17).

30 **Habitat Loss and Condition**

31 The removal of substrate during dredging operations would result in the removal of benthic and
32 epibenthic organisms, which provide direct or indirect food resources for juvenile fall- and late fall–
33 run Chinook salmon. These species are expected to occur primarily along the shoreline, or near the
34 surface in deeper areas, and would be unlikely to be substantially affected by changes in offshore
35 substrate conditions. Any take associated with these activities would likely be negligible, and the
36 expected difference in take between take alternatives would likely be small (Table 9-17).

37 **Predation and Competition**

38 Any effects of maintenance activities on the predation of fall- and late fall–run Chinook salmon, or
39 competition with other species, would likely be temporary, infrequent, and localized. In-water
40 maintenance work would occur during the approved in-water construction window, when limited
41 numbers of these Chinook salmon would be present. Any take associated with these activities would

1 likely be negligible, and the expected difference in take between take alternatives would likely be
 2 small (Table 9-17).

3 **9.4.1.5.3 Operations**

4 In addition to the diversion of water through the proposed north Delta intakes, operations would
 5 include long-term habitat restoration and enhancement activities, as well as predator reduction and
 6 invasive aquatic vegetation control measures. Increased flows during the spring outmigration would
 7 likely increase the access to juvenile rearing habitat, such as the Yolo Bypass. These effects would be
 8 largely beneficial to fall- and late fall–run Chinook salmon.

9 **Entrainment and Impingement**

10 With regard to the BDCP Proposed Action and all take alternatives, some entrainment and
 11 impingement risks to fall- and late fall–run Chinook salmon would arise at the north Delta in-water
 12 structures, compared to existing conditions. All of the take alternatives would include screens
 13 designed to meet and exceed current NMFS sweep- and approach-velocity criteria for salmonids,
 14 while minimizing the overall size of the north Delta intakes or diversion screens. Thus, the overall
 15 risks would be lower than existing conditions because of reduced exports at the existing south Delta
 16 facilities, where entrainment rates are expected to be greater than the at the north Delta facilities.
 17 The reductions in water diversions at the existing SWP/ CVP facilities would also result in a
 18 reduction in associated predation losses.

19 Entrainment would generally be proportional to the number of structures and the proportion of
 20 mean total project water deliveries exported from the north Delta (Table 9-13). Thus, the BDCP
 21 Proposed Action would be similar to **Take Alternatives G, H, and I** (each with three new north
 22 Delta intakes). While **Take Alternatives A, C, and E** would have greater entrainment and
 23 impingement potential (each with five intakes), **Take Alternatives B** (two intakes) would have a
 24 lower potential (Table 9-17). Although **Take Alternative D** would also tend have a lower
 25 entrainment potential, with only one north Delta intake, the increased proportion of south Delta
 26 exports would likely result in greater entrainment effects than the BDCP Proposed Action. Although
 27 **Take Alternative E** would have a higher potential for entrainment and impingement effects than
 28 the BDCP Proposed Action, based on the number of intakes, it would also eliminate exports from the
 29 south Delta facilities and its overall take from entrainment a would likely be lower than the BDCP
 30 Proposed Action. As described for the other species, entrainment rates are expected to be lower
 31 under **Take Alternative F** than the BDCP Proposed Action, although impingement rates and other
 32 screen-related effects would likely be somewhat greater due to the overall length of the diversion
 33 screens and operable gates. Therefore, the overall level of take is expected to be similar for **Take**
 34 **Alternative F** and the BDCP Proposed Action.

35 **Water Quality**

36 Limited water quality effects are expected from operations and the potential differences between
 37 take alternatives would likely be negligible on fall- and late fall–run Chinook salmon (Table 9-17).

38 **Flow**

39 The primary effects of flow changes on fall- and late fall–run Chinook salmon are to flow-related
 40 survival in the Sacramento River mainstem downstream of the north Delta intakes, the diversion of
 41 juveniles into channels leading to the south Delta export facilities (with relatively high predation

1 rates), and as a mechanism to trigger adult upstream spawning migrations. The BDCP Proposed
2 Action and the take alternatives, which would include changes in flows and tidal area from
3 restoration, generally would reduce the flow diversions to the south Delta export facilities,
4 compared to existing conditions. Take alternatives with lower south Delta exports could potentially
5 have proportionally greater benefits to Chinook salmon (Table 9-13) depending on the extent to
6 which the north Delta facilities are used. These benefits would include fewer losses of juvenile
7 Chinook salmon from predation in the interior Delta due to more favorable south Delta
8 hydrodynamics (e.g., less percentage of time with reversed flows), and less entrainment and
9 predation at the south Delta export facilities. Operations of the north Delta facilities also include
10 bypass flow criteria that will be managed in real time to minimize adverse effects of north Delta
11 intake diversions on downstream-migrating salmonids.

12 With the exception of **Take Alternative F**, all the take alternatives would substantially alter the flow
13 characteristics in the Plan Area by reducing exports from the south Delta and increasing north Delta
14 exports, compared with existing conditions (Table 9-17). These changes would potentially provide
15 some benefits, although the magnitude and differences in benefits between take alternatives may be
16 negligible and difficult to discern. While **Take Alternative E** would have the most effects on
17 Sacramento River flows downstream of the north Delta intakes, because all of the project water
18 deliveries would occur through the north Delta facilities (i.e., no south Delta exports), the
19 corresponding flow reductions in the Sacramento River could offset these potential benefits due to
20 other flow-related survival factors (e.g., greater susceptibility to predation) (Chapter 5, *Effects*
21 *Analysis*).

22 The modified spring outflows provided by **Take Alternative I** may improve migration and rearing
23 conditions for juvenile fall- and late fall-run Chinook salmon, potentially resulting in increased
24 conservation benefit relative to the BDCP Proposed Action, depending on the overlap between these
25 higher flows and the species' occurrence in the Plan Area. Sacramento River attraction flows for
26 upstream migrating adult Chinook salmon would also be lower with the operation of the north Delta
27 intakes. The changes in flow would vary by season, such that flows would be relatively unchanged
28 during the adult late fall-run Chinook salmon migration period, but moderately reduced during the
29 fall-run migration season under the BDCP Proposed Action, and most take alternatives (Appendix
30 5.C, *Flow, Passage, Salinity, and Turbidity*).

31 Upstream migration cues for adult San Joaquin River region fall-run Chinook salmon would be
32 greater with reduced operations of the south Delta export facilities under the BDCP Proposed
33 Action, as well as most take alternatives. This could result in considerable potential to reduce
34 straying into the Sacramento River region, depending on the reduction in south Delta exports and
35 the timing of the reductions. Marston et al. (2012) found that both San Joaquin River inflow and
36 south Delta exports were correlated to straying rate. While all the action alternatives would reduce
37 south Delta exports, **Take Alternatives B** and **D** would have greater south Delta exports than north
38 Delta exports, and the BDCP Proposed Action and **Take Alternatives A** and **C** would have similar
39 north and south Delta exports (Table 9-13).

40 Changes in flow under **Take Alternative F** would reduce migration habitat to an adverse/significant
41 level for fall-run/late fall-run Chinook salmon in the Sacramento River, but the distribution of flow
42 could result in beneficial effects on migration conditions for San Joaquin River fall-run Chinook
43 salmon, due to reductions in San Joaquin River exports at the south Delta export facilities. Similarly,
44 **Take Alternative E** would eliminate all south Delta exports, and could result in greater migration
45 benefits to these Chinook salmon (Table 9-17).

1 **Habitat**

2 Habitat restoration activities would benefit rearing salmonids, including fall- and late fall–run
3 Chinook salmon, which rear for several months in the lower river and Delta. Overall, **Take**
4 **Alternative H** would have the most potential to benefit fall- and late fall–run Chinook salmon
5 because it would result in more inundated floodplain and restored tidal and channel margin than
6 the other take alternatives (including the BDCP Proposed Action) (Table 9-17). **Take Alternatives**
7 **D** and **G** would restore less habitat than the BDCP Proposed Action and other take alternatives. Less
8 channel margin would be replaced by in-water structures under **Take Alternative F** than the other
9 take alternatives, resulting in a greater net increase in this type of habitat in the north Delta.

10 The increased spring outflows provided by the BDCP Proposed Action, and most take alternatives,
11 could improve access to additional juvenile Chinook salmon rearing habitat (e.g., Yolo Bypass).
12 Access to such habitat could result in an overall improvement in juvenile survival (Chapter 5, *Effects*
13 *Analysis*).

14 **Predation and Competition**

15 Predation risks to fall- and late fall–run Chinook salmon would likely be similar for the take
16 alternatives (Table 9-17). Take alternatives with the most north Delta intakes would result in less
17 water (and fish) diverted into the interior Delta, and a corresponding reduction in predation losses.
18 Take alternatives with fewer intakes, including the three-intake BDCP Proposed Action, could
19 include corresponding higher flows into the interior delta, and higher predation pressures (Table
20 9-11). However, the differences between take alternatives would be small and likely negligible,
21 except for **Take Alternatives E** and **F**. **Take Alternatives E** and **F** would likely have the lowest
22 predation risks by substantially reducing the movement of fall- and late fall–run Chinook salmon
23 into the interior Delta (Table 9-17).

24 **Foodweb**

25 Take alternatives providing the most habitat restoration, particularly tidal and inundated floodplain
26 habitat, would have the most potential benefits on foodweb conditions for subyearling Chinook
27 salmon. Thus, **Take Alternative H** would have the most potential benefits, **Take Alternatives D**
28 and **G** would have the least benefits, and most other take alternatives would provide benefits similar
29 to the BDCP Proposed Action (Table 9-17).

30 Habitat restoration is expected to provide the most direct foodweb benefits. Additional flows
31 provided by meeting high-outflow scenario and/or Fall X2 commitments under most take
32 alternatives are also likely to provide additional foodweb benefits from increased seasonal
33 floodplain habitat inundation. The additional spring flows provided by **Take Alternative I**, would
34 also provide more inundation-related foodweb benefits.

35 **Conservation Measures**

36 The conservation measures will benefit fall- and late fall–run Chinook salmon by restoring habitat,
37 reducing predation, improving migratory corridor conditions, and controlling invasive aquatic
38 vegetation. Except for the differences identified above, in *Habitat*, there would be no difference in
39 the benefits of the take alternatives (Table 9-17).

1 9.4.1.6 Steelhead, Central Valley

2 The entire population of the Central Valley steelhead distinct population segment must pass through
3 the Plan Area as adults migrating upstream to spawning areas and juveniles emigrating downstream
4 to rearing areas and the ocean. Juvenile steelhead likely use the Delta as well as Suisun Marsh and
5 the Yolo Bypass for rearing. Adult Central Valley steelhead migrating into the San Joaquin River and
6 its tributaries use the central, south, and east edge of the Delta, whereas adults entering the
7 Sacramento River system to spawn use the north, west, and central Delta as a migration pathway.
8 Adults generally migrate upstream from July through March, while juveniles migrate episodically
9 from natal streams during fall, winter, and early spring high flows (Busby et al. 1996; Hallock et al.
10 1957; National Marine Fisheries Service 2009, Nobriga and Cadrett 2001). However, because there
11 is limited adult holding and juvenile rearing habitat in the intake construction areas, individual
12 steelhead would likely migrate relatively quickly through this portion of the river. It is assumed that
13 95% of the juvenile steelhead entering the Plan Area are migrant smolts and 5% are smaller
14 foraging fish (Chapter 5, *Effects Analysis*). The comparison of take alternatives is summarized in
15 Table 9-18.

16 9.4.1.6.1 Construction

17 The main in-water construction activities at the north Delta intakes (CM1) would avoid the primary
18 juvenile downstream migration period (Appendix 5.H, *Aquatic Construction and Maintenance*
19 *Effects*). Construction effects would be temporary, localized, and would occur during the approved
20 in-water work window. Central Valley steelhead typically only occur in the north Delta as they
21 migrate upstream to spawn and downstream as smolts. Adhering to the approved in-water
22 construction window (June through October) would protect a substantial portion of the steelhead
23 population, although some adult steelhead would likely occur in the area in September and October,
24 and some late-migrating smolts could occur in October. The magnitude of effects would be in
25 proportion to the amount of in-water construction activity.

26 Underwater Sound

27 The primary source of underwater sound that could affect steelhead would be from impact pile
28 driving. Such effects would be in proportion to the number and size of the intakes constructed. The
29 five-intake take alternatives would have a greater potential for take than the BDCP Proposed Action
30 and the other take alternatives with three intakes (**Take Alternatives G, H, and I**), and those with
31 fewer or smaller facilities (**Take Alternatives B and D**) would have less potential for take (Table
32 9-18). While the overall length of in-water structures for **Take Alternative F** would be greater than
33 under the BDCP Proposed Action, and the structures would be widely distributed, resulting in a
34 larger area of exposure to pile driving sound, and thus an increased risk of incidental take.

35 Fish Stranding and Handling

36 The potential effects would be low for the take alternatives because juvenile steelhead are large and
37 strong swimmers, allowing them to avoid the construction areas. They are also likely to be
38 distributed away from the shoreline areas where construction activities would occur. No
39 measureable differences between take alternatives are expected (Table 9-18).

1 **Table 9-18. Expected Changes in Incidental Take of Central Valley Steelhead and Conservation Benefits**
 2 **by Take Alternative, Relative to the BDCP Proposed Action**

Stage	Mechanism of Effect	Take Alternatives								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Construction										
	Underwater sound	+	-	+	-	+	+	○	○	○
	Fish stranding and handling	○	○	○	○	○	○	○	○	○
	Water quality	+	○	+	-	+	+	-	+	○
	Dredging	+	-	+	-	+	+	○	○	○
	Habitat alteration	+	-	+	-	+	○	○	○	○
	Habitat restoration	○	○	○	-	○	○	-	+	○
Maintenance										
	Dredging	+	-	+	-	+	○	○	○	○
	Water quality	○	○	○	○	○	○	○	○	○
	Habitat loss and condition	○	○	○	○	○	○	○	○	○
	Predation and competition	○	○	○	○	○	○	○	○	○
Operations										
	Entrainment and impingement	○	○	○	○	-	○	○	○	○
	Water quality	○	○	○	○	○	○	○	+	○
	Flow	○	○	○	○	-	-	○	○	○
	Habitat	○	○	○	+	○	○	+	-	○
	Predation and competition	○	○	○	○	-	-	○	○	○
	Foodweb	○	○	○	+	○	○	+	-	○
	Conservation measures	○	○	○	○	○	○	○	○	○
A three-point scale indicates how the level of take or conservation benefit is expected to change compared with the BDCP Proposed Action. - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action.										

3

4 **Water Quality**

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Few steelhead are expected to occur in the area during the construction window, and as actively migrating adults or juveniles, they would transit through the area for relatively short periods of time. The potential for take is limited, and no measurable differences are expected between take alternatives (Table 9-18). While habitat restoration activities, particularly for channel margin enhancement, would occur in areas more frequently used by steelhead, any associated changes in

1 water quality would be temporary, localized, and would occur during the approved in-water work
2 window. However, even with twice as much channel margin restoration (40 miles) under **Take**
3 **Alternative H**, the potential for take resulting from changes in water quality would not be
4 substantially greater than the other take alternatives.

5 **Dredging**

6 The amount of dredging would vary in proportion to the number and size of in-water structures,
7 similar to the other construction effects (Table 9-11). While **Take Alternative F** would likely
8 require little or no dredging associated with the diversion structures, dredging activity would occur
9 at each operable gate structure, as well as in some of the sloughs to increase their flow capacity, or
10 to extend their length to redirect flows or fish. While this could result in greater dredging than the
11 BDCP Proposed Action, it is assumed that the Delta Cross Channel and Georgiana Slough diversion
12 structures would be in place prior to much of this dredging activity, thereby substantially reducing
13 the numbers of steelhead entering the interior Delta. Overall, **Take Alternative F** is expected to
14 result in greater dredging-related effects on steelhead as the BDCP Proposed Action (Table 9-18).

15 **Habitat Alteration**

16 As described for delta smelt, the potential for take from the loss or alteration of nearshore habitat
17 would vary by the number and size of in-water structures built and the number of barge landings
18 needed (Table 9-11). Considering the amount of habitat available to steelhead in the Plan Area, the
19 degraded condition of the affected habitat, and the limited use of shoreline habitat by steelhead, the
20 overall potential for take would be limited. The temporary effects of the barge landings on steelhead
21 habitat would also be limited and similar for most take alternatives (Table 9-18).

22 **Habitat Restoration**

23 The construction of habitat restoration projects may temporarily disturb or displace covered fish
24 species and their habitat, as well as affect water quality, particularly turbidity, dissolve oxygen, and
25 suspended contaminated sediments. However, most of the restoration activities would be conducted
26 in the dry, and any in-water work would occur during the approved in-water construction window,
27 when relatively few steelhead are expected to occur in the Plan Area. However, some restoration
28 construction could occur during periods when steelhead may be present, depending on the specific
29 location of the restoration. Any negative effects would be localized, temporary, and infrequent.
30 While more habitat would be provided through the implementation of conservation measures,
31 steelhead are not expected to extensively use the shallow and nearshore habitat that would be
32 restored. Any take associated with these activities would likely be negligible, and the expected
33 difference in take between take alternatives would likely be small (Table 9-18).

34 **9.4.1.6.2 Maintenance**

35 Potential effects of maintenance activities would be proportional to the number of in-water
36 structures to maintain. However, maintenance activities would be temporary and unlikely to have a
37 measurable effect on Central Valley steelhead because the species typically spends limited time in
38 the primary maintenance areas. Any effects would be localized and infrequent, and negligibly
39 different between the take alternatives (Table 9-18).

1 **Dredging**

2 The amount of dredging, and potential take, would be proportional to the number and size of in-
3 water facilities (Table 9-11). Take alternatives with five intakes (**Take Alternatives A, C, and E**)
4 would require more maintenance dredging than the BDCP Proposed Action, and **Take Alternatives**
5 **B and D** would require less. **Take Alternative F** would require limited dredging at the in-water
6 facility sites, but would require additional dredging in some sloughs to maintain water transport
7 capacity. Although the frequency of maintenance dredging is unknown, dredging effects of **Take**
8 **Alternative F** would likely be similar to the dredging effects of the BDCP Proposed Action (Table
9 9-18). However, the effects of dredging on steelhead would be limited because few steelhead would
10 be expected to occur in the dredging areas, particularly during the approved in-water work window,
11 and take would likely be small.

12 **Water Quality**

13 Dredging would be the primary maintenance activity that could affect water quality. Dredging would
14 result in temporary increases in turbidity and suspended contaminated sediments, as well as
15 potential decreases in dissolved oxygen levels. However, these effects would be temporary and
16 periodic, of relatively limited extent, and would be unlikely to occur at more than one site at a time.
17 Few steelhead would likely occur in the areas affected by water quality constraints, particularly
18 during the approved in-water construction window. Any take associated with these activities would
19 likely be negligible, and the expected difference in take between take alternatives would likely be
20 small (Table 9-18).

21 **Habitat Loss and Condition**

22 The removal of substrate during dredging operations would result in the removal of benthic and
23 epibenthic organisms, which provide direct or indirect food resources for steelhead. However,
24 steelhead are expected to spend limited time in the dredged areas, and would be unlikely to be
25 substantially affected by changes in substrate conditions near the intake sites. Any take associated
26 with these activities would likely be negligible, and the expected difference in take between take
27 alternatives would likely be small (Table 9-18).

28 **Predation and Competition**

29 Any effects of maintenance activities on the predation of steelhead, or competition with other
30 species, would likely be temporary, infrequent, and localized. Any take associated with these
31 activities would likely be negligible, and the expected difference in take between take alternatives
32 would likely be small (Table 9-18).

33 **9.4.1.6.3 Operations**

34 In addition to the diversion of water through the proposed north Delta facilities, operations would
35 include long-term habitat restoration and enhancement activities, as well as predator reduction and
36 invasive aquatic vegetation control measures. Effects from these measures would be largely
37 beneficial. However, lower river flow downstream of the north Delta intakes under the BDCP
38 Proposed Action may reduce survival of juvenile Sacramento River region steelhead during
39 downstream migration and also could negatively affect upstream migration of adults by changing
40 attraction flows/olfactory cues. Such effects are not readily quantifiable in terms of take. Evaluation
41 of these effects will be made through research and adaptive management.

1 **Entrainment and Impingement**

2 With regard to the BDCP Proposed Action and all take alternatives, some entrainment and
3 impingement risks to steelhead would arise in the north Delta with the addition of the new in-water
4 intake structures, compared to existing conditions without the new in-water structures
5 (Appendix 5.B, *Entrainment*, Section 5.B.6.1.1.1, *Salvage Density Method*). However, the overall risks
6 would be low because of the size and swimming ability of migrating steelhead. Most take
7 alternatives would reduce exports from the south Delta facilities, limiting entrainment at these
8 facilities, although Nobriga and Cadrett (2001) estimated that less than 1% of juvenile steelhead
9 may have been salvaged at the south Delta export facilities from 1997 to 2000. **Take Alternative F**
10 would restrict the movement of steelhead from the Sacramento River into the interior Delta,
11 resulting in less entrainment and impingement effects at the south Delta diversion facilities.
12 Although the cumulative length of the diversion screens constructed under **Take Alternative F** will
13 be greater than the BDCP Proposed Action, the flow velocities through these screens is expected to
14 be less than through the water intake screens. The large size and swimming ability of juvenile
15 steelhead are expected to limit their vulnerability to entrainment and impingement effects.
16 Therefore, overall take due to entrainment and impingement rates is expected to be comparable
17 under **Take Alternative F** and the BDCP Proposed Action. **Take Alternative E** would eliminate
18 water exports from the south Delta facilities, minimizing potential entrainment, while entrainment
19 at the new north Delta in-water structures would likely be negligible, resulting little difference
20 between the BDCP Proposed Action and the take alternatives (Table 9-18).

21 **Water Quality**

22 Limited water quality effects are expected from operations and the potential differences between
23 the take alternatives would likely be negligible. The limited time that steelhead typically rear in the
24 Delta would also typically minimize differences in water quality effects from the take alternatives
25 (Table 9-18). The one possible exception could be **Take Alternative H**, because of potential water
26 quality degradation from the inundation of the additional restored habitat areas, compared to the
27 other take alternatives.

28 **Flow**

29 Central Valley steelhead would not be substantially affected by decreased migration flows in late
30 winter and spring, which could occur under the conservation strategy (Chapter 5, Section 5.5.6.2.2,
31 *Adverse Effects*). The primary effects of flow on steelhead are changes in flow-related survival in the
32 Sacramento River mainstem downstream of the north Delta intakes, the diversion of smolts into
33 channels leading to the south Delta export facilities, the associated relatively high predation rates in
34 the interior Delta, and as a mechanism to trigger adult upstream spawning migrations (Chapter 5,
35 Section 5.5.6.3.1, *Beneficial Effects*). The BDCP Proposed Action and the take alternatives, which
36 would include changes in flows and tidal area from restoration, generally would reduce the
37 diversion of flow to the south Delta export facilities. Take alternatives with lower exports from the
38 south Delta facilities could have proportionally greater benefits to steelhead (Table 9-13),
39 depending on the extent to which the north Delta export facilities are used. These benefits would
40 include reduced losses of juvenile steelhead from predation in the interior Delta because of more
41 favorable south Delta hydrodynamics (e.g., less percentage of time with reversed flows), and less
42 entrainment and predation at the south Delta export facilities. Operations of the north Delta export
43 facilities also include bypass flow criteria that will be managed in real time to minimize adverse
44 effects of north Delta intake diversions on downstream-migrating salmonids.

1 Less south Delta export operations and the construction and operation of an operable gate at the
2 Head of Old River under CM1 also have the potential to improve through-Delta survival of San
3 Joaquin River steelhead juveniles during migration through the Plan Area by keeping fish and flow
4 in the mainstem San Joaquin River (Chapter 5, Section 5.5.6.3.1, *Beneficial Effects*).

5 With the exception of **Take Alternative F**, all the take alternatives would alter the flow
6 characteristics in the Plan Area by reducing exports from the south Delta and increasing north Delta
7 exports. These changes could provide some benefits, although the magnitude or differences in
8 benefits between take alternatives may be difficult to discern. While **Take Alternative E** would have
9 the most effects on Sacramento River flow below the north Delta intakes (no south Delta exports),
10 the corresponding flow reductions in the Sacramento River could offset potential benefits due to
11 other flow-related survival factors (e.g., greater susceptibility to predation) (Chapter 5, *Effects*
12 *Analysis*).

13 In contrast, **Take Alternative F** would have the least effects on flows downstream of where the
14 north Delta intakes would be located under the other take alternatives. Thus, **Take Alternative F**
15 generally would maintain existing conditions but would block juvenile steelhead from entering the
16 interior Delta and encountering the south Delta intakes, which may reduce overall losses (Table
17 9-18). The modified spring outflows provided by **Take Alternative I** are not expected to
18 substantially improve migration and rearing conditions for juvenile steelhead because of the limited
19 overlap in timing between the species' presence and these higher flows.

20 In addition to potential changes in overall juvenile survival, changes in flows could also affect the
21 upstream migration of adult steelhead by changing attraction flows and olfactory cues during the
22 September to March steelhead upstream migration period, although these changes are not readily
23 quantifiable in terms of take period (Appendix 5.C, *Flow, Passage, Salinity, and Turbidity*). As
24 described in the analysis of San Joaquin River region fall-run Chinook salmon, less reliance on the
25 south Delta export facilities under the BDCP Proposed Action may increase the proportion of water
26 contributed by the San Joaquin River at the Sacramento–San Joaquin River confluence (Chapter 5,
27 Section 5.5.6.3.1, *Beneficial Effects*). San Joaquin River flow during the September to March adult
28 steelhead upstream migration period would be around two to ten times greater under the BDCP
29 Proposed Action than for existing and future conditions without the BDCP. However, the uncertainty
30 in overall effects will be informed by monitoring and targeted research under the BDCP (e.g.,
31 examining migration success of tagged adults under different flow regimes), with any adverse
32 effects being addressed by adaptive management.

33 **Habitat**

34 Habitat restoration activities would benefit rearing steelhead, although this species tends to rear for
35 shorter periods of time in the lower river and Delta than other juvenile salmonids (Chapter 5,
36 Section 5.5.6.3.1, *Beneficial Effects*). Therefore, the potential benefits of habitat enhancement would
37 be limited for steelhead. **Take Alternative H** would have a greater potential to benefit steelhead
38 because it would result in more inundated floodplain and restored tidal and channel margin habitat
39 than the other take alternatives (including the BDCP Proposed Action) (Table 9-18). **Take**
40 **Alternatives D and G** would restore less habitat than the other take alternatives, including the
41 BDCP Proposed Action.

1 **Predation and Competition**

2 Any increases in predation pressure at the proposed north Delta diversions would likely be small, as
 3 these facilities would have gradual shoreline transitions, which would substantially minimize
 4 predator habitat (Chapter 5, Section 5.5.6.3.1, *Beneficial Effects*). The implementation of CM15 may
 5 reduce predation pressure at key locations in the Plan Area. These predator reduction measures
 6 would apply to all the take alternatives, so the differences between most take alternatives would be
 7 small and likely negligible (Table 9-18). Although the differences between the take alternatives
 8 would likely be small, take alternatives with a greater number of in-water structures would
 9 generally have a greater potential to provide additional predator habitat (Table 9-11). **Take**
 10 **Alternative F** would reduce the amount of predator pressure by restricting steelhead access to the
 11 extensive predator habitat in the interior Delta, and **Take Alternative E** would eliminate flow
 12 diversions (and corresponding fish) to the south Delta facilities. While the increased spring flows
 13 provided by a number of the take alternatives could increase the migration speed of juvenile
 14 steelhead, the overall effects on predation rates would likely be small.

15 **Foodweb**

16 Habitat restoration is expected to increase primary productivity, which could cause a corresponding
 17 increase in higher trophic-level prey resources important to steelhead and other juvenile salmonids
 18 (Chapter 5, Section 5.5.6.3.1 *Beneficial Effects*). Take alternatives providing the most habitat
 19 restoration, particularly tidal and inundated floodplain habitat, would have the most potential
 20 benefits on foodweb conditions for steelhead. **Take Alternative H** would have the most potential
 21 benefits and **Take Alternative D** would have the least benefits of the take alternatives. Most other
 22 take alternatives would provide benefits similar to the BDCP Proposed Action (Table 9-18).

23 Habitat restoration is expected to provide the most direct foodweb benefits, but additional flows
 24 provided by meeting high-outflow scenario and/or Fall X2 commitments under most take
 25 alternatives are also likely to provide additional foodweb benefits from increased seasonal
 26 floodplain habitat inundation. The additional spring flows provided by **Take Alternative I** would
 27 also provide more inundation-related foodweb benefits.

28 **Conservation Measures**

29 The conservation measures will benefit Central Valley steelhead by restoring habitat, reducing
 30 predation, controlling invasive aquatic vegetation, and improving migration corridor conditions (see
 31 Chapter 5, Section 5.5.6.3.1, *Beneficial Effects*).

32 **9.4.1.7 Sacramento Splittail**

33 The splittail range includes the Sacramento River upstream to the Red Bluff Diversion Dam and the
 34 San Joaquin River to river mile 135. Juvenile and subadult splittail commonly inhabit regions of the
 35 estuary characterized by salinities of 10 to 18 ppt, while adult splittail can survive salinities up to
 36 29 ppt. Splittail also inhabit a broad range of temperature and dissolved oxygen levels, making them
 37 well suited to slow moving sections of sloughs and rivers. The abundance of juvenile splittail
 38 (young-of-the-year) is highly variable from one year to the next and positively correlated with
 39 hydrologic conditions in the rivers and Delta during the late winter and spring spawning period.
 40 Abundance is also correlated with the magnitude and duration of floodplain inundation
 41 (Sommer et al. 1997). Maintaining and increasing this seasonally inundated floodplain habitat
 42 suitable for splittail spawning and juvenile rearing will help maintain successful reproduction and

1 increase juvenile abundance and genetic diversity during prolonged drought events. Channel margin
 2 and backwater habitats can be critical to the survival of splittail, providing refugia from predatory
 3 fishes and feeding sites as fish grow in upstream regions before and during downstream migration.
 4 The comparison of take alternatives is summarized in Table 9-19.

5 **Table 9-19. Expected Changes in Incidental Take of Sacramento Splittail and Conservation Benefits**
 6 **by Take Alternative, Relative to the BDCP Proposed Action**

Stage	Mechanism of Effect	Take Alternatives								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Construction										
	Underwater sound	+	-	+	-	+	+	○	○	○
	Fish stranding and handling	○	○	○	○	○	+	○	○	○
	Water quality	○	○	○	-	○	+	-	+	○
	Dredging	+	-	+	-	+	+	○	○	○
	Habitat alteration	+	-	+	-	+	+	○	○	○
	Habitat restoration	○	○	○	-	○	○	+	-	○
Maintenance										
	Dredging	+	-	+	-	+	○	○	○	○
	Water quality	○	○	○	○	○	○	○	○	○
	Habitat loss and condition	○	○	○	○	○	○	○	○	○
	Predation and competition	○	○	○	○	○	○	○	○	○
Operations										
	Entrainment and impingement	+	-	+	+	+	○	○	○	○
	Water quality	○	○	○	○	○	○	-	+	○
	Flow	○	○	○	○	○	○	○	○	○ ^a
	Habitat	○	○	○	+	○	○	+	-	○ ^a
	Predation and competition	○	○	○	○	○	-	○	○	○ ^a
	Foodweb	○	○	○	+	○	○	+	-	○ ^a
	Conservation measures	○	○	○	○	○	○	○	○	○
<p>A three-point scale indicates how the level of take or conservation benefit is expected to change compared with the BDCP Proposed Action.</p> <ul style="list-style-type: none"> - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action. <p>Note: ^a While there is no expected change in the level of take, this species is expected to have greater conservation benefit from this take alternative.</p>										

1 **9.4.1.7.1 Construction**

2 Construction would be temporary, localized, and would occur during the approved in-water work
3 window (June through October), which would protect a substantial portion of the splittail
4 population. Although some larval and juvenile splittail may occur in the Plan Area during June and
5 July, most Sacramento splittail would occur downstream of most in-water construction activities.
6 The magnitude of effects would be in proportion to the amount of in-water construction activity,
7 including restoration activities, and would vary according to location.

8 **Underwater Sound**

9 The primary source of underwater sound that could affect Sacramento splittail would be from
10 impact pile driving during construction of the intakes and associated facilities. Such effects would be
11 in proportion to the number and size of the intakes constructed (Table 9-11). Under all take
12 alternatives, sound minimization measures would be used to minimize the risk of incidental take
13 attributable to sound exposure associated with impact pile driving. **Take Alternatives G, H, and I,**
14 and the BDCP Proposed Action, and would have the same amount of take, while the five-intake take
15 alternatives (**Take Alternatives A, C, and E**) would have a greater potential for take from pile
16 driving, and those with fewer or smaller structures (**Take Alternatives B and D**) would have less
17 potential for take (Table 9-19).

18 Similar differences in the number of foundation piles, installed in the cofferdams, would occur. As
19 described above, however, the timing of pile driving, the limited use of the construction areas by
20 some covered species, and the primary use of vibratory pile-driving methods would minimize
21 potential effects. **Take Alternative F** would have two primary diversion screen structures (at
22 Georgiana Slough and the Delta Cross Channel), and a number of operable barriers on various
23 sloughs (Table 9-3). The overall length of in-water structures under **Take Alternative F** would be
24 greater than under the BDCP Proposed Action, and the structures would be widely distributed,
25 resulting in a larger area of exposure to pile driving sound, and thus an increased risk of incidental
26 take.

27 **Fish Stranding and Handling**

28 The potential effects would be low for the take alternatives because splittail are not expected to
29 occur in the construction areas during much of the in-water construction period. As a result, no
30 measureable differences are expected between take alternatives (Table 9-19). However, the
31 increased number and wider distribution of the in-water facilities constructed under **Take**
32 **Alternative F**, is expected to result in greater potential for take of Sacramento splittail than the
33 other take alternatives.

34 **Water Quality**

35 Splittail typically occur downstream of the north Delta construction areas, so the potential for take is
36 limited, and no measurable differences are expected between take alternatives. While habitat
37 restoration activities, particularly for tidal and seasonally inundated habitat restoration, could occur
38 in areas more frequently used by splittail, any associated changes in water quality would be
39 temporary and localized. Additionally, restoration construction can occur during periods when
40 splittail are present, depending on the specific location of the restoration.

41 Take alternatives with the most acres of habitat restoration would have proportionally greater
42 potential for take during restoration activities. These estimates represent the most extreme

1 situation and changes in take would likely be lower because much of this activity would occur in the
2 dry and any in-water work would occur during the approved in-water construction window, when
3 few Sacramento splittail are expected to occur in the Plan Area. **Take Alternative H** would have up
4 to a 15% greater potential for take from tidal natural communities and upland transitional habitat
5 restoration activities, and up to a 100% greater potential for take from seasonally inundated
6 floodplain restoration activities, compared to the BDCP Proposed Action. In contrast, **Take**
7 **Alternatives D and G** would have up to about 61 and 23% less potential for take, respectively, than
8 the BDCP Proposed Action (Table 9-19).

9 **Dredging**

10 The amount of dredging would typically vary proportionally to the number of north Delta facilities
11 constructed, similar to the other construction effects. Dredged areas would be 54 to 68% greater for
12 the five-intake take alternatives (**Take Alternatives A, C, and E**) and 73 to 74% smaller for **Take**
13 **Alternative D** (one intake) (Table 9-11). While **Take Alternative F** would likely require limited
14 dredging associated with the diversion structures, substantial dredging activity associated with
15 channel modifications for through-Delta conveyance would occur in some of the interior Delta
16 sloughs where Sacramento splittail may occur. While the diversion structure would reduce the
17 number of splittail entering the interior Delta from the Sacramento River dredging-related effects
18 could still be somewhat greater for **Take Alternative F** than the BDCP Proposed Action (Table
19 9-19).

20 In addition to the potential for dredging to injure or kill fish that come in contact with the dredge,
21 dredging would result in the loss of benthic and epibenthic organisms, which would affect the
22 localized food resources until the area is recolonized. These effects would also be in proportion to
23 the number of north Delta intakes or diversion structures constructed.

24 **Habitat Alteration**

25 As with other construction activities, the potential for take from the loss or alteration of nearshore
26 habitat would vary by the number and size of the in-water structures and barge landings (Table
27 9-11). However, compared to the amount of habitat available to splittail in the Plan Area and the
28 condition of the lost habitat, the overall potential for take would be limited. Nevertheless, the take
29 alternatives with five intakes (**Take Alternatives A, C, and E**) would have substantially greater (58
30 to 68%) habitat loss while **Take Alternative B** (two intakes) and **Take Alternative D** (one intake)
31 would have less (32 and 74%, respectively) effects than the BDCP Proposed Action, respectively
32 (Table 9-19). **Take Alternative F** would likely result in greater benefits from channel margin
33 restoration because less of the existing shoreline habitat would be affected by the construction of
34 the diversion facilities compared to intakes for the other take alternatives (Table 9-11). However,
35 the overall aquatic habitat effects of **Take Alternative F** are likely to be greater than the BDCP
36 Proposed Action and the other three-intake take alternatives, based on the wide distribution and
37 number of in-water structures constructed within the range of Sacramento splittail habitat, as well
38 as the associated dredging effects.

39 The potential effects of the barge landings on splittail habitat would be similar for most take
40 alternatives (typically six barge landings each) and temporary. However, **Take Alternative A** would
41 have only two landings (67% fewer), and **Take Alternative F** would have one less landing (17%
42 less) compared to the BDCP Proposed Action.

1 **Habitat Restoration**

2 The construction of habitat restoration projects may temporarily disturb or displace covered fish
3 species and their habitat, as well as affect water quality, particularly turbidity, dissolved oxygen, and
4 suspended contaminated sediments. However, most of the restoration activities would be conducted
5 in the dry, and any in-water work would occur during the approved in-water construction window,
6 when few Sacramento splittail are expected to occur in the Plan Area. Some restoration construction
7 could occur during periods when Sacramento splittail may be present, depending on the specific
8 location of the restoration. Any negative effects would be localized, temporary, and infrequent. In
9 addition, Sacramento splittail are tolerant of a wide range of habitat conditions.

10 All of the take alternatives would provide substantially more suitable habitat for splittail through
11 the implementation of conservation measures. While all of these restoration actions would benefit
12 Sacramento splittail, the restoration of inundated floodplain habitat is expected to be the primary
13 source of the benefits for splittail spawning and the rearing of larval and early juvenile life stages.
14 Juveniles also use tidal and channel margin habitat for rearing (Chapter 5, *Effects Analysis*).

15 **Take Alternative H** is expected to have a greater potential for take due to construction activities
16 associated with the increased area of habitat restoration and **Take Alternatives G** and **D** would
17 have a lower potential for take compared to the BDCP Proposed Action, because of the reduced
18 habitat restoration provisions (Table 9-19).

19 **9.4.1.7.2 Maintenance**

20 Potential effects of maintenance activities would be proportional to the number of in-water
21 structures. However, maintenance activities would be temporary and unlikely to have a measurable
22 effect on Sacramento splittail because the species typically occurs downstream of the primary
23 maintenance areas. Any take associated with these activities would likely be local and negligible, and
24 the expected difference in take between take alternatives would likely be relatively small (Table
25 9-19).

26 **Dredging**

27 Some dredging would occur outside of the cofferdams to recontour the substrate adjacent to the
28 intakes (Appendix 5.H, *Aquatic Construction and Maintenance Effects*). The amount of dredging
29 would be proportional to the number and size of in-water facilities. The take alternatives with five
30 intakes (**Take Alternatives A, C, and E**) would require 54 to 68% more maintenance dredging and
31 **Take Alternatives B** (two intakes) and **D** (one intake) would require 32 to 74% less maintenance
32 dredging than the BDCP Proposed Action (Table 9-11).

33 Extensive maintenance dredging for **Take Alternative F** may be required in some of the interior
34 Delta sloughs to maintain sufficient water transport capacity, although it is unknown how frequently
35 maintenance dredging would be required. While the diversion structures would reduce splittail
36 access to some of these dredging areas, it is assumed that dredging effects of **Take Alternative F**
37 could be similar to the BDCP Proposed Action (Table 9-19).

38 Periodic channel maintenance excavation and dredging would also occur in the Yolo Bypass as part
39 of CM2. As splittail are more likely to occur in the bypass, the take alternatives would result in
40 greater potential effects than existing conditions. However, dredging would occur in the dry or
41 during low water, when fewer numbers of fish could be affected.

1 **Water Quality**

2 Dredging would be the primary maintenance activity that could affect water quality. Dredging would
 3 result in temporary increases in turbidity and suspended contaminated sediments, as well as
 4 potential decreases in dissolved oxygen levels. However, these effects would be temporary and
 5 periodic, of relatively limited extent, and would be unlikely to occur at more than one site at a time.
 6 Few Sacramento splittail would likely occur in the areas affected by water quality changes during
 7 the approved in-water maintenance window. Any take associated with these activities would likely
 8 be negligible, and the expected difference in take between take alternatives would likely be small
 9 (Table 9-19).

10 **Habitat Loss and Condition**

11 The removal of substrate during dredging operations would also result in the removal of benthic
 12 and epibenthic organisms, which provide direct or indirect food resources for other aquatic species,
 13 including most of the covered fish species. While older Sacramento splittail can also feed on benthic
 14 organisms, splittail primarily occur downstream of dredging areas, and would be unlikely to be
 15 substantially affected by changes in substrate conditions near the intake sites. Any take associated
 16 with these activities would likely be negligible, and the expected difference in take between take
 17 alternatives would likely be small (Table 9-19).

18 **Predation and Competition**

19 Any effects of maintenance activities on the predation of Sacramento splittail, or competition with
 20 other species, would likely be temporary, infrequent, and localized. Any take associated with these
 21 activities would likely be negligible, and the expected difference in take between take alternatives
 22 would likely be small (Table 9-19).

23 **9.4.1.7.3 Operations**

24 In addition to the diversion of water into the north Delta intakes, operations would include long-
 25 term habitat restoration and enhancement activities, as well as predator reduction and invasive
 26 aquatic vegetation control measures. These effects would be largely beneficial.

27 **Entrainment and Impingement**

28 With regard to the BDCP Proposed Action and all take alternatives, some entrainment and
 29 impingement risks to Sacramento splittail would arise in the north Delta with the addition of intake
 30 structures, compared to existing conditions. While the potential effects of the north Delta in-water
 31 structure would produce local entrainment and impingement sources that many splittail must pass
 32 during emigration to downstream rearing areas, the overall risks would be low because splittail
 33 typically occur downstream of the north Delta sites. Exports from these north Delta facilities under
 34 the BDCP Proposed Action would reduce exports from the existing south Delta facilities, where
 35 greater entrainment and associated predation pressures are expected. This would result in a
 36 reduction in overall splittail losses.

37 All the new intakes or diversion structures would include the state-of-the-art fish screen facilities
 38 designed to meet recommended sweep- and approach-velocity criteria, which would minimize
 39 entrainment and impingement of all covered species and life stages. Potential entrainment and
 40 impingement effects would generally be proportional to the number and total area of intakes and
 41 diversion screens, and the proportion of the mean total project water deliveries exported through

1 the north Delta intakes (Table 9-13). Thus, the BDCP Proposed Action would be similar to **Take**
2 **Alternatives G, H, and I** (each with three new north Delta intakes). **Take Alternatives A, C, and E**
3 would have greater entrainment and impingement potential (each with five intakes), and **Take**
4 **Alternative B** (two intakes) would have a lower potential (Table 9-19). Although **Take Alternative**
5 **D** would also tend have a lower potential, with only one north Delta intake, the increased proportion
6 of south Delta exports would likely result in greater entrainment effects than the BDCP Proposed
7 Action. Although **Take Alternative E** would have a higher potential for entrainment and
8 impingement effects than the BDCP Proposed Action, based on the number and size of intakes, it
9 would also eliminate exports from the south Delta facilities and overall take from entrainment
10 would likely be lower than the BDCP Proposed Action. Entrainment rates are expected to be lower
11 under **Take Alternative F** than the BDCP Proposed Action, but impingement rates and other screen-
12 related effects would likely be greater due to the overall length of the diversion screens and
13 operable gates. Therefore, the overall level of take is expected to be similar for **Take Alternative F**
14 and the BDCP Proposed Action.

15 **Water Quality**

16 Limited water quality effects are expected from operations. The potential differences between take
17 alternatives would likely be negligible and any increases in the exposure of splittail to waterborne
18 contaminants during habitat restoration activities would be temporary. **Take Alternative H** would
19 have the most potential for measurable effects of runoff from restored tidal and inundated habitat,
20 based on the amount of habitat restored. **Take Alternative G** would have slightly less potential,
21 with reduced habitat restoration. However, the exposure to agriculture-related contaminants would
22 likely decline over time because of the removal of these areas from active agricultural production
23 (Appendix 5.D, *Contaminants*). As discussed in Chapter 5, *Effects Analysis*, any population-level
24 effects of contaminant exposure would likely be low (Table 9-19).

25 **Flow**

26 Sacramento splittail would not be appreciably affected by changes in transport flows in late winter
27 and spring, which could occur under the conservation strategy. The primary effects of flow on
28 splittail are related to available floodplain habitat for spawning and early rearing, and probably as a
29 mechanism to trigger adult upstream spawning migrations (Harrell and Sommer 2003). The spring
30 flows provided by the BDCP Proposed Action and most take alternatives could provide some
31 additional spawning habitat to benefit Sacramento splittail, compared to existing conditions.
32 However, the additional spring flows provided by **Take Alternative I** would have a greater
33 potential for such beneficial effects downstream of where the north Delta intakes would be located
34 for the other alternatives.

35 **Habitat**

36 The abundance of splittail populations is determined largely by the availability of inundated
37 floodplain habitat, which is used for spawning and rearing of larvae and young juveniles. Habitat
38 restoration activities would benefit Sacramento splittail (Chapter 5, *Effects Analysis*), resulting in
39 less take. CM2 is expected to substantially increase inundated floodplain habitat for splittail.
40 CM5 would restore up to 10,000 acres of new seasonally inundated floodplain under most take
41 alternatives, and 20,000 acres under **Take Alternative H** (Table 9-6). Implementation of CM4
42 would also restore substantial areas of intertidal and subtidal natural communities (55,000 acres),
43 plus up to 10,000 acres of transitional uplands to accommodate sea level rise (65,000 total acres).
44 These restoration actions would provide similar levels of habitat for juvenile and adult splittail

1 under most take alternatives, except for 15% (10,000 acres) more (75,000 total acres) under **Take**
2 **Alternative H** (i.e., 63,000 tidal and 12,000 transitional acres), but 38% (40,000 acres) less for
3 **Take Alternative D** (i.e., 34,000 tidal and 6,000 transitional), and 61% (25,000 acres) less under
4 **Take Alternative G** (21,000 tidal and 4,000 transitional acres). CM6 would restore and enhance 20
5 miles of channel margin in the Delta (40 miles under **Take Alternative H**), primarily benefitting
6 juvenile and adult splittail during their migrations. These measures also would increase food
7 resources for local consumption and potential export of surpluses to the Delta.

8 Overall, **Take Alternative H** would restore more habitat and **Take Alternatives D** and **G** would
9 restore less habitat than the BDCP Proposed Action. **Take Alternative I** would provide greater
10 flows in the spring, during above-normal flow years, potentially providing additional spawning and
11 early rearing habitat for Sacramento splittail, compared to the BDCP Proposed Action and other take
12 alternatives (Table 9-19).

13 **Predation and Competition**

14 Any increases in predation pressure at the north Delta diversions would likely be small, as these
15 structures are located upstream of areas typically occupied by splittail, although many must pass the
16 intakes during emigration to downstream rearing areas. The implementation of CM15 may reduce
17 predation pressure at key locations in the Plan Area. Implementation of CM2 would increase rearing
18 habitat in the Yolo Bypass, where predation pressures are expected to be lower than the interior
19 Delta, thereby potentially improving survival rates of Sacramento splittail. Take Alternative F would
20 result in reduced predation losses by restricting fish access to interior Delta channels that
21 experience high current predation rates. **Take Alternative I** would provide greater flows in some
22 years, which is also expected to increase the use of the Yolo Bypass by Sacramento splittail. Habitat
23 restoration activities are also expected to improve habitat conditions for splittail. Therefore, the
24 differences between the other take alternatives would be negligible due to the reduced habitat
25 restoration activities (Table 9-19).

26 **Foodweb**

27 Habitat restoration is expected to increase primary productivity and a corresponding increase in
28 higher trophic-level prey resources important to larval and juvenile splittail. The production of
29 organic carbon, phytoplankton, and zooplankton in tidal marsh and inundated floodplain habitats is
30 an important factor influencing the foodweb of these pelagic life stages. Restored seasonally
31 inundated floodplain habitat also provides larval and early juvenile rearing habitat. These early life
32 stages grow at an accelerated rate in the warm and food-rich floodplain environment (Moyle et al.
33 2004). However, without detailed information on the habitat requirements of these food resource
34 species, the expected benefits of the BDCP Proposed Action on splittail food resources are assumed
35 to be proportional to the amount of floodplain habitat restored.

36 Changes in the abundance and species composition of zooplankton in the Delta have coincided with
37 the invasion of the nonnative *Potamocorbula*, which consumes phytoplankton and zooplankton
38 (Baxter et al. 2010; Winder and Jassby 2011). The reduction of *Neomysis*, which competes with
39 *Potamocorbula* for phytoplankton, may have caused reduced growth rates and fecundity of splittail
40 (Moyle et al. 2004; Feyrer and Baxter 1998), but there is no evidence of reduced abundance
41 (Kimmerer 2002).

42 Take alternatives providing the most habitat restoration, particularly tidal and inundated floodplain
43 habitat, would have the most potential benefits on foodweb conditions for splittail (Table 9-6). **Take**

1 **Alternative H** would have the most potential benefits and **Take Alternatives D** and **G** would have
 2 the least benefits (Table 9-19). While most other take alternatives would likely provide similar
 3 benefits as the BDCP Proposed Action, the increased flows provided under **Take Alternative I**
 4 would provide increased habitat inundation to potentially benefit primary productivity in the Delta,
 5 and the prey resources for Sacramento splittail.

6 **Conservation Measures**

7 The conservation measures will benefit Sacramento splittail by restoring habitat, reducing
 8 predation, and controlling invasive aquatic vegetation. The loss of tidal wetlands in the Delta is the
 9 most obvious and pervasive change that has occurred as a result of development (Kimmerer 2004;
 10 Reed et al. 2007), and CM4 will require substantial restoration of intertidal habitat to support
 11 Sacramento splittail and other covered fish species. Except for the differences identified above,
 12 under *Habitat*, there would be no difference in the beneficial effects between the different take
 13 alternatives (Table 9-19).

14 **9.4.1.8 Green and White Sturgeon**

15 The Plan Area provides migratory corridors, feeding areas, and juvenile rearing habitat for green
 16 and white sturgeon. Adult green sturgeon migrate upstream primarily through the western edge of
 17 the Delta into the lower Sacramento River between March and June (Adams et al. 2002), although
 18 post-spawning adults also occur in the lower river through December. White sturgeon migrate into
 19 the Delta and lower Sacramento River during the late fall and winter, but also occur in these areas
 20 throughout the year. Larval and post-larval sturgeon are present in the lower Sacramento and north
 21 Delta between May and October, primarily in June and July (California Department of Fish and Game
 22 2002). Juvenile sturgeon have been captured in the Delta during all months of the year (Borthwick
 23 et al. 1999; California Department of Fish and Game 2002). The comparison of take alternatives is
 24 summarized in Table 9-20.

25 **9.4.1.8.1 Construction**

26 Construction at the north Delta intakes, fish diversion structures, restoration sites, conservation
 27 hatcheries, and nonphysical barriers may result in a number of adverse effects on green and white
 28 sturgeon and other covered species, including disturbance from in-water construction activity and
 29 hydrodynamic changes, physical injury from pile-driving sound and vibration levels, exposure to
 30 contaminants, and elevated turbidity levels.

31 Although the potential for construction effects at the north Delta intakes is expected to be
 32 proportional to the number of intakes and total area of intake screen, Construction activities would
 33 be temporary and localized, and would occur mostly in dewatered cofferdams. Some habitat
 34 restoration and nonphysical barrier construction would occur in areas occasionally occupied by
 35 sturgeon. These construction activities are expected to be short-term, temporary, and generally
 36 similar for all take alternatives.

37 Construction at the restoration sites, conservation hatcheries, and the nonphysical barriers would
 38 result in potential effects of short-term and temporary increases in turbidity, exposure to
 39 methylmercury, accidental spills, disturbance of contaminated sediments, construction-related
 40 disturbance, and predation. For the most part, these activities can be located in areas that avoid or
 41 minimize effects on sensitive habitats. However, these effects would be similar for most of the take
 42 alternatives, as the type and location of the restoration actions will likely be similar. The magnitude

1 of effects will vary somewhat based on the overall amount of restoration provided by the various
 2 take alternatives, and, as a result, some of the restoration locations would differ.

3 **Table 9-20. Expected Changes in Incidental Take of White and Green Sturgeon and Conservation**
 4 **Benefits by Take Alternative, Relative to the BDCP Proposed Action**

Stage	Mechanism of Effect	Take Alternatives								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Construction										
	Underwater sound	+	-	+	-	+	+	○	○	○
	Fish stranding and handling	+	-	+	-	+	+	○	○	○
	Water quality	○	○	○	○	○	+	-	○	○
	Dredging	+	-	+	-	+	+	○	○	○
	Habitat alteration	+	-	+	-	+	+	○	○	○
	Habitat restoration	○	○	○	-	○	○	-	+	○
Maintenance										
	Dredging	+	-	+	-	+	○	○	○	○
	Water quality	○	○	○	○	○	○	○	○	○
	Habitat loss and condition	+	-	+	-	+	+	○	○	○
	Predation and competition	○	○	○	○	○	○	○	○	○
Operations										
	Entrainment and impingement	+	+	+	+	-	-	○	○	○ ^a
	Water quality	○	○	○	○	○	○	○	○	○
	Flow	○	○	○	-	○	-	○	○	○ ^a
	Habitat	○	○	○	+	○	○	○	-	○
	Predation and competition	○	○	○	○	○	-	○	○	○
	Foodweb	○	○	○	+	○	○	+	-	○ ^a
	Conservation measures	○	○	○	○	○	○	○	○	○
<p>A three-point scale indicates how the level of take or conservation benefit is expected to change compared with the BDCP Proposed Action.</p> <ul style="list-style-type: none"> - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action. <p>Note: ^a While there is no expected change in the level of take, this species is expected to have greater conservation benefit from this take alternative.</p>										

1 Underwater Sound

2 The primary source of underwater sound that could affect sturgeon would be from impact pile
3 driving. Such effects would be in proportion to the number and size of the intakes constructed
4 (Table 9-12). The five-intake take alternatives (**Take Alternatives A, C, and E**) would have a greater
5 potential for take from pile driving than the BDCP Proposed Action, and the other three-intake
6 alternatives (**Take Alternatives G, H, and I**) (Table 9-20). **Take Alternatives B and D** would have
7 less potential for take because of the fewer intakes constructed, compared with the BDCP Proposed
8 Action. Unlike most other covered species, sturgeon are expected to occur near the construction
9 areas, during the in-water work window, and would be affected by pile-driving activities required to
10 install the cofferdams, the intake foundation piles and barge landing piles. However, all take
11 alternatives would include the implementation of sound minimization measures to minimize the
12 risk of incidental take attributable to sound exposure associated with impact pile driving.

13 **Take Alternative F** would have two primary diversion screen structures, at Georgiana Slough and
14 the Delta Cross Channel, and a number of operable barriers on various sloughs (Table 9-3). The
15 overall length of in-water structures would likely be greater than the other alternatives, although
16 the structures would be smaller overall, likely resulting in less pile driving. However, the structures
17 would be widely distributed, resulting in a larger area of potential exposure to pile driving sound,
18 and thus an increased risk of incidental take due to pile driving.

19 Fish Stranding and Handling

20 As with other construction activities, the potential for take resulting from stranding green and white
21 sturgeon and other covered fish species within cofferdam structures, and the handling associated
22 with their subsequent rescue and removal would be proportional to the number and size of in-water
23 structures built. However, potential effects on green and white sturgeon in the vicinity of the north
24 Delta intakes are expected to be limited based on their low probability of occurrence in the area
25 during the in-water construction period (Chapter 5, *Effects Analysis*). The take alternatives with the
26 most intakes (**Take Alternatives A, C, and E**) would have a greater potential for stranding both
27 adult and juvenile sturgeon than the BDCP Proposed Action (Table 9-20). **Take Alternatives B and**
28 **D** would have less potential to strand fish. These activities would typically occur only once at each
29 site during the construction phase, so the overall effects would be limited, and no substantial
30 differences between take alternatives with new north Delta intakes are expected. The diversion
31 structures built under **Take Alternative F** have a smaller footprint, but the structures are more
32 numerous and more widely distributed; thus this construction would likely result in greater
33 stranding and handling effects than work at the north Delta intakes under the other take
34 alternatives.

35 Water Quality

36 The implementation of appropriate construction best management practices, as described in
37 Appendix 3.C, *Avoidance and Minimization Measures*, would minimize the potential take of green and
38 white sturgeon and other covered species resulting from changes in water quality. The expected
39 limited occurrence of sturgeon in the project construction areas, and the isolation of most
40 construction activities within the cofferdams, would also minimize the potential for effects. As a
41 result, no measurable differences are expected between take alternatives (Table 9-20). **Take**
42 **Alternative F** however, includes a greater number of new in-water structures built over a wider
43 range of the Delta, and thus has greater potential for water quality changes to affect sturgeon.

1 The primary activity that could affect water quality in the construction area is dredging, which is
2 discussed below. Dredging effects would include increased turbidity, potential suspension of
3 contaminated sediments, and decreased dissolved oxygen levels (Appendix 5.D, *Contaminants*). The
4 potential effects would generally vary with the number of in-water structures built, as described
5 below.

6 **Dredging**

7 As a predominantly benthic species, sturgeon are particularly susceptible to injury or mortality from
8 direct contact with dredging equipment (Boysen and Hoover 2009). Buell (1992) reported
9 approximately 2,000 sturgeon entrained in the removal of 1 million tons of sand from the bottom of
10 the Columbia River at depths of 60 to 80 feet (18 to 24 meters). Dredging operations can also result
11 in the resuspension of toxics such as ammonia, hydrogen sulfide, and copper as a result of both
12 dredging and dredge spoil disposal (National Marine Fisheries Service 2006). These risks are
13 expected to be proportional to the amount of dredging required during construction. Dredged areas
14 would be 54 to 68% greater for the five-intake take alternatives (**Take Alternatives A, C, and E**)
15 than the BDCP Proposed Action, while up to about 73% fewer acres of dredging would be expected
16 for **Take Alternatives B and D**. As with other effects, **Take Alternatives G, H, and I**, would be
17 similar to the BDCP Proposed Action. Similar acreages would also be dredged periodically for
18 maintenance purposes.

19 While **Take Alternative F** would likely require limited dredging associated with the diversion
20 structures, dredging activity would occur in some of the sloughs, to increase their flow capacity and
21 extend their length to redirect flows or fish. Although the diversion structure would restrict access
22 to the interior Delta, sturgeon are still likely to occur in the dredging areas because of their extended
23 rearing phase in the Delta. Thus, dredging effects would likely be greater for **Take Alternative F**
24 than the BDCP Proposed Action (Table 9-20).

25 Periodic channel excavation and dredging would also occur in the Yolo Bypass, to enhance the
26 habitat and reduce stranding, as part of CM2. While most take alternatives would result in greater
27 potential effects, this dredging would occur during low water when few sturgeon are expected to
28 occur in the area.

29 **Habitat Alteration**

30 As with other construction activities, the potential for take from the loss or alteration of nearshore
31 habitat would vary by the number and size of in-water structures built and the number of barge
32 landings needed. While the extent that sturgeon use the nearshore habitat in the lower river and
33 Delta is unknown, some effects would be expected. However, compared to the amount of habitat
34 available to green and white sturgeon in the Plan Area, the condition of the lost habitat, and the
35 overall limited use (migration pathway) of the affected habitat by green and white sturgeon, the
36 overall potential for take would be limited. Nevertheless, the take alternatives with five intakes
37 (**Take Alternatives A, C, and E**) would have substantially greater (58 to 68%) habitat losses,
38 compared to the BDCP Proposed Action, while **Take Alternatives B and D** would have 32 and 74%
39 less habitat loss than the BDCP Proposed Action, respectively (Table 9-6). As with other effects,
40 **Take Alternatives G, H, and I**, would be similar to the BDCP Proposed Action. **Take Alternative F**
41 would likely affect less nearshore habitat than other take alternatives, but the overall aquatic habitat
42 effects are likely to be greater than the BDCP Proposed Action and the other three-intake take
43 alternatives, based on as greater number and wider distribution of the in-water structures, as well
44 as the associated dredging.

1 The potential effects of the barge landings on green and white sturgeon habitat would be similar for
2 most take alternatives (typically six barge landings each) and temporary. However, **Take**
3 **Alternative A** would have only two landings (67% less than the BDCP Proposed Action), and **Take**
4 **Alternative F** would have one less landing (17% less) compared to the BDCP Proposed Action.

5 **Habitat Restoration**

6 The construction of habitat restoration projects may temporarily affect water quality, particularly
7 turbidity, dissolved oxygen, and suspended contaminated sediments (Appendix 5.E, *Habitat*
8 *Restoration*). However, most of the restoration construction activities would be conducted in the
9 dry, and any in-water work would occur during the approved in-water construction window
10 (typically June 1 through October 31), However, some restoration construction could occur during
11 periods when sturgeon may be present, depending on the specific location of the restoration. Any
12 potential effects would be localized, temporary, and infrequent. However, restoration activities are
13 predicted to increase methylmercury production, potentially increasing its accumulation in
14 sturgeon tissue, although still at levels lower than those expected to elicit adverse effects
15 (Appendix 5.D, *Contaminants*). Despite regular consumption of *Potamocorbula*, sturgeon are not
16 likely to be affected by increased selenium levels because of localized, temporary and infrequent
17 mobilization of selenium laden sediments. Localized and short-term increases in copper and
18 pesticide (pyrethroids, organophosphate pesticides, and organochlorine pesticides) concentrations
19 are predicted near ROAs, although these increases are not expected to result in increased effects on
20 sturgeon because of their ephemeral and localized nature. In addition, the take alternatives would
21 not measurably alter ammonia concentrations or the corresponding effects on sturgeon.

22 There would be limited differences in amount of restoration construction activity between the BDCP
23 Proposed Action and most of the take alternatives. The exceptions would be about 61 and 23%
24 fewer acres of tidal habitat restored under **Take Alternatives D** and **G**, respectively, and 15% more
25 tidal habitat restored under **Take Alternative H**, compared with the BDCP Proposed Action. **Take**
26 **Alternative H** would also result in 100% more seasonally inundated floodplain acreage (from
27 10,000 to 20,000 acres), and 100% more channel margin enhancement area (from 10 to 20 linear
28 miles). Overall, the differences in the amount of habitat restored are not expected to substantially
29 affect the take of green and white sturgeon, but would likely result in substantial differences in the
30 long-term benefits to the species. For example, tidal natural communities restoration under CM4
31 will considerably increase the amount of potentially suitable green and white sturgeon juvenile and
32 adult foraging area. These areas include the Cache Slough ROA but also in the West Delta and Suisun
33 Marsh ROAs.

34 **9.4.1.8.2 Maintenance**

35 As with initial construction activities, the potential for take resulting from maintenance activities
36 would be proportional to the number of in-water structures. However, maintenance activities would
37 be temporary, localized, and infrequent. Sturgeon would occur in the areas affected by the in-water
38 maintenance activities during the typical in-water construction window, and would be susceptible
39 to effects from these maintenance activities, particularly dredging. A number of measures would
40 minimize effects (Appendix 3.C, *Avoidance and Minimization Measures*), including timing of in-water
41 work. As a result, there would be minimal effect of take from these activities. The maintenance
42 activity most likely to affect aquatic species is dredging to maintain appropriate hydrodynamics at
43 the intakes, and to minimize the amount of sediment entering the intake.

1 **Dredging**

2 As indicated above, dredging would be required to maintain the efficiency of the intakes. This
3 maintenance dredging would occur relatively infrequently, typically during the approved in-water
4 work windows, and would be unlikely to occur at more than one intake at any one time. However,
5 maintenance dredging would occur more often for take alternatives with five intakes, and less with
6 **Take Alternatives B and D** with fewer intakes. Maintenance dredging for **Take Alternative F**
7 would be similar to existing conditions at the south Delta facilities, although extensive maintenance
8 dredging may be required in some of the interior Delta sloughs to maintain sufficient water
9 transport capacity. While it is unknown how frequently any maintenance dredging would be
10 required to maintain these flow routes, it is assumed that dredging effects of **Take Alternative F**
11 would be similar to the BDCP Proposed Action.

12 Dredging can result in take through a number of mechanisms, including physical injury or mortality
13 and habitat alterations. The habitat alterations would include the removal of substrate-based food
14 resources and changes in water quality, although such effects would typically be localized,
15 temporary, and infrequent. Dredging in the interior Delta could affect sturgeon more than most of
16 the other covered species, because sturgeon rear in the Delta for years and could access the
17 dredging areas from channels other than the Delta Cross Channel or Georgiana Slough. Most of the
18 other covered species pass through the north Delta relatively quickly, allowing greater effectiveness
19 of the fish diversion structures.

20 The implementation of CM2 would also require periodic maintenance excavation and dredging to
21 maintain a deepwater fish passage channel through the bypass. Although migrating sturgeon could
22 benefit from this deep channel, they would also be subject to effects from this periodic dredging. As
23 a result, there would be a negligible difference between the take alternatives (Table 9-20).

24 **Water Quality**

25 Dredging and other maintenance activities could result in temporary changes in water quality, as
26 described above under construction effects. However, these effects would be temporary, periodic,
27 and of limited extent. Dredging would result in temporary increases in turbidity and potential
28 suspended contaminated sediments, as well as potential decreases in dissolved oxygen levels.
29 However, these effects would be temporary and periodic, and would be unlikely to occur at more
30 than one site at a time. Therefore, differences between most take alternatives would likely be
31 negligible (Table 9-20).

32 **Habitat Loss and Condition**

33 The removal of substrate during dredging operations would result in the removal of benthic and
34 epibenthic organisms, which provide direct or indirect food effects on sturgeon. As benthic-oriented
35 fish, sturgeon would be affected by the loss or alteration of substrate habitat. These effects would be
36 proportional to the number and size of the in-water facilities and their requirements for periodic
37 maintenance dredging (Table 9-11). Any take associated with these activities would likely be
38 negligible, and the expected difference in take between take alternatives would likely be small, but
39 roughly based on the number of intakes constructed (Table 9-20).

40 **Predation and Competition**

41 Any effects of maintenance activities on the predation of sturgeon would likely be negligible.
42 Maintenance activities would only occur periodically and sturgeon are generally not susceptible to

1 substantial predation pressure after they develop their scutes and armoring as juveniles. Any
2 predation-related take associated with these activities would likely be negligible, as would any
3 differences between take alternatives (Table 9-20).

4 **9.4.1.8.3 Operations**

5 In addition to the diversion of water through the proposed north Delta intakes, operations include
6 conservation measures involving long-term habitat restoration and enhancement activities, as well
7 as predator reduction, improved passage, and invasive aquatic vegetation control measures. These
8 effects would be largely beneficial to sturgeon.

9 Entrainment and impingement represent the primary mechanisms for take of early life stages of
10 green and white sturgeon. Other potential mechanisms for take would include changes in water
11 quality, changes in flow management, alteration (restoration) of habitat, changes to predator habitat
12 or predator numbers, alteration of competitive interactions with other species, and the long-term
13 implementation of other conservation measures.

14 **Entrainment and Impingement**

15 All the take alternatives would include fish screens designed to meet CDFW-recommended delta
16 smelt sweep- to approach-velocity ratios, while minimizing the overall size of the intakes. These
17 design criteria will minimize entrainment and impingement of early life stages of green and white
18 sturgeon. Monitoring programs will be implemented to confirm their effectiveness, and adaptive
19 management procedures will correct unforeseen deficiencies in the screening system. However,
20 there would be some differences in effectiveness between intakes, based on specific characteristics
21 at the various intake sites, as discussed above for delta smelt. As a result, a take alternative with a
22 greater number of intakes would typically have a greater overall incidence of entrainment or
23 impingement (Appendix 5.B, *Entrainment*).

24 In addition to the number and location of the proposed north Delta intakes, the take alternatives
25 also vary in the use of the existing south Delta facilities. With the exception of **Take Alternative E**,
26 which would have no south Delta diversions, all the other take alternatives include some continued
27 use of the south Delta facilities. Fish losses from entrainment and predation would be greater at the
28 south Delta facilities than the north Delta facilities, so the benefits of the take alternatives would
29 vary with the proportion of the mean total project water deliveries provided through the south Delta
30 facilities (Table 9-20).

31 Some entrainment and impingement of early life history stages of green and white sturgeon may
32 occur at the proposed north Delta diversions, but the overall risks would be relatively low because
33 of the low approach velocities, high sweep velocities, benthic nature and swimming ability of green
34 and white sturgeon. While early life stages (eggs and larvae) of white sturgeon have some potential
35 to occur within the area, green sturgeon eggs and larvae are typically not present (Appendix 2.A,
36 *Covered Species Accounts*). Should sturgeon larvae occur in the area during the spring, they would be
37 susceptible to increased impingement and entrainment risks (Israel and Klimley 2008).

38 Juvenile sturgeon entrainment risk is expected to be substantially reduced under the BDCP
39 Proposed Action as a result of reductions in exports at south Delta pumps (Appendix 5.B,
40 *Entrainment*). However, entrainment reductions would be substantially greater (42 to 58%) during
41 wetter (above- normal) water years, compared to below-normal water years (7 to 13%). As with the
42 construction effects, the potential for entrainment and impingement effects is expected to be

1 proportional to the number of intakes and total area of intake screen (Table 9-12). The BDCP
2 Proposed Action would have three new north Delta intakes (Intakes 2, 3, and 5), with a total screen
3 length of about 4,400 feet, which is the same as **Take Alternatives G, H, and I**. By comparison, **Take**
4 **Alternatives A, C, and E** would have greater potential for entrainment and impingement, because
5 they each would have five intakes, with a total screen length between 54 and 66% greater than the
6 BDCP Proposed Action. **Take Alternative B** would have two intakes, with about 34% less overall
7 screen length than the BDCP Proposed Action, while the one intake for **Take Alternative D** would
8 have a screen length about 75% shorter than the BDCP Proposed Action.

9 **Take Alternative F** would limit the number of fish encountering the south Delta pumping facility
10 screens by blocking their access to the Delta Cross Channel and Georgiana Slough. The cumulative
11 length of the diversion screens constructed under **Take Alternative F** will be greater than the BDCP
12 Proposed Action, although flow velocities through these screens are expected to be lower than
13 through the proposed north Delta water intake screens. Therefore, entrainment rates are expected
14 to be less under **Take Alternative F** than the BDCP Proposed Action. Conversely, due to the longer
15 overall diversion screens, impingement and related effects would likely be greater than under the
16 BDCP Proposed Action; however, sturgeon are not expected to be particularly vulnerable to these
17 effects. Therefore, the entrainment and impingement rates are expected to be lower under **Take**
18 **Alternative F** than the BDCP Proposed Action (Table 9-12).

19 **Take Alternative I** would provide increased Delta outflows during the spring in wet and above
20 normal water years, which would further improve this velocity ratio and potentially further
21 reducing entrainment and impingement rates. During some water years, exports from the north and
22 south Delta facilities would also be reduced to help meet the spring outflow target level, reducing
23 entrainment and impingement potential under **Take Alternative I**. Spring entrainment of juvenile
24 green and white sturgeon at the south Delta export facilities would be less because the greater Delta
25 outflow would result in less south Delta exports, which would result in less hydrodynamic influence
26 of the south Delta export facilities in reversing net flows in Old and Middle Rivers (Appendix 5.B,
27 *Entrainment*, Section 5.B.6.1.5.1, *Larva/Juvenile [Proportional Entrainment Loss Regression]*).
28 Therefore, **Take Alternative I** would likely result in lower entrainment and impingement rates of
29 juvenile green and white sturgeon compared to the BDCP Proposed Action, despite having the same
30 water export facilities and reduced late summer and fall flows (Table 9-20).

31 **Water Quality**

32 Effects from restored habitat areas, associated with CM4, CM5, CM6, and CM7 may result in
33 substantial changes in water quality (Appendix 5.E, *Habitat Restoration*). Such changes would
34 include increases in turbidity, temperature and contaminant levels, from the inundation of restored
35 floodplain and tidal habitat area. Sturgeon are not susceptible to turbidity changes like Delta smelt
36 and the changes in contaminants is not expected to show acute or chronic exposure effects
37 (Appendix 5.D, *Contaminants*).

38 While the take alternatives that provide the most habitat restoration could cause greater changes in
39 corresponding water quality, they are also expected to provide offsetting benefits, by increasing the
40 quantity and value of available habitat. As a result, changes in water quality resulting from the
41 various take alternatives are not expected to differentially affect green and white sturgeon, except
42 for potential effects from increased water temperatures in the late summer and fall under Take
43 Alternative I, due to changes in upstream reservoir operations (Table 9-20).

1 **Flow**

2 The reproductive success of white sturgeon is greatest in wet and above-normal water years when
3 spring flows are high, and may be the single most significant factor for white sturgeon year class
4 recruitment (Kohlhorst et al. 1991; Fish 2010). Increased spring flows may also provide similar
5 benefits for green sturgeon. Although the mechanism is unknown, it is hypothesized that higher
6 flows provide increased freshwater rearing habitat, increase spawning activity cued by higher
7 upstream flows, increase nutrient loading into nursing areas, help disperse young sturgeon
8 downstream, or increase downstream migration rate and survival through reduced exposure time to
9 predators (U.S. Fish and Wildlife Service 1995).

10 The BDCP Proposed Action, and most of the take alternatives would substantially increase spring
11 flows in the Feather River, potentially resulting in beneficial effects to sturgeon (Table 9-20). All
12 take alternatives include higher outflows, while the BDCP Proposed Action includes a decision tree
13 that may result in moderately higher or lower outflow (i.e., low-outflow scenario and high-outflow
14 scenario) than existing conditions. **Take Alternative I** would provide the highest spring flow rates
15 throughout the sturgeon range, in some water year types, and could result in greater benefits to
16 sturgeon than the other take alternatives. However, the BDCP Proposed Action and the take
17 alternatives will change the relationship between Sacramento River inflow, Feather River inflow,
18 and Delta outflow, resulting in uncertainty about the effects of outflow and upstream flow changes
19 may have on sturgeon year class strength. All of the take alternatives reduce Feather River summer
20 flow, and although instream flow and temperature criteria are met at the fish barrier, they are
21 exceeded at Honcut June through September. Adaptive management under the BDCP Proposed
22 Action would also be used to make adjustments to meet the biological goals and objectives, if
23 needed.

24 **Habitat**

25 Habitat restoration activities associated with the conservation measures would benefit sturgeon,
26 which extensively rear in the lower river and Delta. **Take Alternative H** would have the most
27 potential to benefit sturgeon, because it would substantially increase inundated floodplain and
28 restored tidal and channel margin habitat, compared to the other take alternatives. **Take**
29 **Alternatives D and G** would restore less habitat than the BDCP Proposed Action, and other take
30 alternatives (Table 9-6).

31 **Predation and Competition**

32 Although predation is a natural part of aquatic community dynamics, excessive predation has been
33 identified as a stressor for covered fish species, especially delta smelt (Baxter et al. 2008). Predators
34 are believed to aggregate in areas around intake screens (Vogel 2008), and the number of predators
35 is expected to be proportional to the size (length) of the screen facility (Table 9-12). Therefore, the
36 five-intake take alternatives (**Take Alternatives A, C, and E**) would provide the most potential
37 predator habitat, compared to the take alternatives with smaller footprints. However, as described
38 above for entrainment and impingement, other site characteristics (water velocities, water depth,
39 and cover habitat) are important variables affecting predation and competition.

40 While in-water and overwater structures can provide habitat for juvenile green and white sturgeon
41 predators, the amount of such habitat produced, compared to the overall availability of predator
42 habitat in the Plan Area, would be small. In addition, juvenile green and white sturgeon generally
43 occur in deeper channel habitats, are not typically associated with structures, and are generally less

1 vulnerable to predation. Therefore, the potential differences in predation risks between take
 2 alternatives would likely be negligible (Table 9-20).

3 Water operations under CM1 would change the proportions of green and white sturgeon entrained
 4 at the south Delta export facilities, which in turn would affect their exposure to predation. **Take**
 5 **Alternative F** would result in the fewest fish diverted to the interior Delta and the lowest predation
 6 levels, as fish would be prevented from entering the Delta Cross Channel or Georgiana Slough. While
 7 the other take alternatives would change the amount of water, and presumably a similar proportion
 8 of fish diverted to the interior Delta, they would not prevent fish from entering these areas. The five-
 9 intake take alternatives (**Take Alternatives A, C, and E**) would result in a lower proportion of water
 10 (and fish) diverted to the south Delta facilities, compared to the take alternatives with fewer intakes,
 11 and would likely result in fewer fish exposed to the predators along this route (Table 9-20).
 12 However, lower flows through the interior Delta would increase the travel time for fish passing
 13 through this route, likely exposing them to greater predation risks and reducing their survival rates.

14 **Take Alternative I** would increase the spring outflows in most years, which could result in
 15 measurable survival benefits as shown by highest year classes of sturgeon associated with high
 16 outflows (Fish 2010).

17 **Foodweb**

18 Tidal natural communities restoration would substantially increase the amount of tidal habitat in
 19 the Plan Area, mostly in the Cache Slough and Suisun Marsh subregions, substantially increasing
 20 suitable habitat for green and white sturgeon, and could potentially increasing food for local
 21 consumption and export to open-estuary areas. Habitat restoration is expected to increase primary
 22 productivity, which could result in a corresponding increase in higher trophic level prey resources
 23 important to green and white sturgeon, although this relationship is not quantified and may only
 24 apply to certain portions of restored habitat (i.e. subtidal).

25 Take alternatives providing the most habitat restoration, particularly tidal and inundated floodplain
 26 habitat, would have potential benefits to foodweb conditions for sturgeon. **Take Alternative H**
 27 would have the most potential benefits, and **Take Alternative D** and **G** would have the least
 28 benefits. Most other take alternatives would provide similar benefits as the BDCP Proposed Action
 29 (Table 9-20).

30 While habitat restoration is expected to provide the most direct foodweb benefits, due to the
 31 increased habitat compared to existing conditions. Additional flows provided by meeting high-
 32 outflow scenario and/or Fall X2 commitments under most take alternatives are also likely to
 33 provide additional foodweb benefits from increased seasonal floodplain habitat inundation. The
 34 additional spring flows provided by **Take Alternative I**, would also provide some additional
 35 inundation-related foodweb benefits.

36 **Conservation Measures**

37 The conservation measures will benefit white and green sturgeon by restoring habitat, reducing
 38 predation, improving migratory corridor conditions, and controlling invasive aquatic vegetation.
 39 Increased food availability in the Delta as a result of habitat restoration will increase the size and,
 40 therefore, fecundity of adult spawners. Overall, the BDCP Proposed Action would provide small
 41 population-level benefits to both white and green sturgeon (Table 9-20). The positive effects of the
 42 BDCP Proposed Action on illegal harvest, habitat restoration, food production, passage, entrainment
 43 in the south Delta, increased spring flows in the Feather River, and predation are expected to

1 provide meaningful benefits for sturgeon. Adaptive management under the BDCP Proposed Action
 2 will ensure adequate outflows for surgeon and therefore, take alternatives are assumed to be equal
 3 relative to this potential effect.

4 **9.4.1.9 Pacific and River Lamprey**

5 While little is known about the occurrence of lamprey in the Sacramento and San Joaquin River
 6 systems, individual adult Pacific and river lamprey are expected to occur in the Plan Area during the
 7 spring and early summer. While Pacific lamprey ammocoetes and macrophthalmia could occur in the
 8 area during the spring and early summer, similar river lamprey life stages likely occur through the
 9 spring and summer (Beamish 1980). Adult lamprey are expected to pass through the Plan Area on
 10 their way toward upstream spawning grounds primarily between March and June. The extent to
 11 which Pacific lamprey use the Plan Area for purposes other than a migration corridor is not known.
 12 The comparison of take alternatives is summarized in Table 9-21.

13 **Table 9-21. Expected Changes in Incidental Take of Pacific and River Lamprey and Conservation**
 14 **Benefits by Take Alternative, Relative to the BDCP Proposed Action**

Stage	Mechanism of Effect	Take Alternatives								
		A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified spring Outflow
Construction										
	Underwater sound	+	-	+	-	+	+	○	○	○
	Fish stranding and handling	+	-	+	-	+	+	○	○	○
	Water quality	+	○	+	-	+	+	-	+	○
	Dredging	+	-	+	-	+	+	○	○	○
	Habitat alteration	+	-	+	-	+	+	○	○	○
	Habitat restoration	○	○	○	-	○	○	-	+	○
Maintenance										
	Dredging	+	-	+	-	+	+	○	○	○
	Water quality	○	○	○	○	○	○	○	○	○
	Habitat loss and condition	+	-	+	-	+	○	○	○	○
	Predation and competition	○	○	○	○	○	○	○	○	○
Operations										
	Entrainment and impingement	+	+	+	+	-	○	○	○	○
	Water quality	○	○	○	-	○	○	○	+	○
	Flow	+	○	+	-	+	-	○	○	○
	Habitat	○	○	○	+	○	-	+	-	○
	Predation and competition	○	○	○	○	○	○	○	○	○
	Foodweb	○	○	○	+	○	○	+	-	○
	Conservation measures	○	○	○	○	○	○	○	○	○
<p>A three-point scale indicates how the level of take or conservation benefit is expected to change compared with the BDCP Proposed Action.</p> <ul style="list-style-type: none"> - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + 										

1 **9.4.1.9.1 Construction**

2 Construction activities would be temporary and localized, and would occur mostly in dewatered
3 cofferdams. Some habitat restoration, conservation hatchery, and nonphysical barrier construction
4 would occur in areas occasionally occupied by lamprey. These construction activities are expected
5 to be short-term, temporary, and generally similar for all take alternatives.

6 **Underwater Sound**

7 The primary source of underwater sound that could affect lamprey would be from impact pile
8 driving. Such effects would be in proportion to the number and size of the intakes constructed
9 (Table 9-12). Under all take alternatives however, sound minimization measures would be used to
10 minimize the risk of incidental take attributable to sound exposure associated with impact pile
11 driving. The five-intake take alternatives (**Take Alternatives A, C, and E**) would have a greater
12 potential for take from pile driving than the BDCP Proposed Action, and the other three-intake
13 alternatives (**Take Alternatives G, H, and I**) (Table 9-21). **Take Alternatives B and D** would have
14 less potential for take because of the fewer intakes constructed, compared with the BDCP Proposed
15 Action. **Take Alternative F** would have two primary diversion screen structures (at Georgiana
16 Slough and the Delta Cross Channel), and a number of operable barriers on various sloughs. The
17 overall length of in-water structures would be greater than under the BDCP Proposed Action, and
18 the structures would be widely distributed, resulting in a larger area of exposure to pile driving
19 sound, and thus an increased risk of incidental take. As with sturgeon, lamprey would occur near the
20 construction areas, throughout the in-water work window, and would be affected by pile-driving
21 activities during cofferdam installation and subsequent foundation pile installation.

22 **Fish Stranding and Handling**

23 Lamprey are expected to occur in the lower river during the in-water construction period, making
24 them susceptible to entrapment in the project cofferdams, and requiring rescue and subsequent
25 handling. As a benthic-oriented species, lamprey may also be particularly susceptible to entrapment,
26 and these risks are also expected to be proportional to the number and size of the in-water facilities
27 constructed (Table 9-12).

28 Ammocoetes remain in fresh water for approximately 5 to 7 years, where they bury into silt and
29 mud and feed on algae, organic material, and microorganisms. Pacific and river lamprey
30 macrophthalmia migrate downstream during winter and spring, likely in association with high-flow
31 events (Moyle 2002). Macrophthalmia spend a short time in the Delta (less than 1 month), compared
32 to the amount of time other life stages spend upstream and in the ocean. Therefore, their exposure
33 to in-Delta stressors would be small relative to stressors of other life stages. While the overall effects
34 are expected to be small, the take alternatives with the most intakes (**Take Alternatives A, C, and E**)
35 would have a greater potential for stranding effects on lamprey (Table 9-21). **Take Alternatives B**
36 and **D** would have less potential to strand fish, while **Take Alternatives G and H** would have a
37 similar potential for stranding effects as the BDCP Proposed Action. The diversion structures built
38 under **Take Alternative F** have a smaller footprint, but the greater number and wider distribution
39 would likely result in greater stranding and handling effects than the other take alternatives.

40 **Water Quality**

41 Most of the construction activities would be conducted in the dry or within cofferdams. As a result,
42 the potential for take would be limited, with only minor differences between take alternatives

1 (Table 9-21). **Take Alternative F** however, includes a greater number of new in-water structures
2 built within portions of lamprey habitat, as well as substantial dredging activity, and thus has
3 greater potential for water quality changes to affect lamprey. **Take Alternative H** includes the most
4 extensive habitat restoration, and would have the most potential to temporarily alter water quality
5 during construction. In contrast, **Take Alternatives D** and **G** would have lower risks of water
6 quality effects than the other take alternatives, including the BDCP Proposed Action. While habitat
7 restoration activities would occur in areas frequently used by lamprey, any associated changes in
8 water quality would be temporary and localized.

9 **Dredging**

10 Lamprey are at risk of entrainment by dredging equipment, with ammocoetes at most risk, as they
11 inhabit the substrate. Beamish and Youson (1987) found that only 3 to 26% of lamprey that pass
12 through a dredge survive. Dredging operations can result in the suspension of toxics such as
13 ammonia, hydrogen sulfide, and copper as a result of both dredging and dredge spoil disposal
14 (National Marine Fisheries Service 2006). Dredging can also affect many age classes of lamprey
15 because of their extended instream rearing phases (3 to 7 years) (Luzier et al. 2009).

16 The potential take related to dredging activities outside of the cofferdams would be proportional to
17 the number and size of the in-water facilities constructed, similar to other construction effects.
18 Dredged areas would be about 54 to 68% greater for the five-intake take alternatives (**Take**
19 **Alternatives A, C, and E**) than the BDCP Proposed Action, while about 73% fewer acres of dredging
20 would be expected for **Take Alternative D** (one intake) (Table 9-11). While **Take Alternative F**
21 would likely require little or no dredging associated with the diversion structures, dredging activity
22 would occur in some of the interior Delta sloughs, potentially resulting in greater dredging effects
23 compared to the BDCP Proposed Action (Table 9-21).

24 Some channel excavation and dredging would also occur in the Yolo Bypass for all the take
25 alternatives, as part of CM2 measures to enhance the habitat and reduce stranding. While this
26 dredging would occur during low water, the extent of lamprey use of the Yolo Bypass is unknown.

27 **Habitat Alteration**

28 While the extent that lamprey use the nearshore habitat in the north Delta is uncertain, some effects
29 would be expected. However, compared to the amount of habitat available in the Plan Area, and the
30 current degraded condition of the affected habitat, the overall potential for take would be limited.
31 Despite the expected limited overall effects, the take alternatives with five intakes (**Take**
32 **Alternatives A, C, and E**) would have substantially greater (58 to 68% more) habitat loss, compared
33 to the BDCP Proposed Action (Table 9-11), while **Take Alternatives B** and **D** would have 32 and
34 74% less habitat loss than the BDCP Proposed Action, respectively (Table 9-21). **Take Alternative F**
35 would likely affect less nearshore habitat than the BDCP Proposed Action, based on the expected
36 sizes of the in-water structures. **Take Alternative F** would also primarily affect deeper offshore
37 areas, compared to the nearshore habitat affected by the BDCP Proposed Action, although any
38 differences in the use of these habitats by lamprey is uncertain. Therefore, the overall aquatic
39 habitat effects are likely to be greater for **Take Alternative F** than the BDCP Proposed Action, and
40 the other three-intake take alternatives, based on the number and distribution of in-water
41 structures, as well as the associated dredging effects. The temporary effects of the barge landings on
42 lamprey habitat would be limited and similar for most take alternatives, although potentially slightly
43 less for **Take Alternative F** because of one less barge landing.

1 **Habitat Restoration**

2 The construction of habitat restoration may temporarily disturb or displace covered fish species and
3 their habitat, as well as affect water quality, particularly turbidity, dissolved oxygen, and suspended
4 contaminated sediments. Most of the construction activities would be conducted in the dry, thereby
5 minimizing potential effects. While most in-water restoration construction activities will occur
6 during the approved in-water work window, some restoration construction could occur during
7 periods when lamprey may be present, depending on the specific location of the restoration. Any
8 potential negative effects would be localized, temporary, and infrequent. While the overall effects
9 are expected to be small, the alternative with the greatest amount of habitat restoration (**Take**
10 **Alternative H**) would have an increased risk of affecting lamprey during construction, compared to
11 the other take alternatives (including the BDCP Proposed Action) (Table 9-21). In contrast, **Take**
12 **Alternatives D** and **G** would likely have a lower risk of effects, based on less habitat restoration
13 construction.

14 **9.4.1.9.2 Maintenance**

15 Potential effects of maintenance activities would be proportional to the number of in-water
16 structures (Table 9-12). Any effects would be localized and infrequent. However, lamprey would
17 occur in the areas affected by the in-water maintenance activities during the typical in-water
18 construction window, and would be susceptible to effects from these maintenance activities,
19 particularly dredging. Dredging effects would include physical injury or mortality from contact with
20 the dredge equipment, as well as habitat alterations, such as water quality and substrate conditions
21 and availability of food resources.

22 **Dredging**

23 The amount of dredging would be proportional to the number and size of the in-water facilities
24 (Table 9-12). Take alternatives with five intakes (**Take Alternatives A, C, and E**) would require
25 more maintenance dredging than the BDCP Proposed Action, while **Take Alternatives B and D**
26 would require less (Table 9-21). **Take Alternative F** would require periodic dredging in some of the
27 interior Delta sloughs, likely resulting in greater maintenance dredging effects than the BDCP
28 Proposed Action. However, maintenance dredging would typically not occur at more than one intake
29 site at a time, thereby minimizing potential effects.

30 The implementation of CM2 would also require periodic channel maintenance excavation and
31 dredging to maintain a deepwater fish passage channel through the bypass. Dredging in the bypass
32 could have a greater effect on lamprey than dredging elsewhere in the Plan Area. While the extent of
33 such effects is unknown, they would be similar for all take alternatives.

34 **Water Quality**

35 Dredging would be the primary maintenance activity that could affect water quality. Dredging would
36 result in temporary increases in turbidity and potential suspended contaminated sediments, as well
37 as potential decreases in dissolved oxygen levels. However, these effects would be temporary and
38 periodic, and would be unlikely to occur at more than one site at a time. Differences between take
39 alternatives would likely be negligible (Table 9-21).

1 **Habitat Loss and Condition**

2 The removal of substrate during dredging operations would result in the removal of benthic and
 3 epibenthic organisms, which provide direct or indirect food resources for lamprey. As benthic-
 4 oriented fish, lamprey would be affected by the loss or alteration of substrate habitat. These effects
 5 would be proportional to the number and size of the in-water facilities and their requirements for
 6 periodic maintenance dredging (Table 9-12).

7 **Predation and Competition**

8 Any effects of maintenance activities on the predation of lamprey would likely be negligible.
 9 Maintenance activities would only occur periodically and lamprey are generally not susceptible to
 10 substantial predation pressure. Any predation-related take associated with these activities would
 11 likely be negligible, as would any differences between take alternatives (Table 9-21).

12 **9.4.1.9.3 Operations**

13 In addition to the diversion of water through the proposed north Delta intakes, operations would
 14 include conservation measures involving long-term habitat restoration and enhancement activities,
 15 as well as predator reduction and invasive aquatic vegetation control measures. These effects would
 16 be generally beneficial to Pacific and river lamprey.

17 **Entrainment and Impingement**

18 With regard to the BDCP Proposed Action and all take alternatives, some entrainment and
 19 impingement risks to lamprey would arise in the north Delta with the addition of the new in-water
 20 intake structures, compared to existing conditions, although entrainment at south Delta export
 21 facilities is expected to decrease by 41% on average (Appendix 5.B, *Entrainment*,). Any new
 22 entrainment at the north Delta structures would be minimized by the intake screens designed to
 23 meet agency-recommended sweep- and approach-velocity criteria, and minimizing the overall size
 24 of the intakes. Little is known concerning lamprey vulnerability to entrainment and impingement, so
 25 potential effects are highly uncertain, but design attributes of the various take alternatives do allow
 26 comparison of relative risk levels.

27 Entrainment would be generally proportional to the number and size of intakes built under the
 28 various take alternatives, and the portion of the mean total project water deliveries exported
 29 through the north Delta intakes (Table 9-12 and Table 9-13). Therefore, the take alternatives with
 30 five north Delta intakes would tend to have a greater potential for entrainment than the BDCP
 31 Proposed Action and take alternatives with fewer intakes. However, despite having the same
 32 number of intakes as the BDCP Proposed Action, **Take Alternative B** is expected to result in more
 33 entrainment because of the greater proportion of exports from the south Delta facilities. The overall
 34 risks would generally be lower for most take alternatives, compared to existing conditions, because
 35 of reduced exports (and entrainment) at the existing south Delta facilities (Table 9-21). **Take**
 36 **Alternatives E and F** would substantially reduce entrainment (and associated predation pressures)
 37 at the south Delta intakes. **Take Alternative E** would eliminate the use of the south Delta facilities,
 38 and **Take Alternative F** would block fish from being diverted to the interior Delta, although
 39 entrainment and impingement effects could also occur at the new fish diversion structures. The
 40 cumulative length of the **Take Alternative F** diversion screens will be greater than that of the
 41 screens constructed for the BDCP Proposed Action, although flow velocities through these screens
 42 are expected to be less than through the proposed north Delta water intake screens. Therefore,

1 entrainment rates are expected to be less, but the other effects associated with the longer overall
2 diversion screens (impingement, descaling, and potential predator habitat) would likely be
3 somewhat greater than under the BDCP Proposed Action. Overall, the entrainment and impingement
4 rates are expected to be similar under **Take Alternative F** to the BDCP Proposed Action (Table
5 9-12).

6 **Water Quality**

7 Limited water quality effects are expected from operations and the potential differences between
8 take alternatives would likely be negligible (Table 9-21).

9 **Flow**

10 Lamprey macrophthalmia have weak swimming ability and rely upon sufficient flows to emigrate
11 downstream (Luzier et al. 2009). The BDCP Proposed Action would cause small to moderate (4 to
12 13%) decreases in the Sacramento River flows downstream of the north Delta diversions, and some
13 other Plan Area rivers during portions of the macrophthalmia downstream migration (primarily in
14 April and May) (Appendix 5.C, *Flow, Passage, Salinity, and Turbidity*). However, there will be no
15 biologically meaningful effects to flows during other months within the emigration period in these
16 rivers or throughout the entire migration period in the San Joaquin River (Chapter 5, Section
17 5.5.9.1.2, *Improved Macrophthalmia Emigration Flows*). The changes in Sacramento River flow would
18 be proportional to the number of intakes. **Take Alternative F** would generally maintain existing
19 flow conditions in the Plan Area. However, no net adverse effects on overall Delta-wide downstream
20 migration flows for Pacific or river lamprey macrophthalmia are expected.

21 Upstream adult attraction flows from the San Joaquin River would improve under the BDCP
22 Proposed Action because the new north Delta export facilities would reduce the export of
23 Sacramento River water to the south Delta. In the Sacramento River, the new north Delta export
24 facilities would result in small reductions in attraction flows during the lamprey upstream migration
25 periods, although it is uncertain if Pacific and river lamprey adults are attracted to chemical cues or
26 exhibit strong natal area fidelity (Goodman 2005). Aside from a few isolated increases and decreases
27 in flows, there will be no biologically meaningful effects on river lamprey adult attraction flows in
28 any river examined throughout the river lamprey adult migration period (September through
29 November) (Chapter 5, Section 5.5.9.1.3, *Improved Adult Attraction Flows*). **Take Alternative F**
30 would maintain existing attraction flow conditions in the Delta, while **Take Alternative E** would
31 result in the most changes as all of the water deliveries would be exported from the north Delta
32 intakes (Table 9-21).

33 **Habitat**

34 Habitat restoration activities associated with the conservation measures would likely provide some
35 small benefits to lamprey, although the knowledge of lamprey use of the habitat in the Plan Area is
36 limited (Chapter 5, Section 5.5.9.1.5, *Improved Tidal Habitat and Channel Margin Conditions for*
37 *Ammocoete Rearing*). **Take Alternative H** would have the most potential to benefit lamprey,
38 because it would substantially increase inundated floodplain and restored tidal and channel margin
39 habitat, compared to the other take alternatives (Table 9-21). **Take Alternatives D** and **G** would
40 restore less habitat than the BDCP Proposed Action and other take alternatives. Less channel margin
41 would be replaced by in-water structures under **Take Alternative F** than the other take
42 alternatives, resulting in a greater net increase in this type of habitat in the north Delta.

1 **Predation and Competition**

2 Changes in predation and interspecies competition under the take alternatives are expected to be
3 small, but increased, relative to existing conditions. These potential effects would be similar for all
4 take alternatives due to a lower proportion of lamprey diverted to, and subsequently entrained at,
5 the south Delta export facilities, which would likely reduce exposure to predation (Table 9-21).

6 **Foodweb**

7 Take alternatives providing the most habitat restoration, particularly tidal and inundated floodplain
8 habitat, would have the most potential benefits on foodweb conditions for lamprey. **Take**
9 **Alternative H** would have the most potential benefits, followed by the BDCP Proposed Action and
10 **Take Alternatives A, B, C, E, and F** (Table 9-21). **Take Alternatives D and G** would have lower
11 potential benefits than the BDCP Proposed Action.

12 While habitat restoration is expected to provide the most direct foodweb benefits, due to the
13 increased habitat compared to existing conditions. Additional flows provided by meeting high-
14 outflow scenario and/or Fall X2 commitments under most take alternatives are also likely to
15 provide additional foodweb benefits from increased seasonal floodplain habitat inundation. The
16 additional spring flows provided by **Take Alternative I**, would also provide some additional
17 inundation-related foodweb benefits.

18 **Conservation Measures**

19 The conservation measures will benefit Pacific and river lamprey by improving passage conditions,
20 restoring habitat, reducing predation, and controlling invasive aquatic vegetation. Increased food
21 availability in the Delta resulting from habitat restoration is expected to benefit lamprey. Except for
22 the differences identified above, under *Habitat*, there would be no difference in the effects of the
23 take alternatives (Table 9-21).

24 **9.4.1 Mammals**

25 Each take alternative is evaluated to assess how take of mammal species would be expected to
26 change. This section summarizes the results of the evaluation, and focuses on those take alternatives
27 that would reduce or avoid take of one or more mammal species. Take alternatives that increase
28 take of covered mammals (if any take alternatives do so) are mentioned but are not the focus of the
29 analysis. The comparison of take alternatives is summarized in Table 9-22.

1 **Table 9-22. Expected Changes in Incidental Take of Mammals and Conservation Benefits by**
 2 **Alternative, Relative to the BDCP Proposed Action**

Mammal Species	Take Alternatives								
	Permanent / Temporary / Periodic Effects								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified spring Outflow
Riparian brush rabbit	-/-/0	+/-/0	+/-/0	-/-/0	+/-/0	-/+/0	-/0/0	+/+/+	0/0/0
Riparian woodrat	0/0/0	0/0/0	0/0/0	-/0/0	0/0/0	0/0/0	-/0/0	+/+/+	0/0/0
Salt marsh harvest mouse	0/0/0	0/0/0	0/0/0	-/0/0	0/0/0	0/0/0	-/0/0	+/+/0	0/0/0
San Joaquin kit fox	-/+/0	-/+/0	-/+/0	0/+/0	-/+/0	-/-/0	0/0/0	0/0/0	0/0/0
Suisun shrew	0/0/0	0/0/0	0/0/0	-/0/0	0/0/0	0/0/0	-/0/0	+/+/0	0/0/0

A three-point scale indicates how the level of take or conservation benefit is expected to change compared to the BDCP Proposed Action.

- Take is likely measurably less than the BDCP Proposed Action.
- 0 Take is not measurably different from the BDCP Proposed Action.
- + Take is likely measurably greater than the BDCP Proposed Action.

3

4 **9.4.1.1 Riparian Brush Rabbit**

5 **Take Alternative I** would not have measurably different levels of take of the riparian brush rabbit
 6 from the BDCP Proposed Action when considering the combined effects of permanent and
 7 temporary effects. **Take Alternatives A, D, G** would have less potential for take and **Take**
 8 **Alternatives B, C, E, F, and H** would have more potential for take of the riparian brush rabbit than
 9 the BDCP Proposed Action. These differences are explained mostly by the amount of tidal natural
 10 communities restoration (CM4) and the conveyance alignments (CM1).

11 **9.4.1.1.1 Permanent Habitat Loss, Conversion, and Fragmentation**

12 The covered activities associated with conveyance facilities construction (CM1), tidal natural
 13 communities restoration (CM4), and floodplain restoration (CM5), may cause take of the riparian
 14 brush rabbit as a result of permanent effects on modeled riparian brush rabbit habitat in
 15 Conservation Zones 7 and 8. The BDCP Proposed Action would result in the permanent loss of
 16 approximately 232 acres of riparian and associated grassland habitat (4% of modeled riparian
 17 brush rabbit habitat in the Plan Area). **Take Alternatives A, F, and G** would have less potential for
 18 take of riparian brush rabbit habitat, due to the conveyance alignment, the number and location of
 19 intakes and/or reduced amount of tidal natural communities restoration. Permanent loss of riparian
 20 and grassland habitat would occur as follows: 86 fewer acres for **Take Alternative A**, and 60 fewer
 21 acres for **Take Alternative F**. **Take Alternatives D and G** are also expected to result in less take
 22 than the BDCP Proposed Action because they include 25,000 and 15,000 fewer acres, respectively, of
 23 tidal natural communities restoration. **Take Alternatives B, C, and E** are expected to have an

1 increase of 30 acres of permanent loss of riparian and grassland habitat. **Take Alternative H** is also
 2 assumed to have a greater potential for take because 10,000 more acres of tidal habitat (75,000 total
 3 acres) would be restored and 10,000 more acres of floodplain restoration (20,000 total acres)
 4 relative to the BDCP Proposed Action. Any riparian brush rabbit habitat loss resulting from
 5 implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-
 6 specific ESA Section 7 and CDFW consultations. Table 9-22 summarizes the varying levels of
 7 potential take from permanent habitat loss.

8 Under the BDCP Proposed Action, at least 800 acres of suitable riparian habitat for riparian brush
 9 rabbit will be restored and maintained and an additional 200 acres riparian brush rabbit habitat will
 10 be protected would offset the loss of modeled riparian brush rabbit habitat. These conservation
 11 measures would be the same for **Take Alternatives A, B, C, D, E, F, G, and I** and therefore would
 12 have no difference in their potential to mitigate take of the riparian brush rabbit. **Take Alternative**
 13 **H** would likely benefit riparian brush rabbit through increases in potentially suitable riparian
 14 habitat that would likely establish within the 10,000 acres of additional floodplain restoration
 15 (CM5), compared to the BDCP Proposed Action, if it occurs in proximity to currently occupied
 16 habitat for these species in Conservation Zone 7.

17 From a review of maps with modeled habitat, California Natural Diversity Database (CNDDDB)
 18 occurrence data, conveyance footprints, and ROAs, the BDCP Proposed Action and take alternatives
 19 would not substantially differ in their potential to fragment modeled habitat and result in take of the
 20 riparian brush rabbit.

21 **9.4.1.1.2 Periodic Effects**

22 Floodplain restoration (CM5) may cause take resulting from the periodic inundation of modeled
 23 riparian brush rabbit habitat in Conservation Zone 7. Floodplain restoration under **Take**
 24 **Alternatives A, B, C, D, E, F, G, and I** would have the same effect on modeled habitat as the BDCP
 25 Proposed Action, resulting in the periodic inundation of approximately 687 acres of riparian habitat
 26 (11% of modeled riparian brush rabbit habitat in the Plan Area). Under **Take Alternative H**,
 27 periodic inundation of modeled riparian brush rabbit habitat would increase due to an increase of
 28 floodplain restoration (additional 10,000 acres), compared to the BDCP Proposed Action.

29 **9.4.1.1.3 Construction-Related Effects**

30 **Temporary Habitat Loss**

31 The potential for take from temporary effects on modeled riparian brush rabbit habitat is attributed
 32 to conveyance facility construction (CM1) and floodplain restoration levee construction (CM5) in
 33 Conservation Zones 6 and 8. The BDCP Proposed Action would result in the temporary loss of
 34 approximately 109 acres of riparian and grassland habitat (2% of modeled habitat in the Plan Area).
 35 **Take Alternative G** and **I** would have the same potential for take as the BDCP Proposed Action
 36 because they only differ by the amounts of tidal natural communities restoration for which there are
 37 temporary effects identified in the Plan. **Take Alternatives A, B, C, D, E, F, G, and H** would differ in
 38 their levels of take from the BDCP Proposed Action based on location of conveyance alignments and
 39 the number and location of intakes and the amount of tidal and floodplain restoration. **Take**
 40 **Alternatives A** (11 acres less), **B** (24 less acres), **C** and **E** (24 less acres), and **D** (24 less acres) would
 41 have less potential for take of the riparian brush rabbit due to temporary habitat loss than the BDCP
 42 Proposed Action. **Take Alternatives F** (90 more acres of effect), and **H** (assumed to be more acres of
 43 temporary habitat loss due to an increase in 10,000 acres of floodplain restoration) would have a

1 greater potential for take of the riparian brush rabbit due to temporary habitat loss than the BDCP
 2 Proposed Action. The Table 9-22 summarizes the varying levels of potential take from temporary
 3 short-term habitat loss.

4 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 5 riparian brush rabbit. One such measure will restore temporarily affected natural communities.
 6 These measures would be the same for all take alternatives and therefore would have no difference
 7 in their potential to affect the take of the riparian brush rabbit.

8 **Construction-Related Injury or Mortality**

9 Water conveyance facility construction is not likely to result in injury or mortality of individual
 10 riparian brush rabbits because the species is not likely to be present in the areas that would be
 11 affected by this activity. Tidal natural communities restoration will not result in injury or mortality
 12 of the riparian brush rabbit because tidal natural communities restoration projects will be designed
 13 to avoid occupied riparian brush rabbit habitat. Activities associated with construction of setback
 14 levees for floodplain restoration could result in injury or mortality of riparian brush rabbits if they
 15 are present within the construction footprint.

16 In general, the potential for take from construction-related injury or mortality between take
 17 alternatives would parallel the amount of permanent and temporary habitat disturbance associated
 18 with floodplain restoration. **Take Alternatives A, B, C, D, E, F, and I** would have the potential for
 19 take compared to the BDCP Proposed Action. **Take Alternative G** would have less potential for take
 20 than the BDCP Proposed Action because it would have a smaller construction and restoration
 21 footprint. **Take Alternative H** would have a greater potential for take compared to the BDCP
 22 Proposed Action because an additional 10,000 acres of floodplain would be restored (20,000 total
 23 acres).

24 Preconstruction surveys, construction monitoring, and other measures identified in Appendix 3.C,
 25 *Avoidance and Minimization Measures*, will be implemented to avoid and minimize injury or
 26 mortality of riparian brush rabbits during construction. These measures would be the same for all
 27 take alternatives and therefore would have no difference in their potential to affect the take of the
 28 riparian brush rabbit.

29 **Indirect Construction-Related Effects**

30 Noise and visual disturbance from adjacent construction activities associated with water
 31 conveyance construction, tidal natural communities restoration construction, and construction of
 32 setback levees could temporarily affect the use of up to 418 acres of riparian and associated
 33 grassland habitat (7% of modeled habitat in the Plan Area) for the riparian brush rabbit.

34 The effect on each species was calculated by intersecting the assumed area of indirect effect
 35 extending from the construction area for each species with each species modeled habitat; the
 36 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
 37 **Alternatives D and G** (assumed to be fewer acres of construction-related disturbance due to a
 38 decrease of 25,000 and 15,000 acres of tidal natural communities restoration, respectively) would
 39 have less potential for take than the BDCP Proposed Action due to smaller construction and
 40 restoration footprints. **Take Alternative A** (332 more acres), **Take Alternatives B, C, and E** (475
 41 more acres each), and **Take Alternative F** (389 more acres), and **Take Alternative H**
 42 (assumed to be more acres of construction-related disturbance because an additional 10,000 acres
 43 of floodplain would be restored) would have a greater potential for take than the BDCP Proposed

1 Action due to having more acres of project-related disturbance. **Take Alternative I** would have the
 2 same potential for take as the BDCP Proposed Action.

3 Preconstruction surveys, construction monitoring, and other measures identified in Appendix 3.C,
 4 *Avoidance and Minimization Measures*, will be implemented to avoid and minimize indirect effects on
 5 riparian brush rabbit during construction. These measures would be the same for all take
 6 alternatives and therefore would have no difference in their potential to affect the take of the
 7 riparian brush rabbit.

8 **9.4.1.2 Riparian Woodrat**

9 **Take Alternatives A, B, C, E, and I** would not have measurably different levels of take of the
 10 riparian woodrat from the BDCP Proposed Action when considering the combined effects of
 11 permanent and temporary effects. **Take Alternatives D and G** would have less potential for take.
 12 **Take Alternative F** would have a slight increase in the potential for take and **Take Alternative H**
 13 would have a greater potential for take of the riparian woodrat than the BDCP Proposed Action. In
 14 general, these differences are explained by the amount of tidal natural communities restoration
 15 (CM4) and the conveyance alignments (CM1).

16 **9.4.1.2.1 Permanent Habitat Loss, Conversion, and Fragmentation**

17 The covered activities associated with tidal natural communities restoration (CM4) and floodplain
 18 restoration (CM5) may cause take of the riparian woodrat as a result of permanent effects on
 19 modeled riparian woodrat habitat in Conservation Zone 7. The BDCP Proposed Action would result
 20 in the permanent loss of approximately 51 acres of riparian woodrat habitat (2% of modeled habitat
 21 in the Plan Area). **Take Alternatives A, B, C, E, and I** would have the same potential for take as the
 22 BDCP Proposed Action since there would be no differences in the amount of tidal and floodplain
 23 restoration. **Take Alternatives F and H** would result in larger effects on modeled habitat relative to
 24 the BDCP Proposed Action due to the location of conveyance facilities and increased amount of
 25 floodplain restoration. Permanent loss of modeled habitat would increase for **Take Alternative F**
 26 (2 more acres) and **Take Alternative H** (assumed to be more acres of effect due to an increase of
 27 10,000 acres of floodplain restoration). **Take Alternatives D and G** are assumed to have fewer acres
 28 of effect due to a decrease of 25,000 and 15,000 acres, respectively, of tidal natural communities
 29 restoration. Any riparian woodrat habitat loss resulting from implementation of the USFWS 2008
 30 BiOp and NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7 consultations.
 31 Table 9-22 summarizes the varying levels of potential take from permanent habitat loss.

32 Under the BDCP Proposed Action, 300 acres of suitable riparian habitat for riparian woodrat will be
 33 restored and maintained and an additional 90 acres riparian woodrat habitat will be protected to
 34 offset the loss of modeled riparian brush rabbit habitat. These conservation measures would be the
 35 same for **Take Alternatives A, B, C, D, E, F, G, and I** and therefore would have no difference in their
 36 potential to mitigate take of the riparian woodrat. **Take Alternative H** would likely benefit riparian
 37 woodrat through increases in potentially suitable riparian habitat that would likely establish within
 38 the 10,000 acres of additional floodplain restoration (CM5) if it occurs in proximity to currently
 39 occupied habitat for these species in Conservation Zone 7.

40 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
 41 ROAs, the BDCP Proposed Action and take alternatives would not substantially differ in their
 42 potential to fragment modeled habitat and result in take of riparian woodrat.

1 **9.4.1.2.2 Periodic Effects**

2 Floodplain restoration (CM5) may cause take resulting from the periodic inundation of modeled
 3 riparian woodrat habitat in Conservation Zone 7. Floodplain restoration under **Take Alternatives**
 4 **A, B, C, D, E, F, G, and I** would have the same effect on modeled habitat as the BDCP Proposed Action,
 5 resulting in the periodic inundation of approximately 203 acres of riparian woodrat habitat (9% of
 6 riparian woodrat habitat in the Plan Area). Under **Take Alternative H**, periodic inundation of
 7 modeled riparian woodrat habitat would increase due to an increase of floodplain restoration
 8 (additional 10,000 acres) relative to the BDCP Proposed Action.

9 **9.4.1.2.3 Construction-Related Effects**

10 **Temporary Habitat Loss**

11 The potential for take from temporary effects on modeled riparian woodrat habitat is attributed to
 12 levee construction associated with flood restoration activities (CM5) in Conservation Zone 7. **Take**
 13 **Alternatives A, B, C, D, E, F, G, and I** would have the same effect on modeled habitat as the BDCP
 14 Proposed Action, which would result in temporary loss of approximately 33 acres of riparian habitat
 15 (2% of riparian woodrat habitat in the Plan Area). **Take Alternative H** would likely have a greater
 16 potential for take because there more temporary habitat loss would result from an increase in
 17 10,000 acres of floodplain restoration.

18 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 19 riparian brush rabbit. One such measure will restore temporarily affected natural communities.
 20 These measures would be the same for all take alternatives and therefore would have no difference
 21 in their potential to affect the take of the riparian woodrat.

22 **Construction-Related Injury or Mortality**

23 Water conveyance facility construction is not likely to result in injury or mortality of individual
 24 riparian woodrats because the species is not likely to be present in the areas that will be affected by
 25 this activity. Tidal natural communities restoration will not result in injury or mortality of the
 26 riparian woodrat because tidal natural communities restoration projects will be designed to avoid
 27 occupied riparian woodrat habitat. Activities associated with construction of setback levees for
 28 floodplain restoration could result in injury or mortality of riparian woodrats if they are present
 29 within the construction footprint.

30 In general, the potential for take from construction-related injury or mortality would parallel the
 31 amount of permanent and temporary habitat disturbance associated with floodplain restoration.
 32 **Take Alternatives A, B, C, D, E, F, and I** would have the potential for take compared to the BDCP
 33 Proposed Action. **Take Alternative G** would have less potential for take than the BDCP Proposed
 34 Action because it would have a smaller construction and restoration footprint. **Take Alternative H**
 35 would have a greater potential for take compared to the BDCP Proposed Action because an
 36 additional 10,000 acres of floodplain would be restored (20,000 total acres).

37 Preconstruction surveys, construction monitoring, and other measures identified in Appendix 3.C,
 38 *Avoidance and Minimization Measures*, will be implemented to avoid and minimize injury or
 39 mortality of riparian woodrats during construction. These measures would be the same for all take
 40 alternatives and therefore would have no difference in their potential to affect the take of the
 41 riparian woodrat.

1 **Indirect Construction-Related Effects**

2 Noise and visual disturbance from adjacent construction activities associated with water
 3 conveyance construction, tidal natural communities restoration construction, and construction of
 4 setback levees could temporarily affect the use of modeled riparian woodrat habitat. The effect on
 5 each species was calculated by intersecting the assumed area of indirect effect extending from the
 6 construction area for each species with each species modeled habitat; the intersection represents
 7 the extent of effect expressed as acres of disturbed habitat. **Take Alternatives A, B, C, E, and I**
 8 would have the same potential for take as the BDCP Proposed Action, because of similar (0 to 2 more
 9 acres) amounts of habitat affects. **Take Alternative G** (assumed to be fewer acres of construction-
 10 related disturbance due to a decrease of 15,000 acres of tidal natural communities restoration)
 11 would have less potential for take than the BDCP Proposed Action due to smaller construction and
 12 restoration footprints. **Take Alternative F and D** would have greater potential for take based on 5
 13 more acres and 207 more acres of effects respectively. **Take Alternative H** would have a greater
 14 potential for take compared to the BDCP Proposed Action as a result of greater permanent and
 15 temporary effects because an additional 10,000 acres of floodplain would be restored.

16 Preconstruction surveys, construction monitoring, and other measures identified in Appendix 3.C,
 17 *Avoidance and Minimization Measures*, will be implemented to avoid and minimize indirect effects on
 18 riparian woodrats during construction. These measures would be the same for all take alternatives
 19 and therefore would have no difference in their potential to affect the take of the riparian woodrat.

20 **9.4.1.3 Salt Marsh Harvest Mouse**

21 **Take Alternatives A, B, C, E, F, and I** would have the same potential for take of the salt marsh
 22 harvest mouse as the BDCP Proposed Action. **Take Alternatives D and G** would have less potential
 23 for take, and **Take Alternative H** would have a greater potential for take of the salt marsh harvest
 24 mouse than the BDCP Proposed Action. These differences are all due to the varying amounts of tidal
 25 natural communities restoration (CM4) between take alternatives.

26 **9.4.1.3.1 Permanent Habitat Loss, Conversion, and Fragmentation**

27 Tidal natural communities restoration (CM4) has the potential for take of the salt marsh harvest
 28 mouse resulting from the permanent effects on modeled salt marsh harvest mouse habitat in
 29 Conservation Zone 7. **Take Alternatives A, B, C, E, F, and I** would have the same potential for take
 30 as the BDCP Proposed Action, which would result from the permanent loss or conversion of
 31 approximately 6,960 acres of wetland habitat (20% of modeled salt marsh harvest mouse wetland
 32 habitat in the Plan Area) and 770 acres of upland habitat (17% of modeled salt marsh harvest mouse
 33 upland habitat in Plan Area). **Take Alternatives D and G** would also have less potential for take
 34 than the BDCP Proposed Action due to fewer acres of project-related disturbance. **Take Alternative**
 35 **H** would have an increase in permanent habitat loss as a result of an increase in tidal natural
 36 communities restoration from 65,000 acres to 75,000 total acres (consisting of tidal natural
 37 communities and transitional upland areas to accommodate sea level rise). Any salt marsh harvest
 38 mouse habitat loss resulting from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp
 39 would be evaluated under project-specific ESA Section 7 and CDFW consultations. Table 9-22
 40 summarizes the varying levels of potential take from permanent habitat loss.

41 Under the BDCP Proposed Action, tidal natural communities restoration (CM4) would offset the loss
 42 of modeled salt marsh harvest mouse habitat by creating 6,000 acres of more self-sustaining habitat
 43 in the form of tidal brackish emergent wetland and protecting and enhancing 8,100 acres of

1 managed wetland in the Grizzly Island Marsh Complex and 4,500 additional acres of protected
 2 managed wetland may benefit the species if it is located in Suisun Marsh. This conservation measure
 3 would be the same for **Take Alternatives A, B, C, E, F, H, and I** and therefore would have no
 4 difference in their potential to offset take of salt marsh harvest mouse. Most likely the 10,000 acres
 5 of additional tidal restoration from **Take Alternative H** would be comprised mostly of subtidal
 6 habitats that would not benefit salt marsh harvest mouse. This assumption is based on the limited
 7 availability of additional restoration opportunities for tidal brackish emergent wetlands in Suisun
 8 Marsh beyond the amounts proposed under the BDCP Proposed Action. **Take Alternatives G and D**
 9 would have less beneficial effects on salt marsh harvest mouse due to the assumption that having
 10 less tidal restoration would result in less restored tidal brackish emergent wetland in Suisun Marsh.

11 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
 12 ROAs, the BDCP Proposed Action and take alternatives would not substantially differ in their
 13 potential to fragment modeled habitat and result in take of the salt marsh harvest mouse.

14 **9.4.1.3.2 Periodic Effects**

15 No periodic inundation effects on the salt marsh harvest mouse would occur as a result of BDCP
 16 Proposed Action or take alternatives.

17 **9.4.1.3.3 Construction-Related Effects**

18 **Temporary Habitat Loss**

19 The BDCP Proposed Action and take alternatives would not result in the temporary loss of modeled
 20 salt marsh harvest mouse habitat from construction; however, salt marsh harvest mouse habitat
 21 may be temporarily made unusable as a result of the indirect effects of noise and visual disturbances
 22 associated with construction.

23 **Construction-Related Injury or Mortality**

24 The operation of equipment for construction could result in injury or mortality of salt marsh harvest
 25 mice, if present. In general, the potential for take from construction-related injury or mortality
 26 would parallel the amount of permanent and temporary habitat disturbance associated with tidal
 27 natural communities restoration. **Take Alternatives A, B, C, E, F, and I** would have the same
 28 potential for take as the BDCP Proposed Action since they would have the same amount of tidal
 29 natural communities restoration. **Take Alternative G** would have less potential for take because it
 30 would have a smaller construction and restoration footprint. **Take Alternatives D and G** would
 31 cause less ground disturbance in salt marsh harvest mouse habitat due to the decrease in tidal
 32 natural communities restoration (25,000 fewer acres and 10,000 fewer acres, respectively) and thus
 33 a lower potential for take from construction-related effects. **Take Alternative H** would have a
 34 greater potential for take compared to the BDCP Proposed Action because an additional 10,000
 35 acres of floodplain would be restored.

36 Preconstruction surveys, construction monitoring, and other measures identified in Appendix 3.C,
 37 *Avoidance and Minimization Measures*, will be implemented to avoid and minimize injury or
 38 mortality of the salt marsh harvest mouse. Such measures include prohibiting use of motorized
 39 equipment to remove vegetation in salt marsh harvest mouse habitat, restricting use of motorized
 40 equipment in habitat areas, implementing biological construction monitoring, and installing
 41 temporary exclusion fences. These measures would be the same for all take alternatives and

1 therefore would have no difference in their potential to mitigate take of the salt marsh harvest
 2 mouse.

3 **Indirect Construction-Related Effects**

4 Noise and visual disturbance from adjacent construction activities associated with tidal natural
 5 communities restoration could temporarily affect the use of 429 acres (1.9%) of modeled salt marsh
 6 harvest mouse habitat. The effect on each species was calculated by intersecting the assumed area of
 7 indirect effect extending from the construction area for each species with each species modeled
 8 habitat; the intersection represents the extent of effect expressed as acres of disturbed habitat. The
 9 potential for take from indirect construction effects would be the same for **Take Alternatives A, B,**
 10 **C, E, F, and I**, since they have the same amount of tidal natural communities restoration. **Take**
 11 **Alternative G** would also have less potential for take than the BDCP Proposed Action due to lower
 12 acreages of project-related disturbance. **Take Alternatives D and G** would cause less ground
 13 disturbance in modeled salt marsh harvest mouse habitat due to the decrease in tidal natural
 14 communities restoration (25,000 acres less for **Take Alternative D** and 10,000 acres less for **Take**
 15 **Alternative G**) and thus a lower potential for take from indirect construction-related effects
 16 compared to the BDCP Proposed Action. **Take Alternative H** would have an increase in potential
 17 take from ground disturbance because an additional 10,000 acres of tidal natural community would
 18 be restored.

19 Preconstruction surveys, construction monitoring, and other measures identified in Appendix 3.C,
 20 *Avoidance and Minimization Measures*, will be implemented to avoid and minimize indirect effects on
 21 salt marsh harvest mouse populations. Such measures include prohibiting use of motorized
 22 equipment to remove vegetation in salt marsh harvest mouse habitat, restricting use of motorized
 23 equipment in habitat areas, and implementing biological construction monitoring. These measures
 24 would be the same for all take alternatives and therefore would have no difference in their potential
 25 to mitigate take of the salt marsh harvest mouse.

26 **9.4.1.4 San Joaquin Kit Fox**

27 When permanent and temporary impacts are combined, **Take Alternatives A, B, C, E, G, H, and I**
 28 would have the same potential for take of the San Joaquin kit fox as the BDCP Proposed Action. **Take**
 29 **Alternative D** would have a greater potential for take and **Take Alternative F** would have less
 30 potential for take of the San Joaquin kit fox than the BDCP Proposed Action. These differences are
 31 explained mostly by the different conveyance alignments (CM1).

32 **9.4.1.4.1 Permanent Habitat Loss, Conversion, and Fragmentation**

33 Conveyance facility construction (CM1) and recreational facility construction (CM11) has the
 34 potential for take of the San Joaquin kit fox resulting from the permanent effects on modeled San
 35 Joaquin kit fox habitat in Conservation Zone 8. **Take Alternatives G and I** would have the same
 36 potential for take as the BDCP Proposed Action, which would result in the permanent loss or
 37 conversion of approximately 214 acres of breeding foraging, and dispersal habitat (4% of the
 38 modeled habitat in Plan Area). Based on the location and type of conveyance facilities, **Take**
 39 **Alternative A** (14 fewer acres), **B, C, D, E, H** (34 fewer acres each), and **F** (192 fewer acres) would
 40 result in less habitat loss relative to the BDCP Proposed Action. Any San Joaquin kit fox habitat loss
 41 resulting from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated

1 under project-specific ESA Section 7 and CDFW consultations. Table 9-22 summarizes the varying
 2 levels of potential take from permanent habitat loss.

3 Grassland (1,000 acres of protection), alkali seasonal wetland, and vernal pool complex protection
 4 and restoration (CMs 3, 8, and 9) in Conservation Zone 8 would mitigate the loss of modeled San
 5 Joaquin kit fox habitat by protecting, creating, and managing up to habitat for the species. However,
 6 this conservation measure is the same for all take alternatives and would have no difference in their
 7 potential to mitigate take of San Joaquin kit fox.

8 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
 9 ROAs, the BDCP Proposed Action and take alternatives would not substantially differ in their
 10 potential to fragment modeled habitat and result in take of the San Joaquin kit fox.

11 **9.4.1.4.2 Periodic Effects**

12 No periodic inundation effects on the San Joaquin kit fox would occur as a result of BDCP Proposed
 13 Action or take alternatives.

14 **9.4.1.4.3 Construction-Related Effects**

15 **Temporary Habitat Loss**

16 The potential for take from short-term effects on modeled San Joaquin kit fox habitat is attributed to
 17 conveyance facility construction (CM1) in Conservation Zone 8. **Take Alternatives G and I** would
 18 have the same effect on modeled habitat as the BDCP Proposed Action, which would result in the
 19 temporary loss of approximately 103 acres of breeding, foraging, and dispersal habitat (2% of
 20 modeled habitat in the Plan Area). **Take Alternatives A** (57 more acres) and **B, C, D, E, and H** (65
 21 more acres each) would have greater temporary San Joaquin kit fox habitat loss than the BDCP
 22 Proposed Action. Based on the location and type of conveyance facilities, **Take Alternative F** would
 23 have less temporary habitat loss (93 fewer acres), relative to the BDCP Proposed Action.

24 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of
 25 San Joaquin kit fox. One such measure will restore temporarily affected natural communities. These
 26 measures would be the same for all take alternatives and therefore would have no difference in their
 27 potential to affect the take of the San Joaquin kit fox.

28 **Construction-Related Injury or Mortality**

29 Construction activities could result in the injury or mortality of San Joaquin kit foxes if individuals
 30 are present; however, no injury or mortality is expected to occur because foxes will likely avoid the
 31 increased activity and noise. Overall, the potential for take from construction-related injury or
 32 mortality would parallel the amount of permanent and temporary habitat disturbance associated
 33 with conveyance facility construction. **Take Alternatives D, G, H, and I** would have the same
 34 potential for take as the BDCP Proposed Action since they have the same location and type of
 35 conveyance facilities resulting in construction effects on 596 acres (11.1% of modeled habitat in the
 36 Plan Area). **Take Alternative F** would have a lower potential for take compared to the BDCP
 37 Proposed Action as a result of less permanent and temporary effects (285 fewer acres). **Take**
 38 **Alternative A** (12 more acres), **B** (31 more acres), **C** (31 more acres), and **E** (31 more acres) would
 39 have a greater potential for take compared to the BDCP Proposed Action with 12 more acres.

1 Preconstruction surveys, construction monitoring, and other measures identified in Appendix 3.C,
 2 *Avoidance and Minimization Measures*, will be implemented to avoid and minimize injury or
 3 mortality. These measures would be the same for all take alternatives and therefore would have no
 4 difference in their potential to mitigate take of the San Joaquin kit fox.

5 **Indirect Construction-Related Effects**

6 Noise and visual disturbance from adjacent construction activities could temporarily affect the use
 7 of 182 acres (4%) of modeled San Joaquin kit fox habitat. The effect on each species was calculated
 8 by intersecting the assumed area of indirect effect extending from the construction area for each
 9 species with each species modeled habitat; the intersection represents the extent of effect expressed
 10 as acres of disturbed habitat. The potential for take from indirect construction effects would be the
 11 same for **Take Alternatives D, G, H, and I** since they would disturb the same amount of modeled
 12 San Joaquin kit fox habitat. **Take Alternatives A** (38 fewer acres), **B** (13 fewer acres), **C** (13 fewer
 13 acres), and **F** (173 fewer acres) and **F** would have a lower potential for take because it would cause
 14 less ground disturbance (173 fewer acres) compared to the BDCP Proposed Action.

15 Preconstruction surveys, construction monitoring, and other measures identified in Appendix 3.C,
 16 *Avoidance and Minimization Measures*, will be implemented to avoid and minimize indirect effects on
 17 the species. These measures would be the same for all take alternatives and therefore would have no
 18 difference in their potential to mitigate take of the San Joaquin kit fox.

19 **9.4.1.5 Suisun Shrew**

20 **Take Alternatives A, B, C, E, F, and I** would have the same potential for take of the Suisun shrew as
 21 the BDCP Proposed Action. **Take Alternatives D and G** would have less potential for take, and **Take**
 22 **Alternative H** would have measurably greater potential for take of the Suisun shrew than the BDCP
 23 Proposed Action. These differences are all due to the varying amounts of tidal natural communities
 24 restoration (CM4) between alternatives.

25 **9.4.1.5.1 Permanent Habitat Loss, Conversion, and Fragmentation**

26 Tidal natural communities restoration (CM4) has the potential for take of the Suisun shrew resulting
 27 from the permanent effects on modeled Suisun shrew habitat in Conservation Zone 7. **Take**
 28 **Alternatives A, B, C, E, F, and I** would have the same potential for take as the BDCP Proposed
 29 Action, which would result in the permanent loss or conversion of approximately 401 acres of
 30 primary and secondary habitat (5% of modeled habitat in Plan Area). **Take Alternatives D and G**
 31 would have less potential for take than the BDCP Proposed Action due to less acreage of project-
 32 related disturbance. **Take Alternative H** would have an increase in permanent habitat loss as a
 33 result of an increase in tidal natural communities restoration from 65,000 acres to 75,000 acres
 34 (consisting of about 85% subtidal and intertidal natural communities, with about 15% transitional
 35 upland areas to accommodate sea level rise). Any Suisun shrew habitat loss resulting from
 36 implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-
 37 specific environmental review under NEPA, CEQA and/or consultation with CDFW. Table 9-22
 38 summarizes the varying levels of potential take from permanent habitat loss.

39 Under the BDCP Proposed Action, tidal natural communities restoration (CM4) would offset the loss
 40 of modeled Suisun shrew habitat by creating/restoring 6,000 acres of tidal brackish emergent
 41 wetland habitat. This conservation measure would be the same for **Take Alternatives A, B, C, E, F,**
 42 **H, and I** and therefore would have no difference in their potential to offset take of salt marsh harvest

1 mouse. Most likely the 10,000 acres of additional tidal restoration from **Take Alternative H** would
 2 be comprised mostly of subtidal habitats that would not benefit Suisun shrew. This assumption is
 3 based on the limited availability of additional restoration opportunities for tidal brackish emergent
 4 wetlands in Suisun Marsh beyond the amounts proposed under the BDCP Proposed Action. **Take**
 5 **Alternatives D** and **G** would have less beneficial effects on Suisun shrew due to the assumption that
 6 having less tidal restoration would result in less restored tidal brackish emergent wetland in Suisun
 7 Marsh.

8 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
 9 ROAs, the BDCP Proposed Action and take alternatives do not substantially differ in their potential
 10 to fragment modeled habitat and result in take of the Suisun shrew.

11 **9.4.1.5.2 Periodic Effects**

12 No periodic inundation effects on the Suisun shrew would occur as a result of BDCP Proposed Action
 13 or take alternatives.

14 **9.4.1.5.3 Construction-Related Effects**

15 **Temporary Habitat Loss**

16 The BDCP Proposed Action and take alternative would not result in temporary loss of Suisun shrew
 17 modeled habitat, and no potential for take is anticipated.

18 **Construction-Related Injury or Mortality**

19 The operation of equipment for construction could result in injury or mortality of the Suisun shrew,
 20 if present. In general, the potential for take from construction-related injury or mortality would
 21 parallel the amount of permanent and temporary habitat disturbance associated with tidal natural
 22 communities restoration. **Take Alternatives A, B, C, E, F, H, and I** would have the same potential for
 23 take as the BDCP Proposed Action since they would have the same amount of tidal natural
 24 communities restoration. **Take Alternative D** would have a lower potential for take compared to
 25 the BDCP Proposed Action as a result of temporary and permanent effects (237 fewer acres). **Take**
 26 **Alternative G** would also have less potential for take than the BDCP Proposed Action due to fewer
 27 acres of project-related disturbance.

28 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize the
 29 potential for take of the Suisun shrew. These measures would be the same for all take alternatives
 30 and therefore would have no difference in their potential to mitigate take of the Suisun shrew.

31 **Indirect Construction-Related Effects**

32 Noise and visual disturbance from adjacent construction activities could temporarily affect the use
 33 of 167 acres (2.2% of modeled habitat in the Plan Area). The effect on each species was calculated by
 34 intersecting the assumed area of indirect effect extending from the construction area for each
 35 species with each species modeled habitat; the intersection represents the extent of effect expressed
 36 as acres of disturbed habitat. The potential for take from indirect construction effects would be the
 37 same as the BDCP Proposed Action for **Take Alternatives A, B, C, E, F, and I** since they would have
 38 the same amount of tidal natural communities restoration. **Take Alternatives D** and **G** would have
 39 less ground disturbance of modeled Suisun shrew habitat due to the decrease in tidal natural
 40 communities restoration (25,000 fewer acres and 10,000 fewer acres, respectively) and thus a lower

1 potential for take from indirect construction-related effects compared to the BDCP Proposed Action.
 2 **Take Alternative H** would have an increase in potential take from ground disturbance within
 3 modeled habitat because an additional 10,000 acres of tidal natural community would be restored.

4 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize the
 5 potential for take of the Suisun shrew. These measures would be the same for all take alternatives
 6 and therefore would have no difference in their potential to mitigate take of the Suisun shrew.

7 **9.4.2 Birds**

8 Each take alternative is evaluated to assess how take of bird species would be expected to change.
 9 This section summarizes the results of the evaluation, and focuses on those take alternatives that
 10 would reduce or avoid take of one or more bird species. Take alternatives that increase take of
 11 covered bird species (if any take alternatives do so) are mentioned but are not the focus of the
 12 analysis. The comparison of take alternatives is summarized in Table 9-23.

13 **Table 9-23. Expected Changes in Incidental Take of Birds and Conservation Benefits by Take**
 14 **Alternative, Relative to BDCP Proposed Action**

Bird Species	Take Alternatives								
	Permanent / Temporary / Periodic Effects								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified spring Outflow
California black rail	○/-/○	+/-/○	+/-/○	-/-/○	+/-/○	+/+/○	-/○/○	+/-/○	○/○/○
California clapper rail	○/○/○	○/○/○	○/○/○	○/○/○	○/○/○	○/○/○	-/○/○	+/○/○	○/○/○
Greater sandhill crane	-/+/○	-/-/○	-/+/○	-/-/○	-/+/○	-/-/○	-/○/○	+/-/○	○/○/○
Least Bell’s vireo	-/+/○	○/-/○	○/-/○	-/-/○	○/-/○	+/+/○	-/○/○	+/+/○	○/○/○
Suisun song sparrow	○/○/○	○/○/○	○/○/○	-/○/○	○/○/○	○/○/○	-/○/○	+/+/○	○/○/○
Swainson’s hawk	+/+/○	-/-/○	-/+/○	-/-/○	-/+/○	-/+/○	-/○/○	+/+/+	○/○/○
Tricolored blackbird	-/+/○	-/-/○	-/+/○	-/-/○	-/+/○	-/+/○	-/○/○	+/+/+	○/○/○
Western burrowing owl	+/+/○	-/-/○	-/+/○	-/-/○	-/+/○	-/+/○	-/○/○	+/+/+	○/○/○
Western yellow-billed cuckoo	-/+/○	-/-/○	○/-/○	-/-/○	○/-/○	+/+/○	-/○/○	+/+/○	○/○/○
White-tailed kite	+/+/○	-/-/○	-/+/○	-/-/○	-/+/○	-/+/○	-/○/○	+/+/+	○/○/○
Yellow-breasted chat	-/+/○	○/-/○	+/-/○	-/-/○	+/-/○	+/+/○	-/○/○	+/+/○	○/○/○

A three-point scale indicates how the level of take or conservation benefit is expected to change compared to the BDCP Proposed Action.

- Take is likely measurably less than the BDCP Proposed Action.
- Take is not measurably different from the BDCP Proposed Action.
- + Take is likely measurably greater than the BDCP Proposed Action.

15

1 **9.4.2.1 California Black Rail**

2 **Take Alternative I** would have the same potential for take as the BDCP Proposed Action. **Take**
 3 **Alternatives A, B, C, E, D,** and **G** would have less potential for take, and **Take Alternatives F** and **H**
 4 would have greater potential for take than the BDCP Proposed Action (Table 9-23). These
 5 differences are largely associated with different amounts of tidal natural communities restoration
 6 (CM4) as well as differences in conveyance alignments (CM1) and the number and location of
 7 intakes.

8 **9.4.2.1.1 Permanent Habitat Loss, Conversion, and Fragmentation**

9 The BDCP Proposed Action would permanently affect 3,127 acres of California black rail habitat
 10 (13% of modeled habitat in the Plan Area). Tidal natural communities restoration (CM4) would
 11 account for nearly all of these effects (3,122 acres) with bypass improvement construction
 12 contributing a relatively small amount (5 acres). The majority of the effects, 3,043 acres (97% of the
 13 effect) represent conversion of one type of habitat to secondary habitat of another type, which
 14 would still be considered habitat for the species. **Take Alternatives A, B, C, E,** and **F** differ in their
 15 potential for take from the BDCP Proposed Action according to differences in conveyance route
 16 and/or the number and location of intakes. (Table 9-23). **Take Alternative A** would have the same
 17 permanent impacts on California black rail habitat as the BDCP Proposed Action. **Take Alternatives**
 18 **B, C, and E** would have more potential for take (3 more acres) than the BDCP Proposed Action and
 19 **Take Alternative F** would have an increased potential in impacts of 15 more acres. **Take**
 20 **Alternatives D, G,** and **H** would differ in potential for take relative to differences in tidal natural
 21 communities restoration (Table 9-3). **Take Alternatives D** and **G** would likely have less potential
 22 for take due to having 25,000 and 15,000 fewer acres of tidal natural communities restoration,
 23 respectively. **Take Alternative H** would have greater potential for take because 10,000 more acres
 24 of tidal natural communities would be restored and 20 more miles of channel margin would be
 25 enhanced. **Take Alternative I** would have the same potential for take as the BDCP Proposed Action
 26 (Table 9-23). Any California black rail habitat loss resulting from implementation of the USFWS
 27 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific CDFW consultations.

28 Under the BDCP Proposed Action the effects on the California black rail would be offset by the
 29 restoration of 30,000 acres of tidal brackish emergent wetland in Suisun Marsh and tidal freshwater
 30 emergent wetland in the Delta region (CM4) and the implementation of measures identified in
 31 Appendix 3.C, *Avoidance and Minimization Measures*. These measures would be the same for **Take**
 32 **Alternatives A, B, C, E, F,** and **I** and therefore would have no difference in their potential to offset
 33 take of the California black rail (Table 9-23). Although **Take Alternative H** would have a greater
 34 potential for take, by the late long-term it is assumed that the 10,000 more acres of tidal natural
 35 community restoration would more than offset any potential for take from these activities through
 36 the creation of additional emergent wetland habitat suitable for the species. **Take Alternatives D**
 37 and **G** would have less potential for take but also have less beneficial effects for California black rail
 38 by the late long-term due to having less restored emergent wetland that could be used by the
 39 species.

40 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, ROAs,
 41 and considering the species biology, the BDCP Proposed Action and take alternatives would not
 42 substantially differ in their potential to fragment modeled habitat and result in take.

1 **9.4.2.1.2 Periodic Effects**

2 No periodic inundation effects on the California black rail would occur as a result of BDCP Proposed
 3 Action or take alternatives.

4 **9.4.2.1.3 Construction-Related Effects**

5 **Temporary Habitat Loss**

6 The BDCP Proposed Action would temporarily affect 18 acres of modeled California black rail
 7 habitat as results of conveyance facility construction. All staging and other temporary construction-
 8 related work areas for tidal natural communities restoration will either be in areas that do not
 9 provide habitat for the species (i.e., already disturbed sites) or within the footprint of permanently
 10 affected areas. **Take Alternatives G, and I** would have the same potential for take associated with
 11 temporary habitat loss as the BDCP Proposed Action (Table 9-23). **Take Alternative A** would have
 12 13 fewer acres and **Take Alternatives B, C, D, E, and H** would have 16 less acres of habitat loss.
 13 **Take Alternative F** (277 more acres) would have a greater potential for take.

14 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 15 California black rail. One such measure will restore temporarily affected natural communities. These
 16 measures would be the same for all take alternatives and therefore would have no difference in their
 17 potential to mitigate take of the California black rail.

18 **Construction-Related Injury or Mortality**

19 Operation of construction equipment, or contamination from petroleum or other chemical spills,
 20 could result in injury or mortality of the California black rail. Risk will be greatest to eggs and
 21 nestlings susceptible to land-clearing activities, nest abandonment, or increased exposure to the
 22 elements or to predators. Injury to adults and fledged juveniles is less likely as these individuals are
 23 expected to avoid contact with construction equipment.

24 In general, the potential for take from construction-related injury or mortality would parallel the
 25 amount of permanent and temporary habitat disturbance associated with each take alternative.
 26 **Take Alternatives A** (13 fewer acres), **B** (13 fewer acre), **C**, (13 fewer acres), **E** (13 fewer acres),
 27 and **D** (assumed fewer based on having 25,000 fewer acres of tidal natural communities
 28 restoration), and **G** (assumed fewer acres based on having 15,000 fewer acres of tidal natural
 29 communities restoration) would have less potential for take than the BDCP Proposed Action (Table
 30 9-3). **Take Alternative F** (293 more acres), and **H** (assumed more effects based on 10,000 more
 31 acres of tidal natural communities restoration) would have a greater potential for take. **Take**
 32 **Alternative I** would have the same potential for take as the BDCP Proposed Action (Table 9-23).

33 Preconstruction surveys, construction monitoring, and other measures identified in Appendix 3.C,
 34 *Avoidance and Minimization Measures*, will be implemented to avoid and minimize injury or
 35 mortality of California black rail during construction. These measures would be the same for all take
 36 alternatives and therefore would have no difference in their potential to affect the take of the
 37 California black rail.

38 **Indirect Construction-Related Effects**

39 Noise and visual disturbance could result from construction activities such as grading, filling,
 40 contouring, and other ground-disturbing operations. If construction occurs during the nesting

1 season, these indirect effects could result in the loss or abandonment of nests, and mortality of any
2 eggs and/or nestlings.

3 The effect on each species was calculated by intersecting the assumed area of indirect effect
4 extending from the construction area for each species with each species modeled habitat; the
5 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
6 **Alternatives A** (113 fewer acres), **B, C, and E** (11 fewer acre), **F** (79 fewer acres), and **D** (assumed
7 to be fewer due to decrease of 25,000 acres of tidal natural community restoration) and **G** (assumed
8 to be fewer acres of construction-related disturbance due to a decrease of 15,000 acres of tidal
9 natural communities restoration) would have less potential for take than the BDCP Proposed Action
10 (Table 9-3). **Take Alternative H** (assumed more effects due to having 10,000 more acres of tidal
11 natural communities restoration) would have a greater potential for take than the BDCP Proposed
12 Action. **Take Alternative I** would have the same potential for take as the BDCP Proposed Action
13 (Table 9-23).

14 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
15 California black rail from indirect effects. These measures would be the same for all take alternatives
16 and therefore would have no difference in their potential to mitigate take of the California black rail.

17 **Other Indirect Effects**

18 ***Transmission Lines***

19 New transmission lines will increase the risk for bird-power line strikes, which could result in injury
20 or mortality of the California black rail. The potential for this risk, however, is considered minimal
21 based on the bird's low-altitude flight behaviors and likely low abundance near the proposed power
22 line corridors.

23 The existing network of transmission lines in the Plan Area currently poses a minimal risk for the
24 California black rail, and any incremental increase in risk associated with the new power line
25 corridors is expected to be low. Therefore, the small differences in transmission line configurations
26 between the BDCP Proposed Action and the take alternatives would not result in substantial
27 differences in level of take (Table 9-23).

28 ***Methylmercury***

29 Increased exposure to methylmercury associated with tidal natural communities restoration could
30 potentially affect California black rails that feed in restored tidal wetlands. **Take Alternatives A, B,**
31 **C, E, F, and I** would have the same levels of take from methylmercury exposure because they would
32 have the same amounts of tidal natural communities restoration. **Take Alternatives D** (25,000
33 fewer acres of tidal natural communities restoration) and **G** (15,000 fewer acres of tidal natural
34 communities restoration) would have less potential for take from methylmercury exposure than the
35 BDCP Proposed Action (Table 9-23). **Take Alternative H** (10,000 more acres of tidal natural
36 communities restoration) would have a greater potential for take than the BDCP Proposed Action.
37 Changes to the level of take from methylmercury exposure would be evaluated under project-
38 specific CDFW consultations.

39 Measures described in Chapter 3, *Conservation Strategy*, for methylmercury management (CM12)
40 are expected to reduce the effects of methylmercury resulting from tidal natural community
41 restoration. These measures would be the same for all take alternatives and therefore would have
42 no difference in their potential to mitigate take of California black rail.

1 **9.4.2.2 California Clapper Rail**

2 **Take Alternatives A, B, C, D, E, F, and I** would have the same potential for take as the BDCP
3 Proposed Action (Table 9-23). **Take Alternatives G** would have less potential for take and **Take**
4 **Alternative H** would have greater potential for take relative to the BDCP Proposed Action. These
5 differences in take are due to the different amounts of tidal natural communities restoration (CM4).

6 **9.4.2.2.1 Permanent Habitat Loss, Conversion, and Fragmentation**

7 The BDCP Proposed Action would permanently affect 35 acres of clapper rail habitat (0.5% of
8 modeled habitat in the Plan Area). All 35 acres of habitat loss are associated with tidal natural
9 community restoration and reflect the conversion of 27 acres of primary habitat to secondary
10 habitat and the conversion of the remaining 8 acres of secondary habitat to different types of
11 secondary habitats. **Take Alternatives A, B, C, E, F, and I** would have the same potential for take,
12 and negligibly different from the BDCP Proposed Action (Table 9-23), because these take
13 alternatives all have the same amount of tidal natural community restoration. **Take Alternative H**
14 would have a greater potential for take because it would restore 10,000 more acres of tidal natural
15 communities. **Take Alternatives D and G** would likely have less potential for take because it would
16 restore fewer acres (25,000 and 15,000 acres respectively) of tidal natural communities. Any
17 California clapper rail habitat loss resulting from implementation of the USFWS 2008 BiOp and
18 NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW consultations.

19 Under the BDCP Proposed Action effects on the California clapper rail would be offset by the
20 restoration of 6,000 acres of tidal brackish emergent wetland in Suisun Marsh (CM4) and the
21 implementation of measures identified in Appendix 3.C, *Avoidance and Minimization Measures*.
22 These measures would be the same for **Take Alternatives A, B, C, E, F, and I** and therefore would
23 have no difference in their potential to offset take of the California clapper rail (Table 9-23). Most
24 likely the 10,000 acres of additional tidal restoration from **Take Alternative H** would be comprised
25 mostly of subtidal habitats that would not benefit California clapper rail. This assumption is based
26 on the limited availability of additional restoration opportunities for tidal brackish emergent
27 wetlands in Suisun Marsh beyond the amounts proposed under the BDCP Proposed Action. **Take**
28 **Alternatives G and D** would have less beneficial effects on California clapper rail due to the
29 assumption that having less tidal restoration would result in less restored tidal brackish emergent
30 wetland in Suisun Marsh.

31 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, ROAs,
32 and considering the species biology, the BDCP Proposed Action and take alternatives would not
33 substantially differ in their potential to fragment modeled habitat and result in take of the California
34 clapper rail.

35 **9.4.2.2.2 Periodic Effects**

36 No periodic inundation effects on the California clapper rail would occur as a result of BDCP
37 Proposed Action or take alternatives.

1 **9.4.2.2.3 Construction-Related Effects**

2 **Temporary Habitat Loss**

3 The BDCP Proposed Action would not result in temporary effects on modeled California clapper rail
4 habitat. All staging and other temporary construction-related work areas for tidal natural
5 communities restoration will either be in areas that do not provide habitat for the species (i.e.,
6 already disturbed sites) or within the footprint of permanently affected areas described above. **Take**
7 **Alternatives A, B, C, D, E, F, G, H,** and **I** would have no temporary effects and thus no potential for
8 take from temporary habitat loss.

9 **Construction-Related Injury or Mortality**

10 Operation of construction equipment could result in injury or mortality of California clapper rails.
11 Risk will be greatest to eggs and nestlings susceptible to land-clearing activities, nest abandonment,
12 or increased exposure to the elements or to predators. Injury to adults and fledged juveniles is less
13 likely as these individuals are expected to avoid contact with construction equipment.

14 In general, the potential for take from construction-related injury or mortality would parallel the
15 amount of permanent and temporary habitat disturbance associated with each take alternative.
16 Using this approach, **Take Alternatives A, B, C, E, F,** and **I** would have the same potential for take,
17 and negligibly different from the BDCP Proposed Action, because these take alternatives would all
18 have the same amount of tidal natural communities restoration (Table 9-23). **Take Alternative H**
19 would likely have a greater potential for take than the BDCP Proposed Action because it would
20 restore 10,000 more acres of tidal natural communities. **Take Alternatives D** and **G** would likely
21 have less potential for take than the BDCP Proposed Action because it would restore fewer acres
22 (25,000 and 15,000 acres respectively) of tidal natural communities.

23 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
24 California clapper rail. These measures would be the same for all take alternatives and therefore
25 would have no difference in their potential to mitigate take of the California clapper rail.

26 **Indirect Construction-Related Effects**

27 Noise and visual disturbance could result from construction activities such as grading, filling,
28 contouring, and other ground-disturbing operations within 500 feet of the construction edge. If
29 construction occurs during the nesting season, these indirect effects could result in the loss or
30 abandonment of nests, and mortality of any eggs and/or nestlings.

31 The effect on each species was calculated by intersecting the assumed area of indirect effect
32 extending from the construction area for each species with each species modeled habitat; the
33 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
34 **Alternatives A, B, C, E, F,** and **I** would have the same potential for take, and also similar to the BDCP
35 Proposed Action, because these take alternatives all restore the same amount of tidal natural
36 communities (Table 9-23). **Take Alternative H** would likely have a greater potential for take than
37 the BDCP Proposed Action because it would restore 10,000 more acres of tidal natural communities.
38 **Take Alternatives D** and **G** would likely have less potential for take than the BDCP Proposed Action
39 because it would restore fewer acres (25,000 and 15,000 acres respectively) of tidal natural
40 communities restoration.

1 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 2 California clapper rail. These measures would be the same for all take alternatives and therefore
 3 would have no difference in their potential to mitigate take of the California clapper rail.

4 **Other Indirect Effects**

5 ***Methylmercury***

6 Increased exposure to methylmercury associated with tidal natural communities restoration could
 7 potentially affect California clapper rails that feed in restored tidal wetlands. **Take Alternatives A,**
 8 **B, C, E, F, and I** would have the same levels of potential take from methylmercury exposure because
 9 they would have the same amounts of tidal natural communities restoration (Table 9-23). **Take**
 10 **Alternatives D** (25,000 fewer acres of tidal natural communities restoration) and **G** (15,000 fewer
 11 acres of tidal natural communities restoration) would have less potential for take from
 12 methylmercury exposure than the BDCP Proposed Action (Table 9-23). **Take Alternative H** (10,000
 13 more acres of tidal natural communities restoration) would have a greater potential for take from
 14 methylmercury exposure than the BDCP Proposed Action. Changes to the level of take from
 15 methylmercury exposure would be evaluated under project-specific ESA Section 7 consultations.

16 Measures described in Chapter 3, *Conservation Strategy*, for methylmercury management (CM12)
 17 are expected to reduce the effects of methylmercury resulting from tidal natural communities
 18 restoration. These measures would be the same for all take alternatives and therefore would have
 19 no difference in their potential to mitigate take of the California clapper rail.

20 **9.4.2.3 Greater Sandhill Crane**

21 **Take Alternatives B, C, D, E, F, and G** would have less potential for take, and **Take Alternatives A**
 22 and **H** would have greater potential for take relative to the BDCP Proposed Action (Table 9-23).
 23 These differences in take are due to the different amounts of tidal natural communities restoration
 24 (CM4), conveyance construction, which includes different numbers and locations of intakes, and
 25 conveyance alignments (CM1). **Take Alternative I** would have the same potential for take as the
 26 BDCP Proposed Action

27 **9.4.2.3.1 Permanent Habitat Loss, Conversion, and Fragmentation**

28 The BDCP Proposed Action would permanently affect 7,107 acres of greater sandhill crane habitat
 29 (4% of the modeled habitat in the Plan Area. These permanent effects are associated with tidal
 30 natural communities restoration (2,754 acres), conveyance construction (1,915 acres), nontidal
 31 marsh restoration (2,699 acres), and grassland restoration (300 acres). The take alternatives would
 32 differ in their potential for take from the BDCP Proposed Action by the amounts of tidal natural
 33 communities restoration (**Take Alternatives D, G, and H**) and conveyance construction, which
 34 includes different numbers and locations of intakes (**Take Alternatives A, B, C, and E**) and
 35 conveyance alignments (**Take Alternatives A and F**) (Table 9-23). **Take Alternatives A and F**
 36 would have less potential for take than the BDCP Proposed Action (1,254 and 2,662 fewer acres,
 37 respectively) because their alignments would be further away from greater sandhill crane habitat.
 38 **Take Alternative B** would have less potential for take (811 fewer acres) because it would have
 39 fewer intakes. **Take Alternatives C and E** would also have less potential for take (727 fewer acres
 40 each) than the BDCP Proposed Action. **Take Alternative D** would have less potential for take
 41 because it would restore 25,000 fewer acres of tidal natural communities. **Take Alternative G**
 42 would likely have less potential for take because it would restore 15,000 fewer acres of tidal natural

1 communities (Table 9-3). **Take Alternative H** would likely have more potential for take because it
 2 would have 10,000 more acres of tidal natural communities restoration. **Take Alternative I** would
 3 have the same potential for take as the BDCP Proposed Action. Any greater sandhill crane habitat
 4 loss resulting from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be
 5 evaluated under project-specific CDFW consultations.

6 Effects on the greater sandhill crane would be offset by the protection of 48,625 acres of cultivated
 7 lands. Create 320 acres of new managed wetlands would include greater sandhill crane roosting
 8 habitat in minimum patch sizes of 40 acres within 2 miles of winter use areas. Measures identified in
 9 Appendix 3.C, *Avoidance and Minimization Measures*, would be implemented. These measures would
 10 be the same for all take alternatives and would have no difference in their potential to offset take of
 11 the greater sandhill crane.

12 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, ROA,
 13 and considering the species biology, the BDCP Proposed Action and take alternatives would not
 14 substantially differ in their potential to fragment modeled habitat and result in take. Fragmentation
 15 of both suitable and occupied habitat is expected to be minimal because the majority of the affected
 16 acres are outside of the core occupied portion of the winter use area.

17 **9.4.2.3.2 Periodic Effects**

18 No periodic inundation effects on the greater sandhill crane would occur as a result of BDCP
 19 Proposed Action or take alternatives.

20 **9.4.2.3.3 Construction-Related Effects**

21 **Temporary Habitat Loss**

22 The BDCP Proposed Action would temporarily affect 985 acres of modeled greater sandhill crane
 23 habitat (0.5% of modeled habitat in the Plan Area). All of these effects are associated with
 24 conveyance facility construction. **Take Alternatives A, B, C, D, E, F, and H** would differ in their
 25 levels of take relative to the BDCP Proposed Action based on differences in conveyance alignments
 26 and/or the number and location of intakes (Table 9-23). **Take Alternative A** (1,275 more acres)
 27 and **C and E** (8 acres more each) would have a greater potential for take than the BDCP Proposed
 28 Action. **Take Alternatives B** (244 fewer acres), **D** (315 fewer acres), **F** (407 fewer acres), and **H**
 29 (169 fewer acres) would have less potential for take than the BDCP Proposed Action. **Take**
 30 **Alternatives G and I** would have the same potential for take because they would have the same
 31 conveyance footprint as the BDCP Proposed Action.

32 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 33 greater sandhill crane. One such measure will restore temporarily affected natural communities.
 34 These measures would be the same for all take alternatives and therefore would have no difference
 35 in their potential to mitigate take of the greater sandhill crane.

36 **Construction-Related Injury or Mortality**

37 In general, the potential for take from construction-related effects would parallel the amount of
 38 permanent and temporary habitat disturbance associated with each take alternative. **Take**
 39 **Alternatives A** (21 more acres) and **H** (assumed more acres because it would restore 10,000 more
 40 acres of tidal natural communities) would have a greater potential for take than the BDCP Proposed
 41 Action (Table 9-3). **Take Alternatives B** (1,054 fewer acres), **C and E** (719 fewer acres), **F** (3,069

1 fewer acres), and **D** and **G** (assumed fewer acres of effects because it would restore 25,000 and
2 15,000 fewer acres, respectively, of tidal natural communities) would have less potential for take
3 than the BDCP Proposed Action.

4 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
5 greater sandhill crane. These measures would be the same for all take alternatives and therefore
6 would have no difference in their potential to mitigate take of the greater sandhill crane.

7 **Indirect Construction-Related Effects**

8 Construction-related noise and visual disturbances within 2,600 feet of construction activities could
9 temporarily affect the use of modeled greater sandhill crane habitat. These construction activities
10 will include water conveyance construction, transmission line construction, and tidal natural
11 communities restoration activities.

12 The effect on each species was calculated by intersecting the assumed area of indirect effect
13 extending from the construction area for each species with each species modeled habitat; the
14 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
15 **Alternative H** (assumed more acres because it would restore 10,000 more acres of tidal natural
16 communities) would have a greater potential for take. **Take Alternatives A** (5,646 fewer acres), **B**
17 (297 fewer acres), **C** and **E** (407 fewer acres), **F** (9,018 fewer acres), and **D** and **G** (assumed fewer
18 acres because it would restore 25,000 and 15,000 fewer acres, respectively, of tidal natural
19 communities) would have less potential for take than the BDCP Proposed Action (Table 9-23). **Take**
20 **Alternative I** would have the same potential for take as the BDCP Proposed Action.

21 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
22 greater sandhill crane. These measures would be the same for all take alternatives and therefore
23 would have no difference in their potential to mitigate take of the greater sandhill crane.

24 **Other Indirect Effects**

25 **Transmission Lines**

26 New transmission lines will increase the risk of greater sandhill crane power line strikes or
27 electrocution. Greater sandhill cranes are susceptible to collision with power lines and other
28 structures during periods of inclement weather and low visibility. The existing network of power
29 lines in the Plan Area currently poses this risk for greater sandhill cranes. New transmission lines
30 will increase this risk. However, power line siting considers and, to the extent possible, reduces the
31 risk by designing the project to avoid high-use areas and flight corridors.

32 In general, the potential for take would differ due to the number and location of intakes and
33 associated transmission line and/or the general conveyance alignment. **Take Alternatives A** and **F**
34 would have substantially less potential for take from transmission lines because associated
35 transmission lines would be further away from known roost sites compared to the BDCP Proposed
36 Action.

37 **9.4.2.4 Least Bell's Vireo**

38 **Take Alternatives A, F, and H** would have a greater potential for take and **Take Alternatives B, C,**
39 **D, E, and G** would have less potential for take than the BDCP Proposed Action (Table 9-23). These
40 differences are attributable to the conveyance alignments and number and location of intakes

1 (CM1), Yolo Bypass fisheries enhancements (CM2), tidal natural communities restoration (CM4),
 2 and floodplain restoration (CM5). **Take Alternative I** would have the same potential for take as the
 3 BDCP Proposed Action.

4 **9.4.2.4.1 Permanent Habitat Loss, Conversion, and Fragmentation**

5 Covered activities associated with conveyance facilities construction (CM1), Yolo Bypass fisheries
 6 enhancements (CM2), tidal natural communities restoration (CM4), and floodplain restoration
 7 (CM5), have the potential to result in take of the least Bell’s vireo as a result of permanent effects on
 8 modeled habitat in Conservation Zones 2, 7, and 8. The BDCP Proposed Action would result in the
 9 permanent loss of approximately 685 acres of primary and secondary nesting and migratory habitat
 10 (6% of modeled habitat in the Plan Area). **Take Alternatives A, B, D, and G** would have a lower
 11 effect on modeled least Bell’s vireo habitat due to the conveyance alignment, the number and
 12 location of intakes and/or reduced amount of tidal natural communities restoration (Table 9-3).
 13 Permanent loss of nesting and migratory habitat would decrease for **Take Alternative A** (15 fewer
 14 acres) and decrease slightly for **Take Alternative B** (2 fewer acres). **Take Alternatives D and G**
 15 would also result in less permanent habitat loss because it would restore 25,000 and 15,000 fewer
 16 acres, respectively, of tidal natural communities. **Take Alternatives C and E (1 more acre), F (20**
 17 **more acres), and H** would result in an increase in primary and secondary nesting and migratory
 18 habitat loss. **Take Alternative H** would result in more habitat loss because it would restore 10,000
 19 more acres of tidal natural communities and 10,000 more acres of floodplains). **Take Alternative I**
 20 would have the same potential for habitat loss as the BDCP Proposed Action (Table 9-23). Any least
 21 Bell’s vireo habitat loss resulting from implementation of the USFWS 2008 BiOp and NMFS 2009
 22 BiOp would be evaluated under project-specific ESA Section 7 and CDFW consultations.

23 Under the BDCP Proposed Action, 5,000 acres of valley/foothill riparian natural community
 24 restoration would occur and 750 acres of existing valley foothill riparian would be protected (CM7)
 25 that would offset the loss of modeled least Bell’s vireo habitat. These conservation measures would
 26 be the same for **Take Alternatives A, B, C, D, E, F, G, and I** and therefore would have no difference
 27 in their potential to mitigate take of least Bell’s vireo. **Take Alternative H** would likely benefit least
 28 Bell’s vireo through increases in potentially suitable riparian habitat that would likely establish
 29 within the 10,000 acres of additional floodplain restoration (CM5).

30 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
 31 ROAs, the BDCP Proposed Action and take alternatives would not substantially differ in their
 32 potential to fragment modeled habitat and result in take of the least Bell’s vireo.

33 **9.4.2.4.2 Periodic Effects**

34 Periodic inundation will not result in adverse effects on the least Bell’s vireo because the increased
 35 flooding regime as a result of the BDCP Proposed Action and take alternatives would be within the
 36 tolerance range for riparian habitat and is unlikely to occur during the breeding season when least
 37 Bell’s vireos could be present. No periodic inundation effects on the least Bell’s vireo would occur as
 38 a result of BDCP Proposed Action or take alternatives.

1 **9.4.2.4.3 Construction-Related Effects**

2 **Temporary Habitat Loss**

3 The BDCP Proposed Action would temporarily affect 132 acres of modeled least Bell’s vireo habitat
 4 (1.2% of the modeled habitat in the Plan Area). These effects are associated with conveyance facility
 5 construction (23 acres), Yolo Bypass fisheries enhancement (88 acres), and levee construction
 6 associated with floodplain restoration (21 acres). **Take Alternatives A, B, C, D, E, F, and H** differ in
 7 their levels of take compared to the BDCP Proposed Action due to differences in conveyance
 8 alignments and/or the number and location of intakes (Table 9-3). **Take Alternative A** (21 more
 9 acres), and **F** (210 more acres) would have a greater potential for take. **Take Alternatives B** (13
 10 fewer acres), **C** and **E** (5 fewer acres), and **D** (12 fewer acres) would have less potential for take.
 11 **Take Alternative H** would have a greater potential for take than the BDCP Proposed Action because
 12 it would restore 10,000 more acres of floodplain. **Take Alternatives G** and **I** would have the same
 13 potential for take as the BDCP Proposed Action (Table 9-23).

14 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 15 least Bell’s vireo. One such measure will restore temporarily affected natural communities. These
 16 measures would be the same for all take alternatives and therefore would have no difference in their
 17 potential to affect take of the least Bell’s vireo.

18 **Construction-Related Injury or Mortality**

19 Operation of construction equipment could result in injury or mortality of the least Bell’s vireo. Risk
 20 will be greatest to eggs and nestlings susceptible to land-clearing activities, nest abandonment, or
 21 increased exposure to the elements or to predators. Injury to adults and fledged juveniles is less
 22 likely as these individuals are expected to avoid contact with construction equipment.

23 In general, the potential for take from construction-related injury or mortality would parallel the
 24 amount of permanent and temporary habitat disturbance associated with each take alternative.
 25 **Take Alternatives A** (6 more acres), **F** (230 more acres), and **H** (assumed more acres because it
 26 would increase the floodplain restoration footprint) would have a greater potential for take than the
 27 BDCP Proposed Action due to larger construction and restoration footprints. **Take Alternatives B**
 28 (6 fewer acres), **C** and **E** (5 fewer acres), and **D** and **G** (assumed fewer acres because it would
 29 decrease the tidal natural communities restoration footprint by 25,000 and 15,000 acres,
 30 respectively) would have less potential for take than the BDCP Proposed Action.

31 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 32 least Bell’s vireo. One such measure will conduct preconstruction nesting surveys. These measures
 33 would be the same for all take alternatives and therefore would have no difference in their potential
 34 to mitigate take of the least Bell’s vireo.

35 **Indirect Construction-Related Effects**

36 Noise and visual disturbances within 1,300 feet of least Bell’s vireo nesting and migratory habitat
 37 could temporarily affect the use of these habitats. Also, petroleum or other contaminant spills from
 38 construction equipment, drilling operations, or other activities could affect least Bell’s vireos if
 39 present.

40 The effect on each species was calculated by intersecting the assumed area of indirect effect
 41 extending from the construction area for each species with each species modeled habitat; the

1 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
 2 **Alternatives D and G** (assumed fewer acres because it would decrease the floodplain restoration
 3 footprint by 25,000 and 15,000 acres, respectively) would have less potential for indirect effects
 4 than the BDCP Proposed Action due to due to larger construction and restoration footprints (Table
 5 9-23). **Take Alternatives A (255 more acres), B (237 more acres), C and E (242 more acres),**
 6 **and F (287 more acres),** and **H** (assumed more acres because it would increase the construction
 7 and restoration footprint) would have a greater potential for take than the BDCP Proposed Action
 8 due to lower acreages of project-related disturbance. **Take Alternative I** would have the same
 9 potential for take as the BDCP Proposed Action.

10 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 11 least Bell's vireo. One such measure will conduct preconstruction nesting surveys. These measures
 12 would be the same for all take alternatives and therefore would have no difference in their potential
 13 to mitigate take of the least Bell's vireo.

14 **9.4.2.5 Suisun Song Sparrow**

15 **Take Alternatives A, B, C, E, F, and I** would have the same potential for take as the BDCP Proposed
 16 Action (Table 9-23). **Take Alternatives D and G** would have less potential for take, and **Take**
 17 **Alternative H** would have a greater potential for take than the BDCP Proposed Action. The
 18 differences in potential for take are due to the amounts of tidal natural communities restoration
 19 (CM4) associated with these alternatives.

20 **9.4.2.5.1 Permanent Habitat Loss, Conversion, and Fragmentation**

21 The BDCP Proposed Action would permanently affect 3,688 acres of modeled Suisun song sparrow
 22 habitat (13% of the modeled habitat in the Plan Area), primarily from tidal natural communities
 23 restoration, only 55 acres of these effects would be on primary habitat. **Take Alternatives A, B, C, E,**
 24 **F, and I** would have the same potential for take as the BDCP Proposed Action because they have the
 25 same tidal natural communities restoration effects (Table 9-23). **Take Alternatives D and G**
 26 (assumed to have fewer acres of effect) would have less potential for take because they would
 27 restore 25,000 and 15,000 fewer acres of tidal natural communities, respectively. **Take Alternative**
 28 **H** (assumed to have more acres of effect) would have greater potential for take because it would
 29 restore 10,000 more acres of tidal natural communities. Any Suisun song sparrow habitat loss
 30 resulting from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated
 31 under project-specific environmental review under NEPA, CEQA and/or consultation with CDFW.

32 Under the BDCP Proposed Action, effects on the Suisun song sparrow would be offset by the
 33 restoration or creation of 6,000 acres of tidal brackish emergent wetland in Suisun Marsh,
 34 protection of 8,000 acres of grassland, the restoration of 2,000 acres of grassland, which could be
 35 used as secondary upland habitat, and the implementation of measures identified in Appendix 3.C,
 36 *Avoidance and Minimization Measures*. These measures would be the same for **Take Alternatives A,**
 37 **B, C, E, F, and I** and therefore would have no difference in their potential to offset take of the Suisun
 38 song sparrow. Most likely the 10,000 acres of additional tidal restoration from **Take Alternative H**
 39 would be comprised mostly of subtidal habitats that would not benefit Suisun song sparrow. This
 40 assumption is based on the limited availability of additional restoration opportunities for tidal
 41 brackish emergent wetlands in Suisun Marsh beyond the amounts proposed under the BDCP
 42 Proposed Action. **Take Alternatives G and D** would have less beneficial effects on Suisun song

1 sparrow due to the assumption that having less tidal restoration would result in less restored tidal
 2 brackish emergent wetland in Suisun Marsh.

3 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, ROAs,
 4 and considering the species biology, the BDCP Proposed Action and take alternatives would not
 5 substantially differ in their potential to fragment modeled habitat and result in take.

6 **9.4.2.5.2 Periodic Effects**

7 No periodic inundation effects on the Suisun song sparrow would occur as a result of BDCP
 8 Proposed Action or take alternatives.

9 **9.4.2.5.3 Construction-Related Effects**

10 **Temporary Habitat Loss**

11 The BDCP Proposed Action would not result in temporary effects on modeled Suisun song sparrow
 12 habitat. All staging and other temporary construction-related work areas for tidal natural
 13 communities restoration will either be in areas that do not provide habitat for the species (i.e.,
 14 already disturbed sites) or within the footprint of permanently affected areas described above. **Take**
 15 **Alternatives A, B, C, D, E, F, G, H, and I** would have no temporary effects and thus no potential for
 16 take from temporary habitat impacts.

17 **Construction-Related Injury or Mortality**

18 Operation of construction equipment could result in injury or mortality of Suisun song sparrows.
 19 Risk will be greatest to eggs and nestlings susceptible to land clearing activities, nest abandonment,
 20 or increased exposure to the elements or to predators. Injury to adults and fledged juveniles is less
 21 likely as these individuals are expected to avoid contact with construction equipment.

22 In general, the potential for take from construction-related injury or mortality would parallel the
 23 amount of tidal natural communities restoration associated with each take alternative. **Take**
 24 **Alternatives A, B, C, E, F, and I** would have the same potential for take as the BDCP Proposed Action
 25 because they have the same tidal natural communities restoration effects (Table 9-23). **Take**
 26 **Alternatives D and G** (assumed to have fewer acres) would have less potential for take because
 27 they would restore 25,000 and 15,000 fewer acres of tidal natural communities, respectively. **Take**
 28 **Alternative H** (assumed to have more acres) would have greater potential for take because it would
 29 restore 10,000 more acres of tidal natural communities. Any construction-related injury or
 30 mortality resulting from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be
 31 evaluated under project-specific environmental review under NEPA, CEQA and/or consultation with
 32 CDFW.

33 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 34 Suisun song sparrow. One such measure will be to conduct preconstruction surveys for the species.
 35 These measures would be the same for all take alternatives and therefore would have no difference
 36 in their potential to mitigate take of the Suisun song sparrow.

37 **Indirect Construction-Related Effects**

38 Noise and visual disturbance could result from construction activities such as grading, filling,
 39 contouring, and other ground-disturbing operations within 500 feet of the construction edge. If

1 construction occurs during the nesting season, these indirect effects could result in the loss or
2 abandonment of nests, and mortality of any eggs and/or nestlings.

3 The effect on each species was calculated by intersecting the assumed area of indirect effect
4 extending from the construction area for each species with each species modeled habitat; the
5 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
6 **Alternatives A, B, C, E, F, and I** would have the same potential for take as the BDCP Proposed Action
7 because they would have the same tidal natural communities restoration effects (Table 9-23). **Take**
8 **Alternatives D and G** (assumed to have fewer acres of effect) would have less potential for take
9 because they would restore 25,000 and 15,000 fewer acres of tidal natural communities,
10 respectively. **Take Alternative H** (assumed to have more acres of effect) would have greater
11 potential for take because it would restore 10,000 more acres of tidal natural communities.

12 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
13 Suisun song sparrow. One such measure will be to conduct preconstruction surveys for the species.
14 These measures would be the same for all take alternatives and therefore would have no difference
15 in their potential to mitigate take of the Suisun song sparrow.

16 **Other Indirect Effects**

17 ***Methylmercury***

18 Increased exposure to methylmercury associated with tidal natural communities restoration could
19 potentially affect Suisun song sparrows that forage in these areas. **Take Alternatives A, B, C, D, F,**
20 **and I** would have the same levels of potential take from methylmercury exposure because they
21 would have the same amounts of tidal natural communities restoration. **Take Alternatives D**
22 **(25,000 fewer acres of tidal natural communities restoration) and G** (15,000 fewer acres of tidal
23 natural communities restoration) would have less potential for take from methylmercury exposure
24 than the BDCP Proposed Action (Table 9-23). **Take Alternative H** (10,000 more acres of tidal
25 natural communities restoration) would have a greater potential for take. Changes to the level of
26 take from methylmercury exposure would be evaluated under project-specific ESA Section 7
27 consultations.

28 Measures described in Chapter 3, *Conservation Strategy*, for methylmercury management (CM12)
29 are expected to reduce the effects of methylmercury resulting from tidal natural communities
30 restoration. These measures would be the same for all take alternatives and therefore would have
31 no difference in their potential to mitigate take of Suisun song sparrow.

32 **9.4.2.6 Swainson's Hawk**

33 **Take Alternatives B, C, D, E, F, and G** would have less potential for take and **Take Alternatives A**
34 **and H** would have more potential for take than the BDCP Proposed Action (Table 9-23). These
35 differences are mostly from effects on foraging habitat associated with tidal natural communities
36 restoration (CM4) and the conveyance alignments and numbers of intakes (CM1). **Take Alternative**
37 **I** would have the same potential for take as the BDCP Proposed Action.

38 **9.4.2.6.1 Permanent Habitat Loss, Conversion, and Fragmentation**

39 The BDCP Proposed Action would permanently affect 53,275 acres of modeled Swainson's hawk
40 habitat (11% of the modeled habitat in the Plan Area), the majority of which loss (52,845 acres)
41 would be of foraging habitat. Most of these effects would be from tidal natural communities

1 restoration (37,654 acres), floodplain restoration (1,857 acres), and conveyance construction (4,353
 2 acres). **Take Alternatives B, C, E, and F** would differ in their potential for take compared to the
 3 BDCP Proposed Action due to conveyance alignment and/or the number and location of intakes
 4 (Table 9-23). **Take Alternatives B** (1,115 fewer acres), **C** and **E** (1,040 fewer acres), and **Take**
 5 **Alternative F** (3,948 fewer acres) would have less potential for take. **Take Alternative A** (599 more
 6 acres) would have a greater potential for take. **Take Alternatives D, G, and H** would differ in their
 7 potential for take from the BDCP Proposed Action mostly due to the amount of tidal natural
 8 communities restoration. **Take Alternatives D and G** (assumed fewer acres because it would
 9 restore 15,000 fewer acres of tidal natural communities) would have less potential for take. **Take**
 10 **Alternative H** is assumed to have a greater potential for take because it would restore 10,000 more
 11 acres of tidal natural communities and 10,000 more acres of floodplain than the BDCP Proposed
 12 Action (Table 9-23). **Take Alternative I** would have the same potential for take as the BDCP
 13 Proposed Action. Any Swainson’s hawk habitat loss resulting from implementation of the USFWS
 14 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific environmental review
 15 under NEPA, CEQA and/or consultation with CDFW.

16 Under the BDCP Proposed Action, effects on the Swainson’s hawk would be offset by the restoration
 17 or creation of 5,000 acres of valley/foothill riparian forest of which at least 3,000 acres would be in
 18 restored seasonally inundated floodplain; the protection of 750 acres of existing valley/foothill
 19 riparian forest; the protection of 8,000 acres of grassland; the restoration of 2,000 acres of
 20 grassland; the protection of 600 acres of vernal pool complex; the protection of 150 acres of alkali
 21 seasonal wetland; the protection and enhancement of 8,100 acres of managed wetland; the
 22 protection of 48,625 acres of cultivated land of which 43,325 acres would be foraging habitat; and
 23 implementation of measures identified in Appendix 3.C, *Avoidance and Minimization Measures*.
 24 These conservation measures would be the same for **Take Alternatives A, B, C, D, E, F, G, and I** and
 25 therefore would have no difference in their potential to mitigate take of Swainson’s hawk (Table
 26 9-23). **Take Alternative H** would likely benefit Swainson’s hawk through increases in potentially
 27 suitable riparian nesting habitat that would likely establish within the 10,000 acres of additional
 28 floodplain restoration (CM5)

29 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, ROAs,
 30 and considering the species biology, the BDCP Proposed Action and take alternatives would not
 31 substantially differ in their potential to fragment modeled habitat and result in take.

32 **9.4.2.6.2 Periodic Effects**

33 There is potential for take of the Swainson’s hawk from periodic inundation of modeled foraging
 34 habitat associated with Yolo Bypass operations (CM2) and floodplain restoration (CM5). This
 35 potential for take is the same for **Take Alternatives A, B, C, D, E, F, G, and I**. **Take Alternative H**,
 36 which would restore 10,000 more acres of floodplain, would have a proportionally greater potential
 37 for take of the Swainson’s hawk from periodic flooding than the BDCP Proposed Action (Table 9-23).

38 **9.4.2.6.3 Construction-Related Effects**

39 **Temporary Habitat Loss**

40 The BDCP Proposed Action would temporarily affect 2,939 acres of modeled Swainson’s hawk
 41 habitat, most of which (2,836 acres) would be foraging habitat. The potential for take would be the
 42 same for **Take Alternative G** and **I** because they would have the same conveyance footprint and
 43 same effects from fisheries enhancement and floodplain restoration. **Take Alternatives A, B, C, D, E,**

1 and **F** would differ in their levels of take compared to the BDCP Proposed Action due to differences
2 in conveyance alignments and/or the number and location of intakes (Table 9-3). **Take**
3 **Alternatives A** (5,647 more acres), **C** and **E** (32 more acres), and **F** (1,249 more acres) would have a
4 greater potential for take. **Take Alternatives B** (109 fewer acres) and **D** (181 fewer acres) would
5 have less potential for take. **Take Alternative H** would have a greater potential for take because it
6 would restore 10,000 more acres of floodplains, which is associated with temporary effects.

7 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
8 Swainson's hawk. One such measure will restore temporarily affected natural communities. These
9 measures would be the same for all take alternatives and therefore would have no difference in their
10 potential to mitigate take of the Swainson's hawk.

11 **Construction-Related Injury or Mortality**

12 The potential for take from construction-related effects would parallel the amount of permanent and
13 temporary habitat disturbance associated with each take alternative. **Take Alternatives A** (6,245
14 more acres) would have a greater potential for take than the BDCP Proposed Action (Table 9-23).
15 **Take Alternatives B** (1,224 fewer acres), **C** and **E** (908 fewer acres), **F** (1,440 fewer acres), and **D**
16 and **G** (assumed fewer acres due to smaller restoration footprint, 25,000 and 15,000 fewer acres,
17 respectively) would have less potential for take. **Take Alternative H** would have a greater potential
18 for take because it would restore 10,000 more acres of floodplains, which is associated with
19 temporary effects. **Take Alternative I** would have the same potential for take as the BDCP Proposed
20 Action.

21 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
22 Swainson's hawk. One such measure will require conducting preconstruction surveys for the
23 species. These measures would be the same for all take alternatives and therefore would have no
24 difference in their potential to mitigate take of the Swainson's hawk.

25 **Indirect Construction-Related Effects**

26 Noise and visual disturbances from construction activities could temporarily affect the use of
27 modeled Swainson's hawk habitat. These construction activities will include water conveyance
28 construction, transmission line construction, tidal natural communities restoration activities, tidal
29 plain restoration, and Fremont Weir/Yolo Bypass enhancements. Noise and visual disturbances
30 associated with the BDCP Proposed Action may temporarily displace Swainson's hawks and
31 temporarily reduce the use of nesting habitat within 0.25 mile of construction areas and foraging
32 habitat within 500 feet of construction areas.

33 The effect on each species was calculated by intersecting the assumed area of indirect effect
34 extending from the construction area for each species with each species modeled habitat; the
35 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
36 **Alternatives A** (1,115 fewer acres), **B** (1,751 fewer acres), **C** and **E** (1,772 fewer acres), **F** (5,826
37 fewer acres), and **D** and **G** (assumed fewer acres due to smaller restoration footprint of 25,000 and
38 15,000 acres, respectively) would have less potential for take (Table 9-23). **Take Alternative H**
39 would have a greater potential for take because it would restore 10,000 more acres of floodplains,
40 which is associated with temporary effects. **Take Alternative I** would have the same potential for
41 take as the BDCP Proposed Action. Any Swainson's hawks affected by implementation of the USFWS
42 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW
43 consultations.

1 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 2 Swainson’s hawk. One such measure will require conducting preconstruction surveys for the
 3 species. These measures would be the same for all take alternatives and therefore would have no
 4 difference in their potential to mitigate take of the Swainson’s hawk.

5 **Other Indirect Effects**

6 New transmission lines will increase the risk of Swainson’s hawk power-line strikes or
 7 electrocution. The existing network of power lines in the Plan Area currently poses this risk for the
 8 Swainson’s hawk, and any incremental increase in risk associated with the new power lines is
 9 expected to be minor. Therefore the take alternatives are not anticipated to greatly differ in their
 10 potential for take from the BDCP Proposed Action.

11 **9.4.2.7 Tricolored Blackbird**

12 **Take Alternatives A and H** would have a greater potentials for take and **Take Alternatives B, C, D,**
 13 **E, F, and G** would have less potential for take than the BDCP Proposed Action (Table 9-23). These
 14 differences are attributable to conveyance alignments (CM1), tidal natural communities restoration
 15 (CM4), and floodplain restoration (CM5). **Take Alternative I** would have the same potential for take
 16 as the BDCP Proposed Action.

17 **9.4.2.7.1 Permanent Habitat Loss, Conversion, and Fragmentation**

18 The BDCP Proposed Action would permanently affect 42,766 acres of modeled tricolored blackbird
 19 habitat (10% of the modeled habitat in the Plan Area). These permanent effects would include
 20 29,074 acres of permanent habitat loss and 13,692 acres of habitat conversion, which mostly
 21 involves the conversion of agricultural foraging habitat into nesting habitat (tidal freshwater marsh)
 22 from tidal natural communities restoration (CM4). Tidal natural communities restoration (CM4)
 23 under the covered actives would account for 28,724 acres of permanently affected modeled habitat
 24 (63% of the total affected habitat). **Take Alternatives A, B, C, E, and F** would differ in their potential
 25 for take from the BDCP Proposed Action by differences in conveyance construction route and/or the
 26 number and location of intakes (Table 9-3). **Take Alternative A** (323 fewer acres), **B** (1,416 fewer
 27 acres), **C and E** (1,348 fewer acres), and **F** (3,823 fewer acres) would have less potential for take due
 28 to the use of the western conveyance route. **Take Alternatives D, G, and H** would differ in potential
 29 for take from the BDCP Proposed Action due to differences in tidal natural communities restoration.
 30 **Take Alternatives D and G** (assumed less effect) would likely have substantially less potential for
 31 take because they would restore 25,000 and 15,000 fewer acres of tidal natural communities,
 32 respectively. **Take Alternative H** is assumed to have substantially greater potential for take than
 33 the BDCP Proposed Action because it would restore 10,000 more acres of tidal natural communities,
 34 10,000 more acres of floodplain, and would enhance 20 more miles of channel margin. **Take**
 35 **Alternative I** would have the same potential for take as the BDCP Proposed Action. Any tricolored
 36 blackbird habitat loss resulting from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp
 37 would be evaluated under project-specific environmental review under NEPA, CEQA and/or
 38 consultation with CDFW.

39 Effects on the tricolored blackbird would be offset by the protection of 8,000 acres of grassland, the
 40 restoration of 2,000 acres of grassland, the protection of 600 acres of vernal pool complex, the
 41 protection of 150 acres of alkali seasonal wetland, the protection of 48,625 acres of cultivated land
 42 (26,300 of which would provide foraging habitat for the species), the protection or restoration of 50

1 acres of recently occupied tricolored blackbird nesting habitat, and the implementation of measures
 2 identified in Appendix 3.C, *Avoidance and Minimization Measures*. These measures would be the
 3 same for all take alternatives and therefore would have no difference in their potential to offset take
 4 of the tricolored blackbird.

5 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, ROAs,
 6 and considering the species biology, the BDCP Proposed Action and take alternatives would not
 7 substantially differ in their potential to fragment modeled habitat and result in take. The BDCP
 8 Proposed Action and take alternatives would not fragment or isolate breeding habitat (nesting and
 9 breeding season foraging) in the Plan Area because most of the known breeding areas are along the
 10 margins of the Plan Area and because most of the effects would occur on cultivated lands that are
 11 abundant throughout the Plan Area.

12 **9.4.2.7.2 Periodic Effects**

13 There is potential for take of the tricolored blackbird from the periodic inundation of modeled
 14 foraging habitat as a result of Yolo Bypass operations (CM2) and floodplain restoration (CM5). This
 15 potential for take would be the same for **Take Alternatives A, B, C, E, F, and I** (Table 9-23). **Take**
 16 **Alternatives D and G**, which would restore 25,000 and 15,000 fewer acres of floodplain
 17 respectively, would have less potential for take. **Take Alternative H**, which would restore 10,000
 18 more acres of floodplains, would have a greater potential for take from periodic flooding than the
 19 BDCP Proposed Action. Any periodic effects to tricolored resulting from implementation of the
 20 USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific environmental
 21 review under NEPA, CEQA and/or consultation with CDFW.

22 **9.4.2.7.3 Construction-Related Effects**

23 **Temporary Habitat Loss**

24 The BDCP Proposed Action would temporarily affect 2,032 acres of modeled tricolored blackbird
 25 habitat (0.5% of the modeled habitat in the Plan Area). These effects are associated with conveyance
 26 facility construction (987 acres), Yolo Bypass fisheries enhancement (367 acres), and levee
 27 construction for floodplain restoration (678 acres). This potential for take would be the same for
 28 **Take Alternative G** because it would have the same conveyance footprint and same effects from
 29 fisheries enhancement and floodplain restoration. **Take Alternatives A, B, C, D, E, and F** would
 30 differ in their levels of take due to differences in conveyance alignments and/or the number and
 31 location of intakes (Table 9-3). **Take Alternatives A** (3,874 more acres), **C** and **E** (164 more acres),
 32 and **F** (1,182 more acres) would have a greater potential for take. **Take Alternatives B** (46 fewer
 33 acres) and **D** (95 fewer acres) would have less potential. **Take Alternative H** would have a greater
 34 potential for take because it would restore 10,000 more acres of floodplains. Any tricolored
 35 blackbird habitat temporarily affected by implementation of the USFWS 2008 BiOp and NMFS 2009
 36 BiOp would be evaluated under project-specific environmental review under NEPA, CEQA and/or
 37 consultation with CDFW.

38 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 39 tricolored blackbird. One such measure will restore temporarily affected natural communities.
 40 These measures would be the same for all take alternatives and therefore would have no difference
 41 in their potential to mitigate take of the tricolored blackbird.

1 **Construction-Related Injury or Mortality**

2 Operation of construction equipment could result in injury or mortality of tricolored blackbirds.
3 Risk will be greatest to eggs and nestlings susceptible to land-clearing activities, nest abandonment,
4 or increased exposure to the elements or to predators. Injury to adults and fledged juveniles is less
5 likely as these individuals are expected to avoid contact with construction equipment.

6 In general, the potential for take from construction-related injury or mortality would parallel the
7 amount of permanent and temporary habitat disturbance associated with each take alternative.
8 **Take Alternative H** would have a greater potential for construction-related injury or mortality than
9 the BDCP Proposed Action due to the greater amounts of tidal, floodplain, and channel margin
10 restoration. **Take Alternative A** (3,550 more acres) would have a greater potential for take due to
11 larger construction and restoration footprints. **Take Alternatives B** (1,462 fewer acres), **C** and **E**
12 (1,184 fewer acres), **F** (2,640 fewer acres), and **D** and **G** (assumed fewer acres of construction-
13 related disturbance due to smaller tidal natural communities restoration footprint [25,000 and
14 15,000 fewer acres, respectively]) would have less potential for take. Any tricolored blackbird
15 affected from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated
16 under project-specific environmental review under NEPA, CEQA and/or consultation with CDFW.

17 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
18 tricolored blackbird. One such measure will require conducting preconstruction surveys for
19 tricolored blackbird nesting colonies. These measures would be the same for all take alternatives
20 and therefore would have no difference in their potential to mitigate take of the tricolored blackbird.

21 **Indirect Construction-Related Effects**

22 Noise and visual disturbances from construction activities within 1,300 feet of tricolored blackbird
23 nesting colonies and 500 feet of foraging habitat could temporarily affect the use of these habitats.
24 Also, petroleum or other contaminant spills from construction equipment, drilling operations, or
25 other activities could affect tricolored blackbirds if present.

26 The effect on each species was calculated by intersecting the assumed area of indirect effect
27 extending from the construction area for each species with each species modeled habitat; the
28 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
29 **Alternative H** would have a greater potential for indirect construction-related effects than the BDCP
30 Proposed Action due to the greater amounts of tidal, floodplain, and channel margin restoration.
31 **Take Alternatives A** (1,706 fewer acres), **B** (1,751 fewer acres), **C** and **E** (1,772 fewer acres), **F**
32 (5,826 fewer acres), and **D** and **G** (assumed fewer acres due to smaller construction and restoration
33 footprint [25,000 and 15,000 fewer acres, respectively]) would have less potential for take due to
34 lower acreages of project related disturbance. Any tricolored blackbirds affected by implementation
35 of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific ESA
36 Section 7 and CDFW consultations.

37 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
38 tricolored blackbird. One such measure will require conducting preconstruction surveys for
39 tricolored blackbird nesting colonies. These measures would be the same for all take alternatives
40 and therefore would have no difference in their potential to mitigate take of the tricolored blackbird.

1 **Other Indirect Effects**

2 **Transmission Lines**

3 New transmission lines will increase the risk for tricolored blackbird power-line strikes, which
 4 could result in injury or mortality of tricolored blackbirds. The existing network of transmission
 5 lines in the Plan Area currently poses this risk for tricolored blackbirds; any incremental increase in
 6 risk associated with the new power line corridors is expected to be low. Therefore, the small
 7 differences in transmission line configurations between the BDCP Proposed Action and the take
 8 alternatives would not result in substantial differences in level of take.

9 **Methylmercury**

10 Increased exposure to methylmercury associated with tidal natural communities restoration could
 11 potentially affect tricolored blackbirds that nest near tidal natural communities restoration sites and
 12 feed in restored tidal wetlands. **Take Alternatives A, B, C, D, F, and I** would have the same levels of
 13 potential take from methylmercury exposure due to having the same amounts of tidal natural
 14 communities restoration (Table 9-23). **Take Alternatives D** (25,000 fewer acres of tidal natural
 15 communities restoration) and **G** (15,000 fewer acres of tidal natural communities restoration)
 16 would have less potential for take from methylmercury exposure than the BDCP Proposed Action.
 17 **Take Alternative H** (10,000 more acres of tidal natural communities restoration) would have a
 18 proportionally greater potential for take from methylmercury exposure than the BDCP Proposed
 19 Action. Any construction-related injury or mortality resulting from implementation of the USFWS
 20 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific environmental review
 21 under NEPA, CEQA and/or consultation with CDFW.

22 Measures described in Chapter 3, *Conservation Strategy*, for methylmercury management (CM12)
 23 are expected to reduce the effects of methylmercury resulting from tidal natural communities
 24 restoration. These measures would be the same for all take alternatives and therefore would have
 25 no difference in their potential to mitigate take of tricolored blackbirds.

26 **9.4.2.8 Western Burrowing Owl**

27 **Take Alternatives B, C, D, E, F, and G** would have less potential for take and **Take Alternatives A**
 28 and **H** would have greater potential for take relative to the BDCP Proposed Action (Table 9-23).
 29 These differences are attributable to the amounts of tidal natural communities restoration (CM4)
 30 and different conveyance alignments (CM1). **Take Alternative I** would have the same potential for
 31 take as the BDCP Proposed Action.

32 **9.4.2.8.1 Permanent Habitat Loss, Conversion, and Fragmentation**

33 The BDCP Proposed Action would permanently affect 43,969 acres of modeled western burrowing
 34 owl habitat, the majority of which (31,519 acres) would be low-value habitat. Most of these effects
 35 would be from tidal natural communities restoration (29,668 acres), floodplain restoration (1,211
 36 acres), and conveyance construction (4,237). **Take Alternatives A, B, C, E, and F** would differ in
 37 their potential for take compared to the BDCP Proposed Action due to the conveyance alignment
 38 and/or the number and location of intakes (Table 9-3). **Take Alternative A** (225 more acres) would
 39 have a greater potential for take. **Take Alternatives B** (997 fewer acres), **C** and **E** (917 fewer acres),
 40 and **F** (3,508 fewer acres) would have less potential for take. **Take Alternatives D, G, and H** would
 41 differ in their potential for take compared to the BDCP Proposed Action mostly due to the amounts

1 of tidal natural communities restoration. **Take Alternatives D** (assumed less because it would
 2 restore 25,000 fewer acres of tidal natural communities) and **G** (assumed less because it would
 3 restore 15,000 fewer acres of tidal natural communities) would have less potential for take. **Take**
 4 **Alternative H** would restore 10,000 more acres of tidal natural communities and 10,000 more acres
 5 of floodplains, and would likely have more potential for take. **Take Alternative I** would have the
 6 same potential for take as the BDCP Proposed Action. Any western burrowing owl habitat loss
 7 resulting from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated
 8 under project-specific environmental review under NEPA, CEQA and/or consultation with CDFW.

9 Effects on the western burrowing owl would be offset by the protection of 8,000 acres of grassland,
 10 the restoration of 2,000 acres of grassland, the projection of 600 acres of vernal pool complex, the
 11 protection of 150 acres of alkali seasonal wetland, protection of 48,625 acres of cultivated lands
 12 (1,000 acres of which would provide foraging habitat for the species and connections to other
 13 protected habitats), and the implementation of measures identified in Appendix 3.C, *Avoidance and*
 14 *Minimization Measures*. These measures would be the same for all take alternatives and therefore
 15 would have no difference in their potential to offset take of the western burrowing owl.

16 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, ROAs,
 17 and considering the species biology, the BDCP Proposed Action and take alternatives would not
 18 substantially differ in their potential to fragment modeled habitat and result in take.

19 **9.4.2.8.2 Periodic Effects**

20 There is potential for take of the western burrowing owl from periodic inundation of modeled
 21 foraging habitat as a result of Yolo Bypass operations (CM2) and flood plain restoration (CM5). This
 22 potential for take would be the same for **Take Alternatives A, B, C, D, E, F, G, and I. Take**
 23 **Alternative H**, which would restore 10,000 more acres of floodplain, would have a greater potential
 24 for take from periodic flooding than the BDCP Proposed Action (Table 9-23). Any periodic effects to
 25 western burrowing owl resulting from implementation of the USFWS 2008 BiOp and NMFS 2009
 26 BiOp would be evaluated under project-specific environmental review under NEPA, CEQA and/or
 27 consultation with CDFW.

28 **9.4.2.8.3 Construction-Related Effects**

29 **Temporary Habitat Loss**

30 The BDCP Proposed Action would temporarily affect 2,339 acres of modeled western burrowing owl
 31 habitat, most of which (1,659 acres) would be low-value habitat. This potential for take would be the
 32 same for **Take Alternative G** and **I** because they would have the same conveyance footprint and
 33 same effects from fisheries enhancement and floodplain restoration. **Take Alternatives A, B, C, D, E,**
 34 **and F** would differ in their levels of take compared to the BDCP Proposed Action based on
 35 differences in conveyance alignments and/or the number and location of intakes (Table 9-3). **Take**
 36 **Alternatives A** (3,897 more acres), **C** and **E** (185 more acres of effect each), and **F** (1,486 more
 37 acres) would have a greater potential for take. **Take Alternatives B** (14 fewer acres) and **D** (48
 38 fewer acres) would have less potential for take. **Take Alternative H** would have a greater potential
 39 for take than the BDCP Proposed Action because it would restore 10,000 more acres of floodplain.
 40 Any western burrowing owl habitat temporarily affected by implementation of the USFWS 2008
 41 BiOp and NMFS 2009 BiOp would be evaluated under project-specific environmental review under
 42 NEPA, CEQA and/or consultation with CDFW.

1 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 2 western burrowing owl. One such measure will restore temporarily affected natural communities.
 3 These measures would be the same for all take alternatives and therefore would have no difference
 4 in their potential to mitigate take of the western burrowing owl.

5 **Construction-Related Injury or Mortality**

6 Construction will not likely cause injury or mortality to the western burrowing owl; however,
 7 preconstruction surveys, construction monitoring, and no-disturbance buffers will be implemented
 8 to avoid and minimize injury or mortality to this species during construction, as described in
 9 Appendix 3.C, *Avoidance and Minimization Measures*. Any potential for take and the avoidance and
 10 minimization measures to be implemented would be the same across all take alternatives and would
 11 not differ from the BDCP Proposed Action.

12 In general, the potential for take from construction-related effects would parallel the amount of
 13 permanent and temporary habitat disturbance associated with each take alternative. **Take**
 14 **Alternative A** (4,122 more acres) would have a greater potential for take than the BDCP Proposed
 15 Action. **Take Alternatives B** (1,011 fewer acres), **C** and **E** (732 fewer acres), **F** (500 fewer acres),
 16 and **D** and **G** (assumed fewer acres due to smaller construction and restoration footprint [25,000
 17 and 15,000 fewer acres, respectively]) would have less potential for take. **Take Alternative H**
 18 would have a greater potential for take because it would restore 10,000 more acres of floodplain
 19 restoration. **Take Alternative I** would have the same potential for take as the BDCP Proposed
 20 Action (Table 9-23). Any western burrowing owl directly affected from implementation of the
 21 USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific environmental
 22 review under NEPA, CEQA and/or consultation with CDFW.

23 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 24 western burrowing owl. One such measure will require preconstruction surveys. These measures
 25 would be the same for all take alternatives and therefore would have no difference in their potential
 26 to mitigate take of the western burrowing owl.

27 **Indirect Construction-Related Effects**

28 Noise and visual disturbances from construction activities within 250 feet of a burrow occupied by
 29 western burrowing owls during the breeding season (February 1 through August 31) and within
 30 160 feet during the nonbreeding season (September 1 through January 31) could potentially
 31 displace owls or cause abandonment of active nests.

32 The effect on each species was calculated by intersecting the assumed area of indirect effect
 33 extending from the construction area for each species with each species modeled habitat; the
 34 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
 35 **Alternatives A** (1,294 fewer acres), **B** (845 fewer acres), **C** and **E** (871 fewer acres), **F** (4,144 fewer
 36 acres), and **D** and **G** (assumed fewer acres due to smaller construction and restoration footprint
 37 [25,000 and 15,000 fewer acres, respectively]) would have less potential for take. **Take Alternative**
 38 **H** would have a greater potential for take because it would restore 10,000 more acres of floodplains
 39 (Table 9-3). **Take Alternative I** would have the same potential for take as the BDCP Proposed
 40 Action. Any western burrowing owls affected by implementation of the USFWS 2008 BiOp and NMFS
 41 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW consultations.

42 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 43 western burrowing owl. One such measure will require preconstruction surveys. These measures

1 would be the same for all take alternatives and therefore would have no difference in their potential
2 to mitigate take of the western burrowing owl.

3 **9.4.2.9 Western Yellow-Billed Cuckoo**

4 **Take Alternatives A, F, and H** would have a greater potential for take and **Take Alternatives B, C,**
5 **D, E, and G** would overall have less potential for take of the western yellow-billed cuckoo than the
6 BDCP Proposed Action (Table 9-23). These differences are attributed to the conveyance alignments
7 and number and location of intakes (CM1), Yolo Bypass fisheries enhancement (CM2), tidal natural
8 communities restoration (CM4), and floodplain restoration (CM5).

9 **9.4.2.9.1 Permanent Habitat Loss, Conversion, and Fragmentation**

10 The BDCP Proposed Action would permanently affect 547 acres of modeled western yellow-billed
11 cuckoo habitat (5% of the habitat in the Plan Area); 397 acres represent migratory habitat. These
12 effects would be from tidal natural communities restoration (420 acres), Yolo Bypass fisheries
13 improvements (83 acres), floodplain restoration (21 acres), and conveyance construction (23 acres).
14 **Take Alternatives A, B, and F** would differ in their potential for take relative to the BDCP Proposed
15 Action due to the conveyance alignment and/or the number and location of intakes (Table 9-3).
16 **Take Alternatives A** (10 fewer acres), **B** (3 fewer acres), and would have less potential for take.
17 **Take Alternative F** (21 more acres) would have a greater potential for take. **Take Alternatives D,**
18 **G, and H** would differ in their potential for take due primarily to different amounts of tidal natural
19 communities restoration. **Take Alternatives D and G** (assumed less because they would restore
20 25,000 and 15,000 fewer acres of tidal natural communities, respectively) would have less potential
21 for take. **Take Alternative H** (assumed to have more effect because it would restore 10,000 more
22 acres of tidal natural communities and 10,000 more acres of floodplains) would have more potential
23 for take. **Take Alternatives C and E** would not have measureable difference (1 less acre) in take
24 from the BDCP Proposed Action and **Take Alternative I** would have the same potential for take as
25 the BDCP Proposed Action. Any western yellow-billed cuckoo habitat loss resulting from
26 implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-
27 specific ESA Section 7 consultations and consultation with CDFW.

28 Under the BDCP Proposed Action, effects on the western yellow-billed cuckoo would be offset by the
29 restoration or creation of 5,000 acres of valley/foothill riparian forest, with at least 3,000 acres
30 occurring on restored seasonally inundated floodplain; the protection of 750 acre of existing
31 valley/foothill riparian forest; the maintenance of at least 500 acres of mature riparian forest; and
32 the implementation of measures identified in Appendix 3.C, *Avoidance and Minimization Measures*.
33 These conservation measures would be the same for **Take Alternatives A, B, C, D, E, F, G, and I** and
34 therefore would have no difference in their potential to mitigate take of western yellow-billed
35 cuckoo (Table 9-23). **Take Alternative H** would likely benefit western yellow-billed cuckoo through
36 increases in potentially suitable riparian habitat that would likely establish within the 10,000 acres
37 of additional floodplain restoration (CM5).

38 Based on a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints,
39 ROAs, and considering the species biology, the BDCP Proposed Action and take alternatives would
40 not substantially differ in their potential to fragment modeled habitat and result in take.

1 **9.4.2.9.2 Periodic Effects**

2 Periodic inundation as a result of Yolo Bypass operations (CM2) and floodplain restoration (CM5) is
 3 not expected to adversely affect the western yellow-billed cuckoo because flooding is unlikely to
 4 occur during the breeding season when cuckoos could be present, and the potential effects of
 5 inundation on existing riparian vegetation are expected to be minimal. There is no difference in
 6 potential for take between the BDCP Proposed Action and the take alternatives.

7 **9.4.2.9.3 Construction-Related Effects**

8 **Temporary Habitat Loss**

9 The BDCP Proposed Action would temporarily affect 123 acres of modeled western yellow-billed
 10 cuckoo habitat (1% of the modeled habitat in the Plan Area). The potential for take would be the
 11 same for **Take Alternative G** and **I** because they would have the same conveyance footprint and
 12 same effects from fisheries enhancement and floodplain restoration. **Take Alternatives A, B, C, D, E,**
 13 **and F** would differ in their levels of take relative to the BDCP Proposed Action based on differences
 14 in conveyance alignments and/or the number and location of intakes (Table 9-3). **Take**
 15 **Alternatives A** (16 more acres), and **F** (198 more acres) would have a greater potential for take.
 16 **Take Alternatives B** (9 fewer acres), **C** and **E** (5 fewer acres), and **D** (9 fewer acres) would have less
 17 potential for take of the western yellow-billed cuckoo. **Take Alternative H** would have a greater
 18 potential for take because it would restore 10,000 more acres of floodplains. Any western yellow-
 19 billed cuckoo habitat temporarily affected by implementation of the USFWS 2008 BiOp and NMFS
 20 2009 BiOp would be evaluated under project-specific ESA Section 7 consultation and in consultation
 21 with CDFW.

22 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 23 western yellow-billed cuckoo. One such measure will restore temporarily affected natural
 24 communities. These measures would be the same for all take alternatives and therefore would have
 25 no difference in their potential to mitigate take of the western yellow-billed cuckoo.

26 **Construction-Related Injury or Mortality**

27 Although western yellow-billed cuckoo nesting has not been confirmed in the Delta for
 28 approximately 100 years, a 2009 sighting (within unconfirmed nesting) and the presence of suitable
 29 habitat indicates that the species may nest in the Plan Area presently or may do so in the future
 30 (California Department of Water Resources 2011). If the western yellow-billed cuckoo nests are
 31 within the footprint of the BDCP Proposed Action, the operation of equipment for construction
 32 activities could result in injury or mortality of individuals. Risk will be greatest to eggs and nestlings
 33 that could be injured or killed through crushing from heavy equipment, nest abandonment, or
 34 increased exposure to the elements or to predators. Injury to adults and fledged juveniles is unlikely
 35 as these individuals are expected to avoid contact with construction equipment.

36 In general, the potential for take from construction-related effects would parallel the amount of
 37 permanent and temporary habitat disturbance associated with each take alternative. **Take**
 38 **Alternatives A** (5 more acres) and **F** (219 more acres) would have a greater potential for take
 39 relative to the BDCP Proposed Action. **Take Alternatives B** (13 fewer acres), **C** and **E** (5 fewer
 40 acres), and **D** and **G** (assumed fewer acres of effect due to smaller construction and restoration
 41 footprint [25,000 and 15,000 fewer acres, respectively]) would have less potential for take. **Take**
 42 **Alternative H** would have a greater potential for take because it would restore 10,000 more acres

1 of floodplains and would have larger construction and restoration footprints resulting in more
 2 construction-related disturbances. **Take Alternative I** would have the same potential for take as the
 3 BDCP Proposed Action (Table 9-23). Any western-yellow billed cuckoo directly affected from
 4 implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-
 5 specific ESA Section 7 consultation and in consultation with CDFW.

6 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of
 7 yellow-billed cuckoo. One such measure will require preconstruction nesting surveys for the
 8 species. These measures would be the same for all take alternatives and therefore would have no
 9 difference in their potential to mitigate take of the western yellow-billed cuckoo.

10 **Indirect Construction-Related Effects**

11 Noise and visual disturbance within 1,300 feet of construction activities could temporarily affect the
 12 use of modeled western yellow-billed cuckoo habitat. As described above, there are no nesting
 13 records for this species in the Plan Area over the last 100 years but recent sightings indicate that the
 14 species may become established in the Plan Area.

15 The effect on each species was calculated by intersecting the assumed area of indirect effect
 16 extending from the construction area for each species with each species modeled habitat; the
 17 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
 18 **Alternatives A** (234 more acres), **B** (246 more acres), **C** and **E** (251 more acres), and **F** (296 more
 19 acres) would have a greater potential for take than the BDCP Proposed Action. **Take Alternatives D**
 20 and **G** (assumed fewer acres due to smaller construction and restoration footprint [25,000 and
 21 15,000 less acres of tidal natural communities restoration, respectively]) would have less potential
 22 for take. **Take Alternative H** would have a greater potential for take because it would restore
 23 10,000 more acres of floodplains, and thus would have larger construction and restoration
 24 footprints resulting in more indirect construction-related effects. **Take Alternative I** would have
 25 the same potential for take as the BDCP Proposed Action (Table 9-23). Any western yellow-billed
 26 cuckoos affected by implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be
 27 evaluated under project-specific ESA Section 7 and CDFW consultations.

28 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 29 western yellow-billed cuckoo. One such measure will require preconstruction nesting surveys for
 30 the species. These measures would be the same for all take alternatives and therefore would have no
 31 difference in their potential to mitigate take of the western yellow-billed cuckoo

32 **9.4.2.10 White-Tailed Kite**

33 **Take Alternatives B, C, D, E, F, and G** would have less potential for take and **Take Alternatives A**
 34 **and H** would have more potential for take than the BDCP Proposed Action (Table 9-23). These
 35 differences are attributed to effects on foraging habitat associated with tidal natural communities
 36 restoration (CM4) and the conveyance alignments and numbers of intakes (CM1). **Take Alternative**
 37 **I** would have the same potential for take as the BDCP Proposed Action.

38 **9.4.2.10.1 Permanent Habitat Loss, Conversion, and Fragmentation**

39 The BDCP Proposed Action would permanently affect 57,548 acres of modeled white-tailed kite
 40 habitat (11% of the habitat in the Plan Area), the majority of which (57,015 acres) would be foraging
 41 habitat. Most of these effects would be from tidal natural communities restoration (42,008 acres),

1 floodplain restoration (1,748 acres), and conveyance construction (4,366 acres). **Take Alternatives**
 2 **A, B, C, E, and F** would differ in their potential for take compared to the BDCP Proposed Action due
 3 to the conveyance alignment and/or the number and location of intakes because all of the
 4 restoration components would be the same (Table 9-3). **Take Alternatives B** (1,115 fewer acres), **C**
 5 and **E** (1,037 fewer acres), and **F** (3,948 fewer acres) would have less potential for take. **Take**
 6 **Alternative A** (455 more acres) would have a greater potential for take. **Take Alternatives D, G,**
 7 and **H** would differ in their potential for take mostly due to the amount of tidal natural communities
 8 restoration. **Take Alternative D and G** (assumed less because they each would restore 25,000 and
 9 15,000 fewer acres of tidal natural communities, respectively) would have less potential for take.
 10 **Take Alternative H** would have more potential for take because it would restore 10,000 more acres
 11 of tidal natural communities and 10,000 more acres of floodplain. **Take Alternative I** would have
 12 the same potential for take as the BDCP Proposed Action. Any white-tailed kite habitat loss resulting
 13 from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under
 14 project-specific environmental review under NEPA, CEQA and/or consultation with CDFW.

15 Under the BDCP Proposed Action, effects on the white-tailed kite would be offset by the restoration
 16 or creation of 5,000 acres of valley/foothill riparian forest, with at least 3,000 acres occurring on
 17 restored seasonally inundated floodplain; the protection of 750 acres of existing valley/foothill
 18 riparian forest; the protection of 8,000 acres of grassland; the restoration of 2,000 acres of
 19 grassland; the protection of 600 acres of vernal pool complex; the protection of 150 acres of alkali
 20 seasonal wetland; the protection and enhancement of 8,100 acres of managed wetland; the
 21 protection of 48,625 acres of cultivated land; and implementation of measures identified in
 22 Appendix 3.C, *Avoidance and Minimization Measures*. These conservation measures would be the
 23 same for **Take Alternatives A, B, C, D, E, F, G, and I** and therefore would have no difference in their
 24 potential to mitigate take of white-tailed kite (Table 9-23). **Take Alternative H** would likely benefit
 25 white-tailed kite through increases in potentially suitable riparian nesting habitat that would likely
 26 establish within the 10,000 acres of additional floodplain restoration (CM5).

27 Based on a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints,
 28 ROAs, and considering the species biology, the BDCP Proposed Action and take alternatives would
 29 not substantially differ in their potential to fragment modeled habitat and result in take.

30 **9.4.2.10.2 Periodic Effects**

31 There is potential for take of the white-tailed kite from periodic inundation of modeled foraging
 32 habitat associated with Yolo Bypass operations (CM2) and floodplain restoration (CM5). This
 33 potential for take would be the same for **Take Alternatives A, B, C, D, E, F, G, and I** (Table 9-23).
 34 **Take Alternative H**, which would restore 10,000 more acres of floodplains, would have a greater
 35 potential for take than the BDCP Proposed Action. Any periodic effects to white-tailed kite resulting
 36 from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under
 37 project-specific environmental review under NEPA, CEQA and/or consultation with CDFW.

38 **9.4.2.10.3 Construction-Related Effects**

39 **Temporary Habitat Loss**

40 The BDCP Proposed Action would temporarily affect 2,923 acres of modeled white-tailed kite
 41 habitat, of which most (2,780 acres) would be to foraging habitat. The potential for take would be
 42 the same for **Take Alternative G** because it would have the same conveyance footprint and same
 43 effects from fisheries enhancement and floodplain restoration. **Take Alternatives A, B, C, D, E, and**

1 **F** would differ in their levels of take compared to the BDCP Proposed Action based on differences in
 2 conveyance alignments and/or the number and location of intakes (Table 9-3). **Take Alternatives A**
 3 (5,357 more acres), **C** and **E** (134 more acres), and **F** (1,313 more acres) would have a greater
 4 potential for take. **Take Alternatives B** (109 fewer acres) and **D** (181 fewer acres) would have less
 5 potential for take. **Take Alternative H** would have a greater potential for take because it would
 6 restore 10,000 more acres of floodplains. **Take Alternative I** would have the same potential for take
 7 as the BDCP Proposed Action. Any white-tailed kite habitat temporarily affected by implementation
 8 of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific
 9 environmental review under NEPA, CEQA and/or consultation with CDFW.

10 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 11 white-tailed kite. One such measure will restore temporarily affected natural communities. These
 12 measures would be the same for all take alternatives and therefore would have no difference in their
 13 potential to mitigate take of the white-tailed kite.

14 **Construction-Related Injury or Mortality**

15 If there are white-tailed kite nests within the construction footprint, the operation of equipment for
 16 construction activities could result in injury or mortality of individuals. Risk will be greatest to eggs
 17 and nestlings that could be injured or killed through crushing by heavy equipment, nest
 18 abandonment, or increased exposure to the elements or to predators. Injury to adults and fledged
 19 juveniles is unlikely as these individuals are expected to avoid contact with construction equipment.

20 In general, the potential for take from indirect construction-related effects would parallel the
 21 amount of permanent and temporary habitat disturbance associated with each take alternative.
 22 **Take Alternatives A** (5,811 more acres) would have a greater potential for take than the BDCP
 23 Proposed Action. **Take Alternatives B** (1,225 fewer acres), **C** and **E** (903 fewer acres), **F** (2635
 24 fewer acres), and **D** and **G** (assumed fewer acres due to smaller construction and restoration
 25 footprint [25,000 and 15,000 fewer acres of tidal natural communities restoration, respectively])
 26 would have less potential for take. **Take Alternative H** would have a greater potential for take
 27 because it would restore 10,000 more acres of floodplains. **Take Alternative I** would have the same
 28 potential for take as the BDCP Proposed Action (Table 9-23). Any white-tailed kite directly affected
 29 from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under
 30 project-specific environmental review under NEPA, CEQA and/or consultation with CDFW.

31 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 32 white-tailed kite. One such measure will require preconstruction nesting surveys for the species.
 33 These measures would be the same for all take alternatives and therefore would have no difference
 34 in their potential to mitigate take of the white-tailed kite.

35 **Indirect Construction-Related Effects**

36 Noise and visual disturbance within 1,300 feet of nesting and foraging habitat could temporarily
 37 affect white-tailed kite use of these habitats. The effect on each species was calculated by
 38 intersecting the assumed area of indirect effect extending from the construction area for each
 39 species with each species modeled habitat; the intersection represents the extent of effect expressed
 40 as acres of disturbed habitat. Using this approach, **Take Alternatives A** (952 fewer acres), **B**
 41 (1,530 fewer acres), **C** and **E** (1,915 fewer acres), **F** (5,619 fewer acres), and **D** and **G** (assumed fewer
 42 acres due to smaller construction and restoration footprint [25,000 and 15,000 fewer acres of tidal
 43 natural communities restoration, respectively]) would have less potential for take. **Take**

1 **Alternative H** would have a greater potential for take because it would restore 10,000 more acres
 2 of floodplains. **Take Alternative I** would have the same potential for take as the BDCP Proposed
 3 Action (Table 9-23). Any white-tailed kites affected by implementation of the USFWS 2008 BiOp and
 4 NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW consultations.

5 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 6 white-tailed kite. One such measure will require preconstruction nesting surveys for the species.
 7 These measures would be the same for all take alternatives and therefore would have no difference
 8 in their potential to mitigate take of the white-tailed kite.

9 **Other Indirect Effects**

10 **Transmission Lines**

11 New transmission lines will increase the risk of white-tailed kite power-line strikes and/or
 12 electrocution. The existing network of power lines in the Plan Area currently poses this risk for the
 13 white-tailed kite, and any incremental increase in risk associated with the new power lines is
 14 expected to be minor. The take alternatives are not anticipated to greatly differ in their potential for
 15 take compared to the BDCP Proposed Action.

16 **9.4.2.11 Yellow-Breasted Chat**

17 **Take Alternatives A, F, and H** would have a greater potential for take and **Take Alternatives B, C,**
 18 **D, E, and G** would have less potential for take of the yellow-breasted chat than the BDCP Proposed
 19 Action (Table 9-23). These differences are attributed to the conveyance alignments and number and
 20 location of intakes (CM1), Yolo Bypass fisheries enhancement (CM2), tidal natural communities
 21 restoration (CM4), and floodplain restoration (CM5). **Take Alternative I** would have the same
 22 potential for take as the BDCP Proposed Action.

23 **9.4.2.11.1 Permanent Habitat Loss, Conversion, and Fragmentation**

24 Covered activities associated with conveyance facilities construction (CM1), Yolo Bypass fisheries
 25 enhancement (CM2), tidal natural communities restoration (CM4), and floodplain restoration (CM5),
 26 have the potential to result in take of the yellow-breasted chat as a result of permanent effects on
 27 modeled habitat in Conservation Zones 2, 7, and 8. The BDCP Proposed Action would result in the
 28 permanent loss of approximately 684 acres of primary and secondary nesting and migratory habitat
 29 (5% of modeled habitat in the Plan Area). **Take Alternatives A** (14 fewer acres) and **D and G**
 30 (assumed less because it would restore 25,000 and 15,000 fewer acres of tidal natural communities,
 31 respectively) would have fewer effects relative to the BDCP Proposed Action **Take Alternatives C,**
 32 **E, (2 more acres) and F (21 more acres)** would increase in primary and secondary nesting and
 33 migratory habitat loss and would have a higher potential for take. **Take Alternative H** would also
 34 have more potential for take because it would restore 10,000 more acres of tidal natural
 35 communities and 10,000 more acres of floodplains (Table 9-3). **Take Alternative B** would not have
 36 a measureable difference (1 less acre) in take from the BDCP Proposed Action and **Take Alternative**
 37 **I** would have the same potential for take as the BDCP Proposed Action. Any yellow-breasted chat
 38 habitat loss resulting from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be
 39 evaluated under project-specific environmental review under NEPA, CEQA and/or consultation with
 40 CDFW.

1 Under the BDCP Proposed Action, 5,000 acres of valley/foothill riparian natural community
 2 restoration would occur and 750 acres of existing valley foothill riparian will be protected (CM7)
 3 that would offset the loss of modeled yellow breasted chat habitat. These conservation measures
 4 would be the same for **Take Alternatives A, B, C, D, E, F, G, and I** and therefore would have no
 5 difference in their potential to mitigate take of yellow breasted chat (Table 9-23). **Take Alternative**
 6 **H** would likely benefit yellow breasted chat through increases in potentially suitable riparian habitat
 7 that would likely establish within the 10,000 acres of additional floodplain restoration (CM5) and 20
 8 miles of additional channel margin enhancement.

9 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
 10 ROAs, the BDCP Proposed Action and take alternatives would not substantially differ in their
 11 potential to fragment modeled habitat and result in take of the yellow-breasted chat.

12 **9.4.2.11.2 Periodic Effects**

13 Periodic inundation will not result in adverse effects on the yellow-breasted chat because the
 14 increased flooding regime as a result of the BDCP Proposed Action and take alternatives would be
 15 within the tolerance range for riparian habitat and is unlikely to occur during the breeding season
 16 when yellow-breasted chats could be present. The BDCP Proposed Action and take alternatives
 17 would not have potential for take of the yellow-breasted chat as a result of periodic inundation. Any
 18 periodic effects to yellow-breasted chat resulting from implementation of the USFWS 2008 BiOp and
 19 NMFS 2009 BiOp would be evaluated under project-specific environmental review under NEPA,
 20 CEQA and/or consultation with CDFW.

21 **9.4.2.11.3 Construction-Related Effects**

22 **Temporary Habitat Loss**

23 The BDCP Proposed Action would temporarily affect 132 acres of modeled yellow-breasted chat
 24 habitat (1% of the modeled habitat in the Plan Area). The potential for take would be the same for
 25 **Take Alternative G and I** because they would have the same conveyance footprint and same effects
 26 from fisheries enhancement and floodplain restoration. **Take Alternatives A, B, C, D, E, and F**
 27 would differ in their levels of take because of different conveyance alignments and/or the number
 28 and location of intakes (Table 9-3). **Take Alternatives A** (21 more acres) and **F** (211 more acres)
 29 would have a greater potential for take than the BDCP Proposed Action. **Take Alternatives B** (11
 30 fewer acres), **C and E** (6 fewer acres) and **D** (12 fewer acres) would have less potential for take.
 31 **Take Alternative H** would have a greater potential for take because it would restore 10,000 more
 32 acres of floodplains. Any yellow-breasted chat habitat temporarily affected by implementation of the
 33 USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific environmental
 34 review under NEPA, CEQA and/or consultation with CDFW.

35 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 36 yellow-breasted chat. One such measure will restore temporarily affected natural communities.
 37 These measures would be the same for all take alternatives and therefore would have no difference
 38 in their potential to mitigate take of the yellow-breasted chat.

39 **Construction-Related Injury or Mortality**

40 Operation of construction equipment could result in injury or mortality of the yellow-breasted chat.
 41 Risk will be greatest to eggs and nestlings susceptible to land clearing activities, nest abandonment,

1 or increased exposure to the elements or to predators. Injury to adults and fledged juveniles is less
 2 likely as these individuals are expected to avoid contact with construction equipment.

3 In general, the potential for take from construction-related injury or mortality would parallel the
 4 amount of permanent and temporary habitat disturbance associated with each take alternative.
 5 **Take Alternatives A** (7 more acres), **F** (232 more acres), and **H** (assumed to be more acres of
 6 construction-related disturbance due to increased floodplain restoration footprint) would have a
 7 greater potential for take than the BDCP Proposed Action. **Take Alternatives B** (13 fewer acres), **C**
 8 and **E** (4 fewer acres), and **D** and **G** (assumed fewer acres due to smaller construction and
 9 restoration footprint [25,000 and 15,000 fewer acres of tidal natural communities restoration,
 10 respectively]) would have less potential for take (Table 9-23). **Take Alternative I** would have the
 11 same potential for take as the BDCP Proposed Action. Any yellow breasted chats directly affected
 12 from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under
 13 project-specific environmental review under NEPA, CEQA and/or consultation with CDFW.

14 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 15 yellow-breasted chat. One such measure will require preconstruction nesting surveys for the
 16 species. These measures would be the same for all take alternatives and therefore would have no
 17 difference in their potential to affect the take of the yellow-breasted chat.

18 **Indirect Construction-Related Effects**

19 Noise and visual disturbance within 1,300 feet of the yellow-breasted chat nesting and migratory
 20 habitat could temporarily affect the use of these habitats. Also, petroleum or other contaminant
 21 spills from construction equipment, drilling operations, or other activities could affect yellow-
 22 breasted chats if present.

23 The effect on each species was calculated by intersecting the assumed area of indirect effect
 24 extending from the construction area for each species with each species modeled habitat; the
 25 intersection represents the extent of effect expressed as acres of disturbed habitat. **Take**
 26 **Alternatives A** (258 more acres), **B** (242 more acres), **C** and **E** (247 more acres), **F** (292 more acres),
 27 and **H** (assumed to be more acres of construction-related disturbance due to increased floodplain
 28 restoration footprint) would have a greater potential for take than the BDCP Proposed Action. **Take**
 29 **Alternatives D** and **G** (assumed fewer acres due to smaller construction and restoration footprint
 30 [25,000 and 15,000 fewer acres of tidal natural communities restoration, respectively]) would have
 31 less potential for take. **Take Alternative I** would have the same potential for take as the BDCP
 32 Proposed Action (Table 9-21). Any yellow-breasted chats affected by implementation of the USFWS
 33 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW
 34 consultations.

35 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 36 yellow-breasted chat. One such measure will require preconstruction nesting surveys for the
 37 species. These measures would be the same for all take alternatives and therefore would have no
 38 difference in their potential to affect the take of the yellow-breasted chat.

39 **9.4.3 Reptiles and Amphibians**

40 Each take alternative is evaluated to assess how take of reptile and amphibian species would be
 41 expected to change. This section summarizes the results of the evaluation, and focuses on those take
 42 alternatives that would reduce or avoid take of one or more reptile and amphibian species. Take

1 alternatives that increase take of covered reptiles and amphibians (if any take alternatives do so)
 2 are mentioned but are not the focus of the analysis. The comparison of take alternatives is
 3 summarized in Table 9-24.

4 **Table 9-24. Expected Changes in Incidental Take of Reptiles and Amphibians and Conservation**
 5 **Benefits by Alternative, Relative to BDCP Proposed Action**

Reptile and Amphibian Species	Take Alternative								
	Permanent / Temporary / Periodic Effects								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified spring Outflow
Giant garter snake	-/+/○	-/-/○	-/-/○	-/-/○	-/-/○	-/+/○	-/○/○	+ / + / +	○/○/○
Western pond turtle	-/-/○	-/-/○	-/-/○	-/-/○	-/-/○	+/-/○	-/○/○	+ / + / +	○/○/○
California tiger salamander	+/-/○	○/+/○	○/+/○	-/+/○	○/+/○	-/-/○	-/○/○	+ / + / ○	○/○/○
California red-legged frog	+/-/○	○/+/○	○/+/○	○/+/○	○/+/○	-/-/○	○/○/○	+ / ○ / ○	○/○/○

A three-point scale indicates how the level of take or conservation benefit is expected to change compared to the BDCP Proposed Action.

- Take is likely measurably less than the BDCP Proposed Action.
- Take is not measurably different from the BDCP Proposed Action.
- + Take is likely measurably greater than the BDCP Proposed Action.

6

7 **9.4.3.1 Giant Garter Snake**

8 **Take Alternatives B, C, E, D,** and **G** would have less potential for take of the giant garter snake as
 9 the BDCP Proposed Action (Table 9-24). **Take Alternatives A, F,** and **H** would have more potential
 10 for take. These differences are largely associated with different amounts of tidal natural
 11 communities restoration (CM4) and the conveyance alignments and associated number and location
 12 of intakes (CM1). **Take Alternative I** would have the same potential for take as the BDCP Proposed
 13 Action.

14 **9.4.3.1.1 Permanent Habitat Loss, Conversion, and Fragmentation**

15 The BDCP Proposed Action would permanently affect 3,437 acres of modeled giant garter snake
 16 habitat (4% of modeled habitat in the Plan Area). Tidal natural communities restoration (CM4)
 17 would account for a loss of 2,518 acres of modeled habitat. **Take Alternatives D, G,** and **H** differ
 18 from the BDCP Proposed Action in the acres of tidal natural communities restoration and numbers
 19 of intakes. **Take Alternatives D** and **G** (assumed fewer acres due to smaller construction and
 20 restoration footprint 25,000 and 15,000 fewer acres of tidal natural communities restoration,
 21 respectively) would have less potential for take. **Take Alternative H** would likely have more effects
 22 due to the increased tidal and floodplain habitat restoration. **Take Alternatives A, B, C, E,** and **F**
 23 would differ in their potential for take due to the conveyance alignment and the number and

1 location of intakes along the Sacramento River. **Take Alternatives A** (255 fewer acres), **B** (79 fewer
 2 acres), **C** and **E** (53 fewer acres), and **F** (132 fewer acres) would have less effect than the BDCP
 3 Proposed Action (Table 9-24). **Take Alternative I** would have the same potential to fragment
 4 habitat as the BDCP Proposed Action. Any giant garter snake habitat loss resulting from
 5 implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-
 6 specific ESA Section 7 and CDFW consultations.

7 Under the BDCP Proposed Action, effects on the giant garter snake would be offset by creating an
 8 area of contiguous habitat along the eastern perimeter of the Plan Area connecting the Coldani/
 9 White Slough subpopulations with other portions of the species historical range in the Delta Basin.
 10 This would involve restoring or creating 1,200 acres of nontidal marsh (CM10), 600 of which would
 11 be aquatic giant garter snake habitat connected to 1,500 acres of protected, restored, and/or created
 12 rice land or equivalent habitat (CM4), and the creation or protection of 200 acres of high-value
 13 upland giant garter snake habitat adjacent to nontidal perennial habitat. The BDCP will also protect,
 14 restore, and/or create 2,740 acres of rice land or equivalent-value habitat (e.g., perennial wetland)
 15 for the giant garter snake in Conservation Zones 1, 2, 4, or 5. Giant garter snake may also benefit
 16 from the restoration or creation of the 24,000 acres of tidal freshwater emergent wetland where
 17 tidal influence is muted, sufficient water is provided during the active season, and adjacent
 18 terrestrial refuge is available. Construction effects would be reduced by conducting preconstruction
 19 surveys and implementing protective measures to avoid and minimize take (Appendix 3.C,
 20 *Avoidance and Minimization Measures*). These measures would generally be the same for all take
 21 alternatives. Though the different amounts of tidal restoration associated with **Take Alternatives**
 22 **D, G, and H** may change the beneficial effects to giant garter snake, the likely small additions of this
 23 very specific subset of the tidal natural community (area tidal influence that are muted, sufficient
 24 water is provided during the active season, and adjacent terrestrial refuge is available), would not
 25 outweigh the potential for take from tidal restoration.

26 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
 27 ROAs, the BDCP Proposed Action and take alternatives would not substantially differ in their
 28 potential to fragment modeled habitat or isolate known occupied habitat.

29 **9.4.3.1.2 Periodic Effects**

30 There is potential for take of the giant garter snake by the periodic inundation of upland habitat
 31 associated with Yolo Bypass operations (CM2) and floodplain restoration (CM5) under the BDCP
 32 Proposed Action. This potential for take would be the same for **Take Alternatives A, B, C, D, E, F, G,**
 33 **and I. Take Alternative H**, which would restore 10,000 more acres of floodplains, would have more
 34 potential for take from periodic flooding than the BDCP Proposed Action (Table 9-24). Any periodic
 35 effects to giant garter snake resulting from implementation of the USFWS 2008 BiOp and NMFS
 36 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW consultations.

37 **9.4.3.1.3 Construction-Related Effects**

38 **Temporary Habitat Loss**

39 The potential for take from temporarily affected modeled giant garter snake habitat are mostly
 40 attributable to fisheries improvements in the Yolo Bypass (CM2) (234 acres) and conveyance effects
 41 (257 acres), which would vary by take alternative. **Take Alternative G** and **I** would have the same
 42 potential for take as the BDCP Proposed Action because the only disturbance-related difference
 43 between the two would be tidal natural communities restoration, which does not have any

1 temporary effects associated with it (Table 9-24). **Take Alternatives A, B, C, D, E,** and **F** would vary
 2 in their potential for take due to the location of alignments and number of intakes along the
 3 Sacramento River, and **Take Alternative F** would have a different conveyance route. **Take**
 4 **Alternatives A** (282 more acres) and **F** (636 more acres each) would have a higher potential for
 5 take than the BDCP Proposed Action. **Take Alternatives B** (70 fewer acres), **C** and **E** (38 fewer
 6 acres), and **D** (72 fewer acres) would result in less potential for take. **Take Alternative H** would
 7 have a greater potential for take because it would restore 10,000 more acres of floodplains. Any
 8 giant garter snake habitat temporarily affected by implementation of the USFWS 2008 BiOp and
 9 NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW consultations.

10 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 11 giant garter snake. One such measure will restore temporarily affected natural communities. These
 12 measures would be the same for all take alternatives and therefore would have no difference in their
 13 potential to mitigate take of the giant garter snake.

14 **Construction-Related Injury or Mortality**

15 Construction may cause injury or mortality to the giant garter snake. If snakes reside where
 16 activities occur (Conservation Zones 2 and 4), the operation of equipment for land clearing,
 17 construction, operation and maintenance, restoration, enhancement, and management activities
 18 could crush or harm snakes. Increased vehicular traffic associated with the BDCP Proposed Action
 19 could contribute to a higher incidence of road kill.

20 In general, the potential for take from construction-related injury or mortality would parallel the
 21 amount of permanent and temporary habitat disturbance associated with each take alternative.
 22 **Take Alternatives A** (27 more acres), **F** (504 more acres), and **H** (more assumed based on larger
 23 restoration footprint) would all have greater potential for take than the BDCP Proposed Action
 24 (Table 9-24). **Take Alternatives B** (150 fewer acres), **C** and **E** (92 fewer acres), and **D** and **G**
 25 (assumed fewer acres due to smaller construction and restoration footprint 25,000 and 15,000
 26 fewer acres of tidal natural communities restoration, respectively) would all have less potential for
 27 take. **Take Alternative I** would have the same potential for take as the BDCP Proposed Action. Any
 28 giant garter snakes directly affected from implementation of the USFWS 2008 BiOp and NMFS 2009
 29 BiOp would be evaluated under project-specific ESA Section 7 and CDFW consultations.

30 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 31 giant garter snake during construction. One such measure will require preconstruction surveys for
 32 the species. These measures would be the same for all take alternatives and therefore would have no
 33 difference in their potential to mitigate take of the giant garter snake.

34 **Indirect Construction-Related Effects**

35 Noise and visual disturbance within 500 feet of construction activities could temporarily affect the
 36 use of giant garter snake habitat. In general, the potential for take from indirect construction-related
 37 effects would parallel the amount of permanent and temporary habitat disturbance associated with
 38 each take alternative. **Take Alternatives A** (462 more acres), **B** (483 more acres), **C** and **E** (480
 39 more acres), **F** (139 more acres), and **H** (more assumed based on larger restoration footprint) would
 40 all have greater potential for take than the BDCP Proposed Action. **Take Alternatives D** and **G**
 41 (assumed less due to small construction and restoration footprint) would all have less potential for
 42 take (Table 9-24). **Take Alternative I** would have the same potential for take as the BDCP Proposed

1 Action. Any giant garter snakes affected by implementation of the USFWS 2008 BiOp and NMFS
 2 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW consultations.
 3 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 4 giant garter snake during construction. One such measure will require preconstruction surveys for
 5 the species. These measures would be the same for all take alternatives and therefore would have no
 6 difference in their potential to mitigate take of the giant garter snake.

7 **9.4.3.2 Western Pond Turtle**

8 **Take Alternative I** would have the same potential for take of the western pond turtle as the BDCP
 9 Proposed Action. **Take Alternatives A, B, C, D, E, F, and G** would have less potential for take and
 10 **Take Alternative H** would have greater potential for take (Table 9-24). These differences in take
 11 are largely associated with the amounts of tidal natural communities restoration (CM4) and the
 12 conveyance alignments and associated infrastructure (CM1).

13 **9.4.3.2.1 Permanent Habitat Loss, Conversion, and Fragmentation**

14 The BDCP Proposed Action would permanently affect 1,657 acres of modeled western pond turtle
 15 habitat (2% of modeled habitat in the Plan Area). Tidal natural communities restoration (CM4)
 16 would account for a loss of 917 acres of modeled habitat. The take alternatives would differ in their
 17 potential for take from the BDCP Proposed Action by the amounts of tidal natural communities
 18 restoration and conveyance construction, which includes different numbers and locations of intakes
 19 and conveyance alignments **Take Alternative A** (350 fewer acres), **B** (307 fewer acres), and **C and E**
 20 (306 fewer acres) would have less potential for take than the BDCP Proposed Action due to the
 21 conveyance alignment (Table 9-24). **Take Alternative I** would have about the same potential for
 22 take. **Take Alternative F** (228 more acres) would have a greater potential for take because of the in-
 23 channel work. **Take Alternatives D and G** are assumed to have less potential for take because they
 24 would restore fewer acres of tidal natural communities (25,000 and 15,000 fewer acres,
 25 respectively). **Take Alternative H**, assumed to have more effect because it would restore 10,000
 26 more acres of tidal natural communities and 10,000 more acres of floodplains, would have more
 27 potential for take than the BDCP Proposed Action. **Take Alternative I** would have the same
 28 potential to fragment habitat as the BDCP Proposed Action. Any western pond turtle habitat loss
 29 resulting from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated
 30 under project-specific environmental review under NEPA, CEQA and/or consultation with CDFW.

31 Under the BDCP Proposed Action, effects on the western pond turtle would be offset by the
 32 restoration of 24,000 acres of tidal freshwater emergent wetland, 1,200 acres of nontidal marsh
 33 with suitable habitat characteristics for the western pond turtle, and the protection of stock ponds
 34 within 8,000 acres of protected grasslands. In addition, measures identified in Appendix 3.C,
 35 *Avoidance and Minimization Measures*, would be implemented. Western pond turtle may also benefit
 36 from the restoration or creation of the 24,000 acres of tidal freshwater emergent wetland there is
 37 slow moving water and adjacent basking sites. Construction effects would be reduced by conducting
 38 preconstruction surveys and implementing protective measures to avoid and minimize take
 39 (Appendix 3.C, *Avoidance and Minimization Measures*). These measures would generally be the same
 40 for all take alternatives. Though the different amounts of tidal restoration associated with **Take**
 41 **Alternatives D, G, and H** may change the beneficial effects to western pond turtle, the likely small
 42 additions of this very specific subset of the tidal natural community (areas with slow moving water
 43 and adjacent basking sites), would not outweigh the potential for take from tidal restoration.

1 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, ROAs,
2 and considering the species biology, the BDCP Proposed Action and take alternatives would not
3 substantially differ in their potential to fragment modeled habitat and result in take.

4 **9.4.3.2.2 Periodic Effects**

5 There is potential for take of the western pond turtle by the periodic inundation of modeled habitat
6 as a result of Yolo Bypass operations (CM2) and floodplain restoration (CM5). This potential for take
7 would be the same for **Take Alternatives A, B, C, D, E, F, G, and I. Take Alternative H**, which would
8 restore 10,000 more acres of floodplains, would have a proportional increase in the potential for
9 take of the western pond turtle from periodic flooding than the BDCP Proposed Action (Table 9-24).
10 Any periodic effects to western pond turtle resulting from implementation of the USFWS 2008 BiOp
11 and NMFS 2009 BiOp would be evaluated under project-specific environmental review under NEPA,
12 CEQA and/or consultation with CDFW.

13 **9.4.3.2.3 Construction-Related Effects**

14 **Temporary Habitat Loss**

15 The BDCP Proposed Action would temporarily affect 2,346 acres of modeled western pond turtle
16 habitat. This potential for take would be the same for **Take Alternative G and I** because they would
17 have the same conveyance footprint and same effects from fisheries enhancement and floodplain
18 restoration. **Take Alternatives A, B, C, D, E, and F** would differ in their levels of take compared with
19 the BDCP Proposed Action based on differences in conveyance alignments and/or the number and
20 location of intakes (Table 9-24). **Take Alternatives A** (1,943 fewer acres), **B** (2,040 fewer acres), **C**
21 and **E** (2,029 fewer acres), **D** (2,040 fewer acres), and **F** (1,523 fewer acres) would have less
22 potential for take than the BDCP Proposed Action. **Take Alternative H** would have a greater
23 potential for take than the BDCP Proposed Action because it would restore 10,000 more acres of
24 floodplains. Any western pond turtle habitat temporarily affected by implementation of the USFWS
25 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific environmental review
26 under NEPA, CEQA and/or consultation with CDFW.

27 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
28 western pond turtle. One such measure will restore temporarily affected natural communities.
29 These measures would be the same for all take alternatives and therefore would have no difference
30 in their potential to mitigate take of the western pond turtle.

31 **Construction-Related Injury or Mortality**

32 Use of heavy equipment during construction may result in injury or mortality of western pond
33 turtles. However, to avoid injury or mortality, preconstruction surveys will be conducted in suitable
34 aquatic or upland nesting and overwintering habitat for the western pond turtle, and turtles found
35 will be located outside the construction areas as described in Appendix 3.C, *Avoidance and*
36 *Minimization Measures*.

37 In general, the potential for take from construction-related injury or mortality would parallel the
38 amount of permanent and temporary habitat disturbance associated with each take alternative.
39 **Take Alternatives A** (2,304 fewer acres), **B** (2,346 fewer acres), **C** and **E** (2,336 fewer acres), and **F**
40 (1,295 more acres). **Take Alternatives D** and **G** (assumed fewer acres due to smaller construction
41 and restoration footprint 25,000 and 15,000 fewer acres of tidal natural communities restoration,

1 respectively) would all have less potential for take than the BDCP Proposed Action (Table 9-24).
 2 **Take Alternative H** (more assumed based on larger restoration footprint) would all have greater
 3 potential for take than the BDCP Proposed Action Any western pond turtles directly affected from
 4 implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-
 5 specific environmental review under NEPA, CEQA and/or consultation with CDFW.

6 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 7 western pond turtle during construction. One such measure will require preconstruction surveys for
 8 the species. These measures would be the same for all take alternatives and therefore would have no
 9 difference in their potential to mitigate take of the western pond turtle.

10 **Indirect Construction-Related Effects**

11 Noise and visual disturbance within 500 feet of construction activities could temporarily affect the
 12 use of western pond turtle habitat. In general, the potential for take from construction-related
 13 indirect effects would parallel the amount of permanent and temporary habitat disturbance
 14 associated with each take alternative. **Take Alternatives A** (309 more acres), **B** (555 more acres), **C**
 15 and **E** (568 more acre), **F** (267 more acres), **H** (more assumed based on larger restoration footprint)
 16 would all have greater potential for take than the BDCP Proposed Action (Table 9-24). **Take**
 17 **Alternatives D** (369 fewer acres) and **G** (assumed less due to small construction and restoration
 18 footprint) would all have less potential for take than the BDCP Proposed Action. **Take Alternative I**
 19 would have the same potential for take as the BDCP Proposed Action. Any western pond turtles
 20 affected by implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated
 21 under project-specific environmental ESA Section 7 and CDFW consultations.

22 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 23 western pond turtle during construction. One such measure will require preconstruction surveys for
 24 the species. These measures would be the same for all take alternatives and therefore would have no
 25 difference in their potential to mitigate take of the western pond turtle.

26 **9.4.3.3 California Tiger Salamander**

27 **Take Alternative I** would have the same potential for take of the California tiger salamander as the
 28 BDCP Proposed Action. **Take Alternatives D, F, and G** would have less potential for take and **Take**
 29 **Alternatives A, B, C, E, and H** would have greater potential for take (Table 9-24). These differences
 30 in take are largely associated with the amounts of tidal natural communities restoration (CM4) and
 31 the conveyance alignments and associated infrastructure (CM1).

32 **9.4.3.3.1 Permanent Habitat Loss, Conversion, and Fragmentation**

33 The BDCP Proposed Action would permanently affect 639 acres of modeled California tiger
 34 salamander habitat (2% of modeled habitat in the Plan Area). Tidal natural communities restoration
 35 (CM4) would account for a loss of 517 acres of modeled habitat. **Take Alternative I** would all have
 36 the same potential for take as the BDCP Proposed Action (Table 9-24). **Take Alternative A** (66
 37 more acres) would have a greater potential for take due mostly to effects on terrestrial cover habitat
 38 but also on 2 acres of aquatic habitat from the construction of the western conveyance option to the
 39 north and west of Clifton Court Forebay. **Take Alternative D** would have less potential for take
 40 because it would restore 25,000 fewer acres of tidal natural communities. **Take Alternatives B, C,**
 41 **and E** (1 less acre each) would no measureable difference in the potential for take and **F** (5 fewer
 42 acres) would have less potential for take than the BDCP Proposed Action because of the difference in

1 the conveyance option. **Take Alternatives G** would restore 15,000 fewer acres of tidal natural
2 communities and would have less potential for take, while **Take Alternative H** would restore
3 10,000 more acres of tidal natural communities and would have more potential for take.

4 Effects on the California tiger salamander would be offset by the protection of 8,000 acres of
5 grassland, the restoration of 2,000 acres of grassland, the protection of 600 acres of vernal pool
6 complex, the protection of 150 acres of alkali seasonal wetland, and the implementation of vernal
7 pool restoration, which will ensure that there is no net loss of wetted vernal pool acreage. Measures
8 identified in Appendix 3.C, *Avoidance and Minimization Measures*, would be the same for all take
9 alternatives and therefore would have no difference in their potential to offset take of the California
10 tiger salamander.

11 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
12 ROAs, the BDCP Proposed Action and **Take Alternatives B, C, D, E, F, and G** would not substantially
13 differ in their potential to fragment modeled habitat and result in take. The conveyance route for
14 **Take Alternative A** would pass through an area of vernal pool complex, which would result in the
15 fragmentation of this habitat, thus further isolating this area from the surrounding landscape. **Take**
16 **Alternative H**, which would include a greater amount of tidal natural communities restoration,
17 would likely have a higher potential for fragmenting habitat and resulting in potential take. **Take**
18 **Alternative I** would have the same potential to fragment habitat as the BDCP Proposed Action. Any
19 California tiger salamander habitat loss resulting from implementation of the USFWS 2008 BiOp and
20 NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW consultations.

21 **9.4.3.3.2 Periodic Effects**

22 The BDCP Proposed Action would result in potential for take of the California tiger salamander from
23 periodic flooding of terrestrial cover habitat in Yolo Bypass during all of the modeled flow events at
24 the proposed Fremont Weir notch (CM2). The potential for take would be same for all take
25 alternatives (Table 9-24). Any periodic effects to California tiger salamander resulting from
26 implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-
27 specific ESA Section 7 and CDFW consultations.

28 **9.4.3.3.3 Construction-Related Effects**

29 **Temporary Habitat Loss**

30 The BDCP Proposed Action would temporarily affect 32 acres of modeled California tiger
31 salamander habitat (less than 1% of the modeled habitat in the Plan Area). All effects would be
32 associated with conveyance facility construction in the south Delta. The potential for take would be
33 the same for **Take Alternatives G** and **I** because they have the same conveyance footprint or the
34 same level of temporary effect as that of the BDCP Proposed Action (Table 9-24). **Take Alternative**
35 **A** (22 fewer acres) and **Take Alternative F** (32 fewer acres) would have less potential for take
36 because of the locations of the borrow and spoils areas for the construction of the conveyance
37 facility. **Take Alternatives B** (125 more acres), **C** and **E** (124 more acres), **D** (125 more acres), and
38 **H** (125 more acres) would have a greater potential for take than the BDCP Proposed Action. Any
39 California tiger salamander habitat temporarily affected by implementation of the USFWS 2008
40 BiOp and NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW
41 consultations.

1 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 2 California tiger salamander. One such measure will restore temporarily affected natural
 3 communities. These measures would be the same for all take alternatives and therefore would have
 4 no difference in their potential to mitigate take of the California tiger salamander.

5 **Construction-Related Injury or Mortality**

6 Use of heavy equipment during construction may result in injury or mortality of California tiger
 7 salamanders, if present. Increased vehicular traffic associated with the BDCP Proposed Action could
 8 contribute to a higher incidence of road kill.

9 In general, the potential for take from construction-related injury or mortality would parallel the
 10 amount of permanent and temporary habitat disturbance associated with each take alternative. Only
 11 **Take Alternative H** would have a greater potential for take than the BDCP Proposed Action due to
 12 the greater amounts of tidal, floodplain, and channel margin restoration. **Take Alternative I** would
 13 have the same potential for take as the BDCP Proposed Action. **Take Alternatives A** (44 more
 14 acres), **B** (124 more acres), and **C and E** (124 more acres), would all have a greater potential for
 15 take. **Take Alternatives F** (38 fewer acres), and **D and G** (assumed fewer acres due to smaller
 16 construction and restoration footprint 25,000 and 15,000 fewer acres of tidal natural communities
 17 restoration, respectively) would all have less potential for take (Table 9-24). Any California tiger
 18 salamander directly affected from implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp
 19 would be evaluated under project-specific ESA Section 7 and CDFW consultations.

20 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 21 California tiger salamander during construction. One such measure will require preconstruction
 22 surveys for the species. These measures would be the same for all take alternatives and therefore
 23 would have no difference in their potential to mitigate take of the California tiger salamander.

24 **Indirect Construction-Related Effects**

25 Noise and visual disturbance within 500 feet of construction activities could temporarily affect the
 26 use of aquatic and terrestrial cover and aestivation habitat. Also, petroleum or other contaminant
 27 spills from construction equipment, drilling operations, or other activities could affect California
 28 tiger salamanders if present.

29 In general, the potential for take from indirect construction-related effects would parallel the
 30 amount of permanent and temporary habitat disturbance associated with each take alternative. Only
 31 **Take Alternative H** would have a greater potential for that than the BDCP Proposed Action due to
 32 the greater amounts of tidal, floodplain, and channel margin restoration. **Take Alternatives I** would
 33 have the same potential for take as the BDCP Proposed Action. **Take Alternatives A** (294 more
 34 acres), **B** (121 more acres), and **C and E** (123 more acres) would have a greater potential for
 35 take of California tiger salamander. **Take Alternatives F** (85 fewer acres) and **D and G** (assumed
 36 fewer acres due to smaller construction and restoration footprint 25,000 and 15,000 fewer acres of
 37 tidal natural communities restoration, respectively) would all have less potential for take (Table
 38 9-24). Any California tiger salamanders affected by implementation of the USFWS 2008 BiOp and
 39 NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7 and CDFW consultations.

40 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 41 California tiger salamander during construction. One such measure will require preconstruction
 42 surveys for the species. These measures would be the same for all take alternatives and therefore
 43 would have no difference in their potential to mitigate take of the California tiger salamander.

1 **9.4.3.4 California Red-Legged Frog**

2 **Take Alternative I** would have the same potential for take of the California red-legged frog as the
3 BDCP Proposed Action (Table 9-24). **Take Alternatives D, F, and G** would have less potential for
4 take and **Take Alternatives A, B, C, E, and H** would have greater potential for take. These
5 differences in take are largely associated with the amounts of tidal natural communities restoration
6 (CM4) and the conveyance alignments and associated infrastructure (CM1).

7 **9.4.3.4.1 Permanent Habitat Loss, Conversion, and Fragmentation**

8 BDCP covered activities that would result in permanent loss of California red-legged frog habitat
9 include conveyance facility construction and recreational related facility construction (CM11).
10 Conveyance construction would permanently affect 7 acres and recreational related construction
11 would permanently affect 24 acres of modeled California red-legged frog habitat (both less than 1%
12 of this habitat in the Plan Area). **Take Alternative I** would all have the same potential for take as the
13 BDCP Proposed Action due to having the same construction footprint in modeled habitat (Table
14 9-24). **Take Alternative A** (56 more acres) would have a higher potential for take. **Take**
15 **Alternatives B, C, and E** (1 less acre each) would not have a measureable difference in take relative
16 to the BDCP Proposed Action and **Take Alternative F** (4 fewer acres) would have a lower potential
17 for take. Take Alternatives D and G (assumed fewer acres due to smaller construction and
18 restoration footprint 25,000 and 15,000 fewer acres of tidal natural communities restoration,
19 respectively), would have less potential for take than the BDCP Proposed Action. **Take Alternative**
20 **H** would restore 10,000 more acres of tidal natural communities and would have more potential for
21 take.

22 Effects on the California red-legged frog would be offset by the protection of 8,000 acres of grassland
23 and, if present, the protection of stock ponds and other aquatic features in these grasslands, and the
24 measures identified in Appendix 3.C, *Avoidance and Minimization Measures*. These measures would
25 be the same for all take alternatives and therefore would have no difference in their potential to
26 offset take of the California red-legged frog.

27 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
28 ROAs, the BDCP Proposed Action and **Take Alternatives A, B, C, D, E, F, G, and H** would not
29 substantially differ in their potential to fragment modeled habitat and result in take. **Take**
30 **Alternative I** would have the same potential to fragment habitat as the BDCP Proposed Action.

31 **9.4.3.4.2 Periodic Effects**

32 The BDCP Proposed Action would not result in potential for take of the California red-legged frog
33 from periodic inundation (CM2 and CM5). The potential for take would be the same for all take
34 alternatives (Table 9-24).

35 **9.4.3.4.3 Construction-Related Effects**

36 **Temporary Habitat Loss**

37 The BDCP Proposed Action would temporarily affect 39 acres of modeled California red-legged frog
38 habitat (less than 1% of the modeled habitat in the Plan Area). All effects would be associated with
39 conveyance facility construction in the south Delta. The potential for take would be the same for
40 **Take Alternatives G and I** because they have the same conveyance footprint in modeled habitat as

1 that of the BDCP Proposed Action (Table 9-24). **Take Alternatives A** (28 fewer acres) and **F** (39
2 fewer acres) would have less potential for take. **Take Alternatives B, C, D, E, and H** (115 more acres
3 each) would have a greater potential for take than the BDCP Proposed Action.

4 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
5 California red-legged frog. One such measure will restore temporarily affected natural communities.
6 These measures would be the same for all take alternatives and therefore would have no difference
7 in their potential to mitigate take of the California red-legged frog.

8 **Construction-Related Injury or Mortality**

9 Use of heavy equipment during construction may result in injury or mortality of California red-
10 legged frogs, if present. Increased vehicular traffic associated with the BDCP Proposed Action could
11 contribute to a higher incidence of road kill.

12 In general, the potential for take from construction-related injury or mortality would parallel the
13 amount of permanent and temporary habitat disturbance associated with each take alternative.
14 **Take Alternative I** would have the same potential for take as the BDCP Proposed Action (Table
15 9-24). **Take Alternatives A** (28 more acres), **B** (113 more acres), and **C and E** (113 more acres)
16 would have a greater potential for take than the BDCP Proposed Action. **Take Alternative F** (46
17 fewer acres) and **D and G** (assumed fewer acres due to smaller construction and restoration
18 footprint 25,000 and 15,000 fewer acres of tidal natural communities restoration, respectively)
19 would have less potential for take than the BDCP Proposed Action. **Take Alternative H** would
20 restore 10,000 more acres of tidal natural communities and would have more potential for take.

21 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
22 California red-legged frog during construction. One such measure will require preconstruction
23 surveys for the species. These measures would be the same for all take alternatives and therefore
24 would have no difference in their potential to mitigate take of the California red-legged frog.

25 **Indirect Construction-Related Effects**

26 Noise and visual disturbance within 500 feet of habitat could temporarily affect the use of aquatic
27 and terrestrial cover and aestivation habitat. Also, petroleum or other contaminant spills from
28 construction equipment, drilling operations, or other activities could affect California red-legged
29 frogs if present.

30 In general, the potential for take from indirect construction-related effects would parallel the
31 amount of permanent and temporary habitat disturbance associated with each take alternative.
32 **Take Alternatives D, G, H, and I** would have the same potential for take as the BDCP Proposed
33 Action (Table 9-24). **Take Alternatives B** (83 more acres), **C, and E** (83 more acres) would have a
34 greater potential for take. **Take Alternatives A** (27 fewer acres) and **F** (64 fewer acres) would have
35 less potential for take.

36 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
37 California red-legged frog during construction. One such measure will require preconstruction
38 surveys for the species. These measures would be the same for all take alternatives and therefore
39 would have no difference in their potential to mitigate take of the California red-legged frog.

1 9.4.4 Invertebrates

2 Each take alternative is evaluated to assess how take of invertebrate species would be expected to
 3 change. This section summarizes the results of the evaluation, and focuses on those take alternatives
 4 that would reduce or avoid take of one or more invertebrate species. Take alternatives that increase
 5 take of covered invertebrates (if any take alternatives do so) are mentioned but are not the focus of
 6 the analysis.

7 The comparison of take alternatives is summarized in Table 9-25.

8 **Table 9-25. Expected Changes in Incidental Take of Invertebrates and Conservation Benefits by**
 9 **Alternative, Relative to the BDCP Proposed Action**

Species	Take Alternative								
	Permanent / Temporary / Periodic Effects								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified spring Outflow
Valley elderberry longhorn beetle	- / + / 0	- / - / 0	- / + / 0	- / - / 0	- / + / 0	- / + / 0	- / 0 / 0	+ / + / +	0 / 0 / 0
Vernal pool tadpole shrimp	+ / + / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	+ / 0 / 0	0 / 0 / 0
Conservancy fairy shrimp	+ / + / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	+ / 0 / 0	0 / 0 / 0
Longhorn fairy shrimp	+ / + / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	+ / 0 / 0	0 / 0 / 0
Vernal pool fairy shrimp	+ / + / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	+ / 0 / 0	0 / 0 / 0
Midvalley fairy shrimp	+ / + / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	+ / 0 / 0	0 / 0 / 0
California linderiella	+ / + / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0	+ / 0 / 0	0 / 0 / 0
A three-point scale indicates how the level of take or conservation benefit is expected to change compared to the BDCP Proposed Action. - Take is likely measurably less than the BDCP Proposed Action. 0 Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action.									

10

11 9.4.4.1 Valley Elderberry Longhorn Beetle

12 **Take Alternatives F and H** would have a greater potential for take and **Take Alternatives A, B, C,**
 13 **D, E, and G** would have less potential for take than the BDCP Proposed Action (Table 9-25). The
 14 differences in potential for take are largely due to tidal natural communities restoration (CM4) and
 15 conveyance footprints (CM1). **Take Alternative I** would have the same potential for take as the
 16 BDCP Proposed Action.

17 9.4.4.1.1 Permanent Habitat Loss, Conversion, and Fragmentation

18 The BDCP Proposed Action would permanently affect 1,250 acres of modeled valley elderberry
 19 longhorn beetle habitat (4% of modeled habitat in the Plan Area). Tidal natural communities

1 restoration (CM4) would account for a loss of 813 acres. **Take Alternative I** would have the same
 2 level of effect as the BDCP Proposed Action. **Take Alternatives D** and **G** would restore 25,000 and
 3 15,000 fewer acres of tidal natural communities, respectively, and would have less potential for
 4 take. **Take Alternative H** would restore 10,000 more acres and would have greater potential for
 5 take. **Take Alternatives A, B, C,** and **E** would differ in their potential for take due to the conveyance
 6 alignments and number and location of intakes along the Sacramento River. **Take Alternatives A**
 7 (153 fewer acres), **B** (30 fewer acres), and **C** and **E** (10 fewer acres) would have less effect on
 8 modeled habitat than the BDCP Proposed Action. **Take Alternative F** (97 fewer acres), would have
 9 less potential for take associated with channel modifications and the construction of operable
 10 barriers. Any valley elderberry longhorn beetle habitat loss resulting from implementation of the
 11 USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7
 12 consultations.

13 Under the BDCP Proposed Action, 5,000 acres of valley/foothill riparian natural community
 14 restoration would occur and 750 acres of existing valley foothill riparian will be protected (CM7)
 15 together with the transplanting of elderberry shrubs identified within project footprints to
 16 conservation areas, and the planting of additional elderberry seedlings and associated native plants
 17 according to U.S. Fish and Wildlife Service guidelines (Appendix 3.F, *U.S. Fish and Wildlife Service*
 18 *Conservation Guidelines for the Valley Elderberry Longhorn Beetle*) would offset the effects on the
 19 species. These conservation measures would be the same for **Take Alternatives A, B, C, D, E, F,** and
 20 **G** and, therefore, would have no difference in their potential to mitigate take of valley elderberry
 21 longhorn beetle (Table 9-25). **Take Alternative H** would likely benefit valley elderberry longhorn
 22 beetle through increases in potentially suitable riparian habitat in higher elevation portions of the
 23 riparian areas within the 10,000 acres of additional floodplain restoration (CM5) and 20 miles of
 24 additional channel margin enhancement.

25 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
 26 ROAs, the BDCP Proposed Action and take alternatives would not substantially differ in their
 27 potential to fragment modeled habitat or isolate known occupied habitat.

28 **9.4.4.1.2 Periodic Effects**

29 The potential for take from the periodic inundation of modeled valley elderberry longhorn beetle
 30 habitat is largely unknown due to a lack of data regarding elderberry shrubs' tolerance of
 31 inundation. It is assumed that there would be some potential for take from Yolo Bypass operations
 32 (CM2) and floodplain restoration (CM5), which would be the same for the BDCP Proposed Action
 33 and **Take Alternatives A, B, C, D, E, F,** and **G**. **Take Alternative H** would restore 10,000 more acres
 34 of floodplains and would thus, likely have more potential for take than the BDCP Proposed Action
 35 (Table 9-25).

36 **9.4.4.1.3 Construction-Related Effects**

37 **Temporary Habitat Loss**

38 The BDCP Proposed Action would temporarily affect 311 acres of modeled habitat in the Plan Area.
 39 **Take Alternative G** and **I** would have the same potential for take because the only disturbance-
 40 related difference between G and the BDCP Proposed Action is tidal natural communities
 41 restoration, which does not have any temporary beetle habitat effects associated with it, the physical
 42 footprint of **Take Alternative I** is exactly the same as the BDCP Proposed Action (Table 9-25). **Take**
 43 **Alternatives A, B, C, D,** and **E** would vary in their potential for take based on the conveyance

1 alignment and location and number of intakes along the Sacramento River. **Take Alternatives A**
 2 (142 more acres), **C** and **E** (8 more acres), and **F** (435 more acres) would result in more effects on
 3 modeled habitat than the BDCP Proposed Action. **Take Alternatives B** and **D** (5 fewer acres each)
 4 would have less potential for take. **Take Alternative H** would have a greater potential for take than
 5 the BDCP Proposed Action because it would restore 10,000 more acres of floodplains.

6 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 7 valley elderberry longhorn beetle during construction. One such measure will require surveys for
 8 elderberry shrubs. These measures would be the same for all take alternatives and, therefore, would
 9 have no difference in their potential to mitigate take of the valley elderberry longhorn beetle.

10 **Indirect Construction-Related Effects**

11 Noise and visual disturbance within 100 feet of occupied elderberry shrubs could result in potential
 12 take through potential damage to host shrubs (dust and altered hydrology) and disrupting behavior
 13 (vibrations). In general, the potential for take from indirect construction-related effects would
 14 parallel the permanent and temporary habitat disturbance associated with each take alternative.
 15 **Take Alternatives A, B, C, E, F,** and **H** would likely have more indirect effects than the BDCP
 16 Proposed Action and **Take Alternatives D** and **G** would have fewer indirect effects. **Take**
 17 **Alternative I** would have the same potential for take as the BDCP Proposed Action because the
 18 physical foot print is the same (Table 9-25). Any valley elderberry longhorn beetles affected by
 19 implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-
 20 specific ESA Section 7 consultations.

21 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of the
 22 valley elderberry longhorn beetle during construction. One such measure will require surveys for
 23 elderberry shrubs. These measures would be the same for all take alternatives and therefore would
 24 have no difference in their potential to mitigate take of the valley elderberry longhorn beetle.

25 **9.4.4.2 Vernal Pool Crustaceans**

26 **Take Alternatives B, C, D, E, F, G,** and **I** would have the same potential for take as the BDCP
 27 Proposed Action. **Alternatives A** and **H** would have a greater potential for take (Table 9-25). The
 28 differences in take are largely due to tidal natural communities restoration effects (CM4) and in
 29 some cases from the conveyance alignments (CM1).

30 **9.4.4.2.1 Permanent Habitat Loss, Conversion, and Fragmentation**

31 The BDCP Proposed Action would permanently affect up to 67 acres of modeled vernal pool
 32 crustacean habitat (less than 1% of modeled habitat in the Plan Area); the majority of this (59 acres)
 33 is categorized as degraded vernal pool complex, which has been identified as containing lower-value
 34 vernal pools at low densities. Total permanent loss was reduced from 372 acres (CM4) to 67 acres.
 35 This reduction is based on a 10-acre cap for total loss of wetted acres, assuming 15% density of
 36 vernal pools in the area affected. Acreage of vernal pool complex loss may be higher if actual vernal
 37 pool density is lower. **Take Alternatives B, C, D, E, F, G,** and **I** would have the same cap, therefore
 38 the same potential for take as the BDCP Proposed Action because the physical foot print is the same.
 39 **Take Alternative A** (14 more acres) includes the same cap. However, the cap would be exceeded
 40 because CM1 alone results in 81 acres of impacts to vernal pool complex habitat. Therefore,
 41 assuming that tidal restoration could not fully avoid additional impacts, would have a greater
 42 potential for take due to the loss of high-value vernal pool complex (Table 9-25). **Take Alternative**

1 **H** would restore 10,000 more acres of tidal natural communities, and would have more potential for
2 take. Any vernal pool crustacean habitat loss resulting from implementation of the USFWS 2008
3 BiOp and NMFS 2009 BiOp would be evaluated under project-specific ESA Section 7 consultations.

4 Effects on vernal pool crustaceans would be offset by the protection of 600 acres of existing vernal
5 pool complex, primarily in core vernal pool recovery areas, the implementation of vernal pool
6 restoration (CM9), which will ensure that there is no net loss of wetted vernal pool acreage, and
7 avoidance and minimization measures that require conducting presence/absence surveys and using
8 the results to avoid and minimize take from restoration projects (Appendix 3.C, *Avoidance and*
9 *Minimization Measures*). These measures would be the same for all take alternatives and would have
10 no difference in their potential to offset take of vernal pool crustaceans, except for Alternatives A
11 and H, which would likely require additional vernal pool crustacean protection and restoration to
12 offset take.

13 From a review of maps with modeled habitat, CNDDDB occurrence data, conveyance footprints, and
14 ROAs, the BDCP Proposed Action and **Take Alternatives B, C, D, E, F, and G** would not substantially
15 differ in their potential to fragment modeled habitat and result in take (Table 9-25). The conveyance
16 route for **Take Alternative A** would pass through an area of vernal pool complex, which would
17 result in the fragmentation of this habitat, thus further isolating this area from the surrounding
18 landscape. **Take Alternative H**, which would include a greater amount of tidal natural communities
19 restoration, would likely have a higher potential for fragmenting habitat and resulting in potential
20 take. **Take Alternative I** would have the same potential to fragment habitat as the BDCP Proposed
21 Action.

22 **9.4.4.2.2 Periodic Effects**

23 The BDCP Proposed Action would only result in a small amount of potential for take of vernal pool
24 crustaceans from periodic flooding of 4 acres of vernal pool complex in Yolo Bypass during the
25 highest projected flows at the proposed Fremont Weir notch (CM2). The potential for take would be
26 same for all take alternatives, which would not result in any take of vernal pool crustaceans.

27 **9.4.4.2.3 Temporary Construction-Related Effects**

28 **Temporary Habitat Loss**

29 The BDCP Proposed Action are not expected to result in temporary habitat losses because all work
30 areas for tidal natural communities restoration (the only activity directly affecting habitat) will
31 occur within the footprints of permanent losses or in areas that do not provide habitat. **Take**
32 **Alternatives B, C, D, E, F, G, H, and I** are also not expected to result in temporary effects on modeled
33 habitat and thus would not differ in the potential for take from the BDCP Proposed Action (Table
34 9-25). **Take Alternative A** (39 more acres) would have a higher potential for take associated with
35 the construction of the conveyance facilities near Clifton Court Forebay.

36 Measures identified in Appendix 3.C, *Avoidance and Minimization Measures*, will minimize take of
37 vernal pool crustaceans. One such measure will restore temporarily affected natural communities.
38 These measures would be the same for all take alternatives and therefore would have no difference
39 in their potential to mitigate take of vernal pool crustaceans.

1 Indirect Construction-Related Effects

2 Construction within 250 feet of vernal pools may alter the hydrology of these pools by removing a
3 portion of the contributing watershed, disrupting subsurface groundwater flow, and/or altering the
4 local perched aquifer by breaking through restrictive soil layers.

5 Indirect effects would be less (26 less acres) for **Take Alternatives B, C, and F**. **Take Alternative A**
6 (20 more acres) would have a higher potential for take resulting from the construction of the
7 western conveyance option. **Take Alternatives D and G** would have less potential for take
8 (assumed fewer acres due to smaller construction and restoration footprint 25,000 and 15,000
9 fewer acres of tidal natural communities restoration, respectively). **Take Alternative H** would have
10 less potential for take because there would not be any indirect effects associated with these take
11 alternatives. **Take Alternative I** would have the same potential for take as the BDCP Proposed
12 Action because the physical foot print is the same. Any vernal pool crustaceans affected by
13 implementation of the USFWS 2008 BiOp and NMFS 2009 BiOp would be evaluated under project-
14 specific environmental review under ESA Section 7 consultations.

15 As described in Appendix 3.C, *Avoidance and Minimization Measures*, the restoration activities will be
16 designed to avoid indirect effects on vernal pools to the extent possible, with 250-foot no-
17 disturbance buffers between construction activities and vernal pools. These measures would be the
18 same for all take alternatives and therefore would have no difference in their potential to mitigate
19 take of vernal pool crustaceans.

20 9.4.5 Summary of Incidental Take Analysis

21 The outcomes of the take alternatives analysis are summarized for the covered species in the
22 subsections below. This includes the net effect of each take alternative based on the expected level
23 of incidental take and the likely conservation benefit compared with the BDCP Proposed Action.

24 9.4.5.1 All Covered Fish

25 The difference in the amount of take of covered fish among take alternatives is generally
26 proportional to the number and overall size of the in-water structures, the extent of water deliveries
27 provided through the south Delta facilities (where greater entrainment, impingement, and predation
28 are expected to occur), and the associated and proportional construction, maintenance, and
29 operational activities. This summary focuses on the relative differences of each take alternative,
30 compared with the BDCP Proposed Action (Table 9-26). The BDCP Proposed Action, with three
31 intakes, would likely result in less take of covered fish from entrainment or impingement at the
32 north Delta facilities than **Take Alternatives A, C, and E**, which would each have five new intakes
33 and total screen lengths between 54 and 66% greater than the BDCP Proposed Action (Table 9-12).
34 However, **Take Alternative E** would not export water from the south Delta facilities, where
35 substantial entrainment and associated predation levels are expected to occur. It is assumed that
36 any increased fish losses at the north Delta intakes would be more than offset by the reduced losses
37 at the south Delta facilities. **Take Alternatives B and D** would have greater water exports from the
38 south Delta facilities than the BDCP Proposed Action, resulting in slightly greater take of most
39 covered fish species at the south Delta facilities. These effects would be magnified in dry years,
40 because of the expected greater use of the south Delta facilities and the more upstream distribution
41 of estuarine-rearing fish. **Take Alternative F** would also have greater water exports at the south
42 Delta facilities than the BDCP Proposed Action, although the number of fish diverted from the

1 Sacramento River to the south Delta facilities would be substantially reduced by the north Delta
 2 diversion screens and operable gates. However, the greater overall screen length, dredging, and
 3 wider distribution of construction activities would be expected to have a greater potential for take
 4 during construction, compared to the BDCP Proposed Action. **Take Alternatives G, H, and I** would
 5 be similar to the BDCP Proposed Action, although **Take Alternative I** provides fixed spring flows
 6 during wet and above normal water years, which is expected to reduce entrainment, impingement,
 7 and potentially predation. These increased spring flows could also provide additional habitat in the
 8 Delta, through an increase in inundation areas that provide increased conservation benefits.

9 **Table 9-26. Take Alternatives Summary: Fish**

Fish Species	Take Alternative								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified Spring Outflow
Delta smelt	+	+	+	+	-	+	○	-	○
Longfin smelt	+	+	+	+	-	+	○	-	○ ^a
Sacramento River winter-run Chinook salmon	+	+	+	+	-	+	○	-	○
Central Valley spring-run Chinook salmon	+	+	+	+	-	+	○	-	○ ^a
Central Valley fall- and late fall-run Chinook Salmon	+	+	+	+	-	+	○	-	○
Central Valley steelhead	+	+	+	+	-	+	○	-	○
Sacramento splittail	○	○	○	○	-	+	○	-	○ ^a
White sturgeon	+	+	+	+	-	+	○	-	○ ^a
North American green sturgeon	+	+	+	+	-	+	○	-	○ ^a
Pacific lamprey	+	-	+	-	+	+	○	-	○
River lamprey	+	-	+	-	+	+	○	-	○

A 3-point scale is used to indicate how the level of take is expected vary from the BDCP Proposed Action.
 - Take is likely measurably less than the BDCP Proposed Action.
 ○ Take is not measurably different from the BDCP Proposed Action.
 + Take is likely measurably greater than the BDCP Proposed Action.
 Note:
 .
^a While there is no expected change in the level of take, these species are expected to have greater conservation benefit from this take alternative.

10

11 **9.4.5.1.1 Construction**

12 While construction-related take would be minimized for most species by adhering to the approved
 13 in-water work window, the five-intake take alternatives (**Take Alternatives A, C, and E**) would
 14 typically result in greater take than the BDCP Proposed Action (Table 9-26). These three take
 15 alternatives have larger in-water footprints and would require up to about 59% more pile driving to

1 install the cofferdams and foundation piles, a greater potential for stranding fish because of the
2 larger number and overall size of the cofferdam enclosures, and an estimated 54 to 68% more area
3 dredged outside of the cofferdams to recontour the substrate in front of the intakes.

4 The take alternatives with five intakes (**Take Alternatives A, C, and E**) would have substantially
5 greater (58 to 68%) habitat loss, due to the larger intake footprint, compared with the BDCP
6 Proposed Action. The other three-intake take alternatives (**Take Alternatives G, H, and I**) would
7 have similar levels of habitat loss as the BDCP Proposed Action, as the total intake footprints would
8 be similar. The take alternatives with fewer intakes (**Take Alternatives B and D**) would have
9 proportionally lower potential for take (32 to 74% less habitat loss) than the BDCP Proposed Action.
10 Although very similar in size to the three-intake take alternatives, **Take Alternative F** is expected to
11 have greater construction effects from pile driving, stranding, and habitat alteration/loss than the
12 BDCP Proposed Action, and most other take alternatives. **Take Alternative F** would also include
13 greater dredging, particularly in some of the interior Delta channels to provide adequate water
14 transport capacity to the south Delta facilities. This would include dredging and excavation activities
15 to reroute the Mokelumne and Cosumnes Rivers to flow into the Sacramento River instead of the
16 San Joaquin River.

17 **9.4.5.1.2 Maintenance**

18 A similar pattern of potential take is expected with regard to the periodic maintenance
19 requirements for the various take alternatives. The five-intake take alternatives would require more
20 maintenance activities. Of the covered activities occurring during the maintenance phase, dredging
21 in front of the intakes to maintain efficient hydrologic flow conditions would result in the greatest
22 potential for take. **Take Alternative F** would also require periodic dredging to maintain flow
23 capacity in some of the channels leading to the south Delta facilities, increasing the potential level of
24 take. However, most of the covered species would occur less frequently in the interior delta
25 channels, compared to the other take alternatives because of the fish diversion structures
26 constructed as part of **Take Alternative F**. However, despite the apparent differences between take
27 alternatives, the level of take for the typical maintenance activities would be minimized by adhering
28 to the approved in-water construction window.

29 **9.4.5.1.3 Operations**

30 While extensive in-water work would occur during the construction phase, for all of the take
31 alternatives, the operation phase has the most potential for take for all or most of the covered
32 species. This increased risk is because the operational effects would occur throughout the year, not
33 just during periods of low species abundance (such as during the approved in-water work
34 windows), and throughout 40 years of the 50-year permit term (80%). Given these extended
35 timeframes, all of the covered species will be affected to some degree, along with multiple year-
36 classes of these populations. Therefore, the overall levels of take for most covered species are driven
37 primarily by these operational effects (Table 9-26).

38 The take alternatives would result in changes in the timing and patterns of water flow through the
39 Delta, which would affect migration timing, habitat availability and condition, entrainment and
40 impingement, and exposure to predators. As with the construction phase, the effects of the take
41 alternatives would typically be proportional to the size and the number of intakes, with the five-
42 intake take alternatives (**Take Alternatives A, C, and E**) having the most potential to alter all of
43 these potential mechanisms of effect. The larger size of the combined intake facilities would result in

1 55 to 66% greater screen length than the BDCP Proposed Action and **Take Alternatives G, H, and I**
 2 (all with the same intakes as the BDCP Proposed Action), with a corresponding increase in potential
 3 take from entrainment and impingement. Although the new screens would minimize the overall take
 4 by conforming to the agency-recommended design standards, take would generally increase with
 5 increased screen area.

6 Although the potential for entrainment and impingement would increase at the north Delta intake
 7 facilities in general proportion to the number of intakes and overall screen area, the increased
 8 number of intakes would also result in less flow (and fish) diverted from the Sacramento River to
 9 the interior Delta and the south Delta export facilities. The decrease in flow diversion will reduce
 10 fish losses (take) due to predation in the interior Delta, as well as predation, entrainment, and
 11 impingement at the south Delta facilities. Compared with the BDCP Proposed Action, the five-intake
 12 take alternatives would typically result in slightly higher take levels because the covered species
 13 would also still have access to the interior Delta area, where lower flows, decreased water quality
 14 conditions, slower migrations, and greater predator pressures are expected to occur. In addition,
 15 entrainment and impingement would continue to occur in various times of the year at the south
 16 Delta facilities. However, **Take Alternative E** would have no water exports from the south Delta
 17 facilities, so despite the number and size of the north Delta intakes, the losses (take) associated with
 18 **Take Alternative E** would be lower than the BDCP Proposed Action.

19 The take alternatives with fewer intakes than the BDCP Proposed Action would tend to have an
 20 overall lower potential for take from entrainment and impingement (34% less screen length for
 21 **Take Alternative B** and 75% less for **Take Alternative D**) at the north Delta facilities. However,
 22 both of these take alternative would have greater exports from the south Delta facilities than the
 23 BDCP Proposed Action, and therefore would result in greater overall levels of take from entrainment
 24 and impingement.

25 In addition to the changes in entrainment and impingement, the five-intake take alternatives would
 26 also affect downstream flows, and the availability and general value of the habitat. Species with life
 27 stages that are particularly sensitive to flow or Delta habitat conditions, such as delta and longfin
 28 smelt and Sacramento splittail, would be affected to a greater degree than species that are more
 29 mobile or occur in the delta for relatively shorter period of time (i.e., salmonids and sturgeon). While
 30 **Take Alternative I** is similar to the BDCP Proposed Action, it would provide greater spring flows
 31 during some water years, which is expected to benefit longfin smelt. Other species in the Plan Area
 32 would also benefit from these increased flows, particularly those that migrated downstream, or
 33 extensively rear in the Delta in the spring.

34 Overall, take alternatives with fewer intakes than the BDCP Proposed Action would tend to have
 35 lower levels of take, while those with more intakes tend to have greater levels of take. **Take**
 36 **Alternative F** would have no intakes, so it would result in the least amount of flow changes in the
 37 Delta, and would block fish from entering the interior Delta and being affected by the operations of
 38 the south Delta facilities. However, the overall length of the diversions screens and operable gates,
 39 compared to the BDCP Proposed Action, would likely result in a greater level of take from screen-
 40 related effects. As such, this take alternative would generally result in similar overall screen-related
 41 take levels to the BDCP Proposed Action, particularly for species with juvenile downstream
 42 migrants, which would benefit from remaining in the mainstem Sacramento River.

43 Although Take Alternative F would have limited flow effects in the Delta, upstream flow reductions
 44 are expected to result in significant unavoidable adverse effects on migration habitat for

1 downstream migrating juvenile fall-/late fall-run Chinook salmon, as well as increased egg mortality
 2 and reduced rearing habitat for green sturgeon.

3 Despite the potential for increased take during operations, all take alternatives also provide
 4 substantial increases in habitat restoration in the Plan Area, directly or indirectly benefiting aquatic
 5 species. While there is the potential for substantial benefits, it is not possible to predict the level of
 6 benefit, beyond at least a minor beneficial effect. However, take alternatives that provide greater
 7 amounts of habitat restoration have the most potential to have beneficial effects. **Take Alternative**
 8 **H** would have the most potential benefits, as it provides 10,000 (15%) additional acres of tidal
 9 habitat, and 100% more seasonally inundated floodplain and channel margin (10,000 acres, and 20
 10 miles more, respectively) than other take alternatives. The additional spring flows provided by **Take**
 11 **Alternative I**, are also expected to increase seasonally inundated habitats in the Plan Area. **Take**
 12 **Alternatives G** and **D** would provide 23% (15,000 acres) and 38% (25,000 acres) less tidal habitat
 13 than most other take alternatives (**Take Alternatives A, B, C, E, and F**), respectively.

14 In addition to the conservations measures focusing on restoring habitat, the other conservation
 15 measures incorporated in all the take alternatives will also benefit aquatic species. This would
 16 include the benefits associated with reducing predation, improving habitat and water quality
 17 conditions, reducing illegal harvest, and reducing effects of nonproject diversions. All of these
 18 measures are expected to benefit the covered fish species, by improving growth and survival rates.

19 **9.4.5.2 All Covered Mammals**

20 The potential for take of covered mammals varies by species habitat requirements and distribution
 21 in the Plan Area. Because none of these species occur in the northeast portion of the Plan Area, the
 22 number and location of intakes would not contribute to the differences in take of covered mammals.
 23 **Take Alternative I** would have the same potential for take as the BDCP Proposed Action because
 24 the physical foot print is the same, only operations would be different. (Table 9-27). For the
 25 remaining take alternatives, the differences in potential for take would vary largely by the species'
 26 geographic distributions. For riparian brush rabbit, **Take Alternatives A, B, C, E, and F** would have
 27 differences in potential for take and for riparian woodrat **Alternative F** would have a difference in
 28 potential for take. The amount of tidal natural communities restoration in the east Delta (major
 29 differences for **Take Alternatives D, G, and H**), and the amount of floodplain restoration in the
 30 south Delta (a major difference for **Take Alternative H**) also have differences in potential for take of
 31 the riparian brush rabbit and riparian woodrat. Suisun shrews and salt marsh harvest mice only
 32 occur in Suisun Marsh and thus the take alternatives would only differ in their potential for take
 33 based on the amount of tidal natural communities restoration there (**Take Alternatives D, G, and**
 34 **H**). The potential for take of the San Joaquin kit fox differs between **Take Alternatives A, B, C, E,**
 35 **and F. Take Alternatives D, G, and H** would have different potentials for take (except for the San
 36 Joaquin kit fox) based largely on the overall amount of tidal natural communities restoration, even
 37 though some of these differences would be due to Delta and Suisun Marsh tidal natural communities
 38 restoration. Table 9-27 provides a summary of the take alternatives for covered mammals.

39 Despite the potential for increased take as a result of implementing the BDCP Proposed Action, all
 40 take alternatives would provide increases in habitat restoration, protection, and management for
 41 mammal species in the Plan Area that otherwise would not happen and which would contribute to
 42 the long-term conservation of covered mammals. However, the increased habitat restoration
 43 associated with **Take Alternative H** would only likely benefit riparian brush rabbit and riparian
 44 woodrat through increases in potentially suitable riparian habitat that would likely establish within

1 the 10,000 acres of additional floodplain restoration (CM5) if it occurs in proximity to currently
 2 occupied habitat for these species in Conservation Zone 7. Most likely the 10,000 acres of additional
 3 tidal restoration from **Take Alternative H** would be comprised mostly of subtidal habitats that
 4 would not benefit the salt marsh harvest mouse and Suisun shrew. This assumption is based on the
 5 limited availability of additional restoration opportunities for tidal brackish emergent wetlands in
 6 Suisun Marsh beyond the amounts proposed under the BDCP Proposed Action. **Take Alternatives G**
 7 and **D** would have less beneficial effects on salt marsh harvest mouse and Suisun shrew due to the
 8 assumption that having less tidal restoration would result in less restored tidal brackish emergent
 9 wetland in Suisun Marsh. For the remaining mammal species, the benefits from the BDCP Proposed
 10 Action would be the same for all take alternatives.

11 **Table 9-27. Take Alternatives Summary: Mammals**

Mammal Species	Take Alternative								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified spring Outflow
Riparian brush rabbit	-	+	+	-	+	+	-	+	○
Riparian woodrat	○	○	○	-	○	+	-	+	○
Salt marsh harvest mouse	○	○	○	-	○	○	-	+	○
San Joaquin kit fox	+	+	+	○	+	-	○	○	○
Suisun shrew	○	○	○	-	○	○	-	+	○
A 3-point scale is used to indicate how the level of take is expected vary from the BDCP Proposed Action. - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action.									

12

13 **9.4.5.3 All Covered Birds**

14 The potential for take of covered birds varies by species habitat requirements and distribution in
 15 the Plan Area but in general is associated with the amount of tidal natural communities restoration.
 16 **Take Alternatives D, G, and H** would have different amounts of tidal natural communities
 17 restoration and correspondingly different take potentials. **Take Alternatives B, C, and E** would have
 18 the same acres of tidal natural communities restoration, and their differences in potential for take
 19 are associated with the number and location of intakes. **Take Alternatives A and F** would have
 20 differences in potential for take associated with the conveyance route. **Take Alternative H**
 21 generally would have a higher potential for take than the BDCP Proposed Action, whereas **Take**
 22 **Alternatives D and G** generally would have less potential for take. **Take Alternatives A, B, C, E, and**
 23 **F** would vary largely by differences in species range and habitat requirements. **Take Alternative I**
 24 would have the same potential for take as the BDCP Proposed Action because the physical foot print

1 is the same, only operations would be different. Table 9-28 provides a summary of the take
 2 alternatives for covered birds.

3 Despite the potential for increased take as a result of implementing the BDCP Proposed Action, all
 4 take alternatives would provide increases in habitat restoration, protection, and management for
 5 bird species in the Plan Area that otherwise would not happen and which would contribute to the
 6 long term conservation of covered bird species. **Take Alternative H** would result in substantial
 7 increases in potential nesting habitat for riparian bird species (least Bell’s vireo, Swainson’s hawk,
 8 western yellow-billed cuckoo, white-tailed kite, and yellow breasted chat) relative to the other take
 9 alternatives from the 10,000 more acres of floodplain restoration (CM5) and the 20 more miles of
 10 channel margin enhancement (CM6) both of which would result in the establishment and natural
 11 recruitment of riparian vegetation. **Take Alternative H** would also increase habitat for the
 12 California black rail in long term from the additional 10,000 acres of tidal natural community
 13 restoration. **Take Alternatives D and G** would have less potential for take but also have less
 14 beneficial effects for the California black rail, California clapper rail, and Suisun song sparrow by the
 15 late long-term due to having less restored emergent wetland that could be used by the species. For
 16 the remaining bird species, the benefits would be the same for the BDCP Proposed Action and all
 17 take alternatives.

18 **Table 9-28. Take Alternatives Summary: Birds**

Bird Species	Take Alternative								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified spring Outflow
California black rail	-	-	-	-	-	+	-	+	○
California clapper rail	○	○	○	-	○	○	-	+	○
Greater sandhill crane	+	-	-	-	-	-	-	+	○
Least Bell’s vireo	+	-	-	-	-	+	-	+	○
Suisun song sparrow	○	○	○	-	○	○	-	+	○
Swainson’s hawk	+	-	-	-	-	-	-	+	○
Tricolored blackbird	+	-	-	-	-	-	-	+	○
Western burrowing owl	+	-	-	-	-	-	-	+	○
Western yellow-billed cuckoo	+	-	-	-	-	+	-	+	○
White-tailed kite	+	-	-	-	-	-	-	+	○
Yellow-breasted chat	+	-	-	-	-	+	-	+	○
A 3-point scale is used to indicate how the level of take is expected vary from the BDCP Proposed Action. - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action.									

19

1 **9.4.5.4 All Covered Reptiles and Amphibians**

2 The potential for take of covered reptiles and amphibians varies by species habitat requirements
 3 and distribution in the Plan Area. Tidal natural communities restoration accounts for the majority of
 4 effects on the giant garter snake, the western pond turtle, and the California tiger salamander. **Take**
 5 **Alternatives D, G, and H** would have different amounts of tidal natural communities restoration
 6 and correspondingly different take potentials. **Take Alternatives B, C, and E** would have the same
 7 acres of tidal natural communities restoration, and their differences in potential for take are
 8 associated with the number and location of intakes. **Take Alternatives A and F** would have
 9 differences in potential for take associated with the conveyance route. **Take Alternative I** would
 10 have the same potential for take as the BDCP Proposed Action because the physical foot print is the
 11 same, only operations would be different.

12 **Take Alternative H** generally would have a higher potential for take than the BDCP Proposed
 13 Action, whereas **Take Alternatives D and G** generally would have less potential for take. **Take**
 14 **Alternatives A, B, C, E, and F** show less of a general trend for amphibians and reptiles, varying
 15 largely by differences in species range and habitat requirements. Table 9-29 provides a summary of
 16 the take alternatives for covered reptiles and amphibians.

17 **Table 9-29. Take Alternatives Summary: Reptiles and Amphibians**

Reptile and Amphibian Species	Take Alternative								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified spring Outflow
Giant garter snake	+	-	-	-	-	+	-	+	○
Western pond turtle	-	-	-	-	-	-	-	+	○
California red-legged frog	+	+	+	-	+	-	-	○	○
California tiger salamander	+	+	+	-	+	-	-	+	○
A 3-point scale is used to indicate how the level of take is expected vary from the BDCP Proposed Action. - Take is likely measurably less than the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action.									

18

19 Despite the potential for increased take as a result of implementing BDCP Proposed Action, all take
 20 alternatives would provide increases in habitat restoration, protection, and management for
 21 amphibian and reptile species in the Plan Area that otherwise would not happen, and which would
 22 contribute to the long-term conservation of the covered amphibian and reptile species. These
 23 benefits to amphibian and reptile species would be the same for all take alternatives.

1 **9.4.5.5 All Covered Invertebrates**

2 The potential for take of covered invertebrates is mostly attributable to the amount of tidal natural
 3 communities restoration. **Take Alternatives D, G, and H** would have different amounts of tidal
 4 natural communities restoration and correspondingly different take potentials. **Take Alternatives**
 5 **B, C, and E** would have the same acres of tidal natural communities restoration, and their differences
 6 in potential for take are associated with the number and location of intakes. **Take Alternatives A**
 7 **and F** would have differences in potential for take associated with the conveyance route. **Take**
 8 **Alternatives A and H** would have a higher potential for take than the BDCP Proposed Action,
 9 whereas **Take Alternatives D and G** would have less potential for take. **Take Alternative I** would
 10 have the same potential for take as the BDCP Proposed Action because the physical foot print is the
 11 same, only operations would be different. Table 9-30 provides a summary of the take alternatives
 12 for covered invertebrates.

13 **Table 9-30. Take Alternatives Summary: Invertebrates**

Invertebrate Species	Take Alternative								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Modified spring Outflow
Valley elderberry longhorn beetle	-	-	○	-	○	+	-	+	○
Vernal pool tadpole shrimp	+	○	○	○	○	○	○	+	○
Conservancy fairy shrimp	+	○	○	○	○	○	○	+	○
Longhorn fairy shrimp	+	○	○	○	○	○	○	+	○
Vernal pool fairy shrimp	+	○	○	○	○	○	○	+	○
Midvalley fairy shrimp	+	○	○	○	○	○	○	+	○
California linderiella	+	○	○	○	○	○	○	+	○
A 3-point scale is used to indicate how the level of take is expected to vary compared with the BDCP Proposed Action. ○ Take is not measurably different from the BDCP Proposed Action. - Take is likely measurably less than the BDCP Proposed Action. + Take is likely measurably greater than the BDCP Proposed Action.									

14

15 Despite the potential for increased take as a result of implementing the BDCP Proposed Action, all
 16 take alternatives would provide increases in habitat restoration, protection, and management for
 17 invertebrate species in the Plan Area that otherwise would not happen, and which would contribute
 18 to the long-term conservation of covered invertebrate species. **Take Alternative H** would result in
 19 substantial increases in riparian habitat that could support valley elderberry longhorn beetle
 20 relative to the other take alternatives from the 10,000 more acres of floodplain restoration (CM5)
 21 and the 20 more miles of channel margin enhancement (CM6) both of which would result in the

1 establishment and natural recruitment of riparian vegetation. For the remaining invertebrate
2 species, the benefits from would be the same for the BDCP Proposed Action and all take alternatives.

3 **9.5 Assessment of Take Alternatives**

4 **9.5.1 Take Alternative A: W Canal 15,000 cfs**

5 **Take Alternative A: W Canal 15,000 cfs** would involve construction of dual conveyance facilities
6 with a western canal alignment and five intakes. The capacity of the conveyance facilities would be
7 15,000 cfs.

8 **9.5.1.1 Effects on Covered Species**

9 **9.5.1.1.1 Covered Fish**

10 **Construction**

11 Construction at the north Delta intakes, fish diversion structures, restoration sites, conservation
12 hatcheries, and nonphysical barriers may result in a number of adverse effects on the covered
13 species, including disturbance from in-water construction activity and hydrodynamic changes,
14 physical injury from pile-driving sound and vibration levels, exposure to contaminants, and elevated
15 turbidity levels. The five intakes of **Take Alternative A** would result in a substantially greater
16 potential for effects than the three intakes for the BDCP Proposed Action. For example, **Take**
17 **Alternative A** could require about 80% more pile driving, dredging, and aquatic habitat alteration
18 than the BDCP Proposed Action. These construction activities would result in greater effects on fish
19 from underwater sound, fish handling and stranding, and water quality impairment (e.g., increased
20 turbidity and contaminants). The effects would include increased stress, injury, and/or mortality to
21 the covered species.

22 In addition to the construction of the intakes, **Take Alternative A** includes the construction of a
23 water conveyance canal, which would increase the in-water construction effects. This would entail
24 constructing 10 invert culvert siphons to allow the water to pass under existing waterways. This
25 would result in about an additional 5.7 acres of in-water construction, along with the associated pile
26 driving, fish handling, and potential water quality effects. While the potential effects of constructing
27 the conveyance canal would be greater for **Take Alternative A** than the BDCP Proposed Action, the
28 construction of the canal would require four fewer barge landings than the subsurface tunnel
29 conveyance facility under the BDCP Proposed Action.

30 Measurable differences in construction effects between **Take Alternative A** and the BDCP Proposed
31 Action would vary by fish species.

32 ***Delta Smelt***

33 Construction effects would be greater for **Take Alternative A**, compared with the BDCP Proposed
34 Action. The differences would be limited, and perhaps not measurable, because delta smelt occur
35 primarily downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011), which is about 20
36 miles downstream of the intake construction locations (Table 9-10).

1 ***Longfin Smelt***

2 As with delta smelt, potential construction effects on longfin smelt would be greater for **Take**
3 **Alternative A**, compared with the BDCP Proposed Action. However, only limited differences in
4 overall effects would be expected because longfin smelt occur primarily downstream of Rio Vista,
5 over 20 miles downstream of the north Delta intake facilities (Moyle 2002) (Table 9-14).

6 ***Chinook Salmon***

7 Chinook salmon would likely experience measurably greater effects from fish stranding/handling
8 and reductions in water quality under **Take Alternative A** compared with the BDCP Proposed
9 Action (Table 9-15 through Table 9-17).

10 ***Steelhead***

11 Steelhead would experience greater effects from construction activities under **Take Alternative A**,
12 compared with the BDCP Proposed Action (Table 9-18). Steelhead would be marginally less
13 vulnerable to impacts than Chinook salmon because of their larger size and shorter period of
14 presence in Delta waters. Thus steelhead would have a slightly lower potential for effects than
15 Chinook salmon, but more than the smelts, which typically occur some 20 miles downstream of the
16 intake construction areas (Moyle 2002; Kimmerer 2004; Merz et al. 2011).

17 ***Sacramento Splittail***

18 Construction effects would be about 68% greater for **Take Alternative A**, compared with the BDCP
19 Proposed Action, due to in-water construction and dredging activities associated with two
20 additional intakes.

21 ***Sturgeon***

22 Green and white sturgeon would experience measurably greater effects from fish
23 stranding/handling and reductions in water quality under **Take Alternative A**, compared with the
24 BDCP Proposed Action (Table 9-20).

25 ***Lamprey***

26 Pacific and river lamprey would experience measurably greater effects from fish stranding/handling
27 and reductions in water quality under **Take Alternative A**, compared with the BDCP Proposed
28 Action (Table 9-21).

29 **Maintenance**

30 The increased number and overall size of the water facilities in the north Delta for **Take Alternative**
31 **A** would result in proportionally greater maintenance activities, relative to the BDCP Proposed
32 Action. While most of the potential effects would be associated with periodic maintenance dredging
33 activities, some additional effects on covered fish species could occur from increased predation and
34 periodic decreases in water quality. The effects of maintenance dredging would be similar to the
35 construction dredging effects discussed above, and would be about 80% greater for **Take**
36 **Alternative A** than for the BDCP Proposed Action. In addition, the periodic need for maintenance
37 dredging would result in greater effects than the one-time dredging occurring during the
38 construction phase. The effects of other in-water maintenance activities (e.g., screen cleaning) would
39 be small, with minimal differences between **Take Alternative A** and the BDCP Proposed Action.

1 **Operations**

2 **Take Alternative A** would follow Operational Scenario A, while the BDCP Proposed Action would
3 follow Operational Scenario H, with four potential operational sub-scenarios, depending on the
4 outcome of the decision tree process for spring outflow and Fall X2.

5 **Take Alternative A** would have five intakes in the north Delta that could convey up to 15,000 cfs, while
6 the BDCP Proposed Action consists of three intakes and could only convey up to 9,000 cfs. **Take**
7 **Alternative A** would have about 66% more intake screen length, compared with the BDCP
8 Proposed Action, which is expected to result in a proportional increase in potential entrainment and
9 impingement effects on the covered species.

10 Average annual exports in the early long-term under **Take Alternative A** are anticipated to be 5.01
11 MAF while the BDCP Proposed Action would have anticipated exports ranging from 4.71 to 5.59
12 MAF annually. Average annual outflows would typically be greater for the operational scenarios
13 under the BDCP Proposed Action (16.14 MAF) than under **Take Alternative A** (15.81 MAF), as well
14 as existing conditions (15.53 MAF) on average.

15 A greater percentage of average annual water exports would occur at the south Delta facilities under
16 the four operational sub-scenarios of the BDCP Proposed Action (51%), than under **Take**
17 **Alternative A** (48%). Thus, the average annual exports from the south Delta facilities under **Take**
18 **Alternative A** would be less than under all of the action sub-scenarios of the BDCP Proposed Action
19 (H1 through H4).

20 The effects of operations on fish entrainment or spawning, rearing and migration conditions vary by
21 fish species.

22 **Delta Smelt**

23 Delta smelt typically occur downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011),
24 which is about 20 miles downstream of the north Delta intakes. The primary difference between the
25 BDCP Proposed Action and **Take Alternative A** on delta smelt would be the effects on rearing
26 habitat conditions. **Take Alternative A** would have a negative effect on rearing habitat, while the
27 BDCP Proposed Action would have a somewhat beneficial effect. No measurable differences are
28 expected with the potential effects on entrainment, and spawning and migration habitat conditions
29 between **Take Alternative A** and the BDCP Proposed Action.

30 **Longfin Smelt**

31 Effects on longfin smelt would be greater for **Take Alternative A**, compared with the BDCP
32 Proposed Action. **Take Alternative A** would have negative effects on longfin smelt rearing and
33 migration habitat conditions, while no adverse effects would occur under the BDCP Proposed
34 Action. In addition, the BDCP Proposed Action would have beneficial effects on entrainment of
35 longfin smelt. However, the differences in overall effects would likely be limited because longfin
36 smelt occur primarily downstream of the north Delta intake facilities.

37 **Chinook Salmon**

38 **Take Alternative A** would likely have measurably beneficial effects on entrainment of the Chinook
39 salmon species, while the BDCP Proposed Action would primarily benefit the entrainment of spring-
40 run Chinook salmon. For the most part, no adverse effects are expected with regard to spawning,
41 rearing, or migration conditions. While there would be negative effects on spring-run Chinook

1 salmon spawning conditions, these effects are due to future climate change, sea level rise, and/or
 2 changes in water demand, rather than this take alternative.

3 ***Steelhead***

4 As with Chinook salmon, **Take Alternative A** would have beneficial effects on steelhead
 5 entrainment, while no adverse effects are expected with regard to spawning, rearing, or migration
 6 conditions.

7 ***Sacramento Splittail***

8 **Take Alternative A** and the BDCP Proposed Action are expected to have similar effects, as both
 9 would benefit Sacramento splittail migration conditions. No adverse effects are expected with
 10 regard to entrainment, spawning, or rearing conditions.

11 ***Sturgeon***

12 The primary difference in operational effects of **Take Alternative A** and the BDCP Proposed Action
 13 on sturgeon is **Take Alternative A's** projected negative effects on migration conditions for green
 14 and white sturgeon. **Take Alternative A** would also have negative effects on green sturgeon
 15 spawning and rearing conditions, although these effects would be due to future climate change, sea
 16 level rise, and/or changes in water demand. No adverse effects are expected under the BDCP
 17 Proposed Action.

18 ***Lamprey***

19 There are no substantial differences in the operational effects of **Take Alternative A** and the BDCP
 20 Proposed Action with regard to lamprey. No adverse effects are expected with regard to
 21 entrainment, spawning, rearing, or migration conditions under either alternative.

22 **9.5.1.1.2 Covered Mammals**

23 Modeled habitat for covered mammal species would be permanently, temporarily, and periodically
 24 affected by the implementation of the conservation measures under **Take Alternative A**, in
 25 particular the conveyance facilities construction (CM1), tidal natural communities restoration
 26 (CM4), and floodplain restoration (CM5). Of the covered mammals, the greatest potential for take
 27 resulting from the implementation of **Take Alternative A** would be of San Joaquin kit fox. **Take**
 28 **Alternative A** less potential of take for riparian brush rabbit and would have the same level of take
 29 of riparian woodrat, salt harvest mouse, and Suisun shrew as the BDCP Proposed Action.

30 As seen in Table 9-22, **Take Alternative A** differs from the BDCP Proposed Action and **Take**
 31 **Alternative I** in its potential for take of riparian brush rabbit (measurably less) and San Joaquin kit
 32 fox (measurably greater) and is not measurably different for the remaining covered mammal
 33 species. These differences are attributable to **Take Alternative A's** western alignment and higher
 34 degree of permanent and temporary surface impacts resulting from construction of a conveyance
 35 canal.

36 Relative to most of the other take alternatives (**Take Alternative F** has less potential for Take of San
 37 Joaquin Kit Fox), **Take Alternative A** would have the same differences mentioned above for San
 38 Joaquin kit fox and riparian brush rabbit and would differ the same way that the BDCP Proposed
 39 Action and **Take Alternative I** do from **Take Alternatives D, G, and H** for riparian woodrat, salt

1 marsh harvest mouse, and Suisun shrew due to the amounts of tidal restoration (**Take Alternatives**
 2 **D, G, and H**) and floodplain restoration (**Take Alternative H**) (Table 9-22). The effects on covered
 3 mammal species from **Take Alternative A** would be offset over time through the implementation of
 4 the conservation measures.

5 **9.5.1.1.3 Covered Birds**

6 Modeled habitat for covered bird species would be permanently and temporarily affected by the
 7 implementation of the conservation measures under **Take Alternative A**, in particular the
 8 conveyance facilities construction (CM1) and tidal natural communities restoration (CM4). Modeled
 9 habitat for Swainson’s hawk, white-tailed kite, tricolored blackbird, and western burrowing owl
 10 would be periodically affected by Yolo Bypass operations (CM2) and floodplain restoration
 11 (CM5). The greatest potential for take of covered bird species from **Take Alternative A** would be in
 12 the near-term from the loss of riparian habitat. Although the BDCP Proposed Action would result in
 13 5,000 acres of valley/foothill riparian natural community restoration and 750 acres of protection,
 14 the time it takes for riparian trees to mature would result in temporary loss of habitat for covered
 15 birds that use riparian habitats (Swainson’s hawk, white-tailed kite, least Bell’s vireo, western
 16 yellow-billed cuckoo, and yellow-breasted chat). The installation of new transmission lines to power
 17 the construction and operations of the conveyance facilities (CM1) is another source of potential
 18 take. During the winter months, most covered species, in particular greater sandhill crane, would
 19 have a greater potential to collide with transmission lines because of decreased visibility due to fog
 20 and cloudy skies.

21 As seen in Table 9-23, **Take Alternative A** differs from the BDCP Proposed Action by having greater
 22 potential for take of species that use grassland and agricultural habitats for foraging (greater
 23 sandhill crane, Swainson’s hawk, white-tailed kite, tricolored blackbird, and western burrowing
 24 owl) and that occur entirely in riparian habitats (least Bell’s vireo, western yellow-billed cuckoo, and
 25 yellow breasted chat) and having less potential of take of species that use emergent wetlands
 26 (California black rail). These differences are attributable to **Take Alternative A**’s western alignment
 27 and higher degree of permanent and temporary surface impacts resulting from construction of a
 28 canal through agricultural areas, grasslands, and vernal pool complexes. Relative to the other take
 29 alternatives, **Take Alternative A** would have a greater potential for take those species that use
 30 grassland and agricultural habitats for foraging (greater sandhill crane, Swainson’s hawk, white-
 31 tailed kite, tricolored blackbird, and western burrowing owl) except for **Take Alternative H**, which
 32 would likely result in greater losses of those habitats.

33 Relative to **Take Alternatives B, C, D, E, F, and G**, **Take Alternative A** would have a greater
 34 potential for take of those species that use grassland and agricultural habitats for foraging
 35 (Swainson’s hawk, white-tailed kite, tricolored blackbird, and western burrowing owl) and less
 36 potential for take of these species relative to **Take Alternative H**. **Take Alternative A** would also
 37 have greater potential for take of species that only use riparian habitats (least Bell’s vireo, western
 38 yellow-billed cuckoo, and yellow breasted chat) than **Take Alternatives B, C, E, F, and I** because of
 39 the western conveyance alignment and associated intakes having fewer riparian impacts, and would
 40 have greater potential for take of these riparian species than **Take Alternatives D and G** because of
 41 their having less tidal restoration. **Take Alternative A**’s conveyance alignment is also largely the
 42 reason why it would have fewer impacts on California black rail relative the other take alternatives,
 43 except for those that have differing levels of tidal restoration (**Take Alternatives D, F, G, and**
 44 **H**). **Take Alternative A** would have the same potential for take of Suisun song sparrow and
 45 California clapper rail as those alternatives that have the same proposed tidal restoration (**Take**

1 **Alternatives B, C, E, F, and I**) as the BDCP Proposed Action do in and differ for those take
 2 alternatives with differing amounts of tidal restoration (**Take Alternatives D, G, and H**) (Table
 3 9-23). In general, the effects on covered bird species from **Take Alternative A** would be offset over
 4 time, through the implementation of the conservation measures.

5 **9.5.1.1.4 Covered Reptiles and Amphibians**

6 Modeled habitat for covered reptiles and amphibians would be permanently, temporarily, and
 7 periodically affected by the implementation of the conservation measures under **Take Alternative**
 8 **A**, in particular the conveyance facilities construction (CM1), Yolo Bypass operations (CM2), and
 9 tidal natural communities restoration (CM4).

10 As seen in Table 9-24, **Take Alternative A** differs from the BDCP Proposed Action by having a
 11 greater potential for take of giant garter snake, California red-legged frog and California tiger
 12 salamander and less potential for take of western pond turtle because of differences in the
 13 conveyance alignment.

14 Relative to the **Take Alternatives B, C, E, F, and H**, **Take Alternative A** has slightly more potential
 15 for take of giant garter snake and western pond turtle. **Take Alternative A** also, likely has slightly
 16 more potential for take of giant garter snake and western pond turtle than **Take Alternative D** and
 17 **G** by having more tidal natural communities restoration (CM4). **Take Alternative A** would also have
 18 less potential for take of California red-legged frog and California tiger salamander than all of the
 19 other take alternatives except **Take Alternative F**. These differences are attributable to **Take**
 20 **Alternative A's** western alignment and higher degree of permanent and temporary surface impacts
 21 resulting from construction of a canal. The effects on covered reptile and amphibian species from
 22 **Take Alternative A** would be offset over time, through the implementation of the conservation
 23 measures.

24 **9.5.1.1.5 Covered Invertebrates**

25 Modeled habitat for covered invertebrates would be permanently, temporarily, and periodically
 26 affected by the implementation of the conservation measures under **Take Alternative A**, in
 27 particular conveyance facilities construction (CM1) and tidal natural communities restoration
 28 (CM4). The conveyance facilities alignment passes through an area of high-value vernal pool
 29 crustacean habitat that is known to support vernal pool fairy shrimp. The tidal natural communities
 30 restoration (CM4) would result in large impacts on modeled habitat for valley elderberry longhorn
 31 beetle. There are no documented occurrences of this species in these areas, though they do likely
 32 support the species' host plant (elderberry shrubs). As seen in Table 9-25, **Take Alternative A** has a
 33 greater potential for take of vernal pool crustaceans and less potential for take of valley elderberry
 34 longhorn beetle than the BDCP Proposed Action. These differences are attributable to **Take**
 35 **Alternative A's** western alignment and higher degree of permanent and temporary surface impacts
 36 resulting from construction of a canal. **Take Alternative A** would have a greater potential for take of
 37 valley elderberry longhorn beetle than **Take Alternatives B, D, and G** because of differences in the
 38 amounts of tidal restoration and the number of intakes associated with **Take Alternative B**. **Take**
 39 **Alternative A** would less potential for take valley elderberry longhorn beetle than **Take**
 40 **Alternatives C, E, and F** because of the differences in conveyance alignments and locations of
 41 intakes. The effects on covered invertebrates from **Take Alternative A** would be offset over time,
 42 through the implementation of the conservation measures.

1 Total permanent loss of vernal pool complex was reduced from 372 acres (CM4) to 67 acres. This
 2 reduction is based on a 10-acre cap for total loss of wetted acres, assuming 15% density of vernal
 3 pools in the area affected. Acreage of vernal pool complex loss may be higher if actual vernal pool
 4 density is lower. **Take Alternatives B, C, D, E, F, G,** and **I** would have the same cap, therefore the
 5 same potential for take as the BDCP Proposed Action because the physical foot print is the same.
 6 **Take Alternative A** which has a greater potential for take on vernal pool crustaceans than the BDCP
 7 Proposed Action includes the same cap. However, the cap would be exceeded because CM1 alone
 8 results in 81 acres of impacts to vernal pool complex habitat. Therefore, assuming that tidal
 9 restoration could not fully avoid additional impacts, **Take Alternative A** would have a greater
 10 potential for take of vernal pool crustaceans due to the loss of high-value vernal pool complex

11 **9.5.1.2 Consistency with BDCP Goal**

12 **Take Alternative A** is consistent with the overall goal to provide “a comprehensive conservation
 13 strategy for the Sacramento-San Joaquin River Delta designed to restore and protect ecosystem
 14 health, water supply and water quality within a stable regulatory framework. This take alternative
 15 would have the same amount of habitat restoration as the BDCP Proposed Action. All other
 16 conservation components under **Take Alternative A** would be the same as under the BDCP
 17 Proposed Action and would support the goal of ecosystem protection and restoration and
 18 conservation of covered species that depend on these habitats.

19 The use of two additional intakes in the north Delta would provide more flexibility to maintain
 20 adequate velocities and comply with sweep-velocity criteria during periods when tidal direction
 21 changes. An increase in the number of intakes would also enhance the ability to more frequently
 22 divert water at the north Delta intakes and increase water supply reliability relative to the BDCP
 23 proposed action. Early long-term mean total project water deliveries for this take alternative would
 24 be 5.01 MAF annually, which would be within the range of the BDCP Proposed Action at 4.71 to
 25 5.597 MAF annually, under the high-outflow scenario. Like the BDCP Proposed Action, this take
 26 alternative would provide adequate diversion capacity at the north Delta intakes to allow for use of
 27 the Banks Pumping Plant at its full capacity of 10,300 cfs.

28 Aquatic habitat improvements associated with increased in stream water quality associated with
 29 this take alternative would be similar to the BDCP Proposed Action. However, the larger number of
 30 intakes added to the north Delta would result in a higher level of incidental take than the BDCP
 31 Proposed Action. In summary, this take alternative would provide a higher level of water supply
 32 reliability, but would have a higher likelihood for additional take of covered species.

33 **9.5.1.3 Practicability**

34 **9.5.1.3.1 Cost**

35 The economic benefits of **Take Alternative A** include the value of a reduction in the frequency and
 36 magnitude of water shortages, a reduced need to invest in water supply alternatives, changes in
 37 operating cost including energy costs of water conveyance and distribution, improved water quality,
 38 and reduced seismic risk.

39 The total cost of **Take Alternative A** would be a present value of \$11.1 billion, which is \$2.4 billion
 40 less than the total cost of the BDCP Proposed Action (Appendix 9.A, *Economic Benefits of the BDCP*
 41 *and Take Alternatives*). **Take Alternative A** would result in mean annual project water deliveries at

1 the early long-term (ELT) of 5.01 MAF annually for the state and federal contractors south of the
2 Delta. This figure is greater than the mean yield of 3.45 MAF annually in the Existing Conveyance
3 High-Outflow Scenario. Increased Delta exports would result in smaller and less frequent water
4 supply shortages experienced by urban and agricultural water users. Relative to the Existing
5 Conveyance High-Outflow Scenario, **Take Alternative A** would reduce the amount of agricultural
6 groundwater pumping, resulting in less dry-year fallowing, and would affect operations costs in
7 both the urban and agricultural sectors.

8 **Take Alternative A** would reduce seismic risks and improve water quality relative to the Existing
9 Conveyance High-Outflow Scenario. With a 15,000 cfs isolated conveyance facility, post-earthquake
10 water supplies could be maintained at a level of 4.5 MAF under **Take Alternative A**. Mean water
11 supplies following an earthquake in the Existing Conveyance High-Outflow Scenario are 1.0 MAF.

12 With respect to water quality, the majority (52%) of state and federal project supplies would
13 originate in the north Delta (as compared to 49% for the BDCP Proposed Action). As a result, project
14 water deliveries would be less saline under **Take Alternative A** than under the Existing Conveyance
15 High-Outflow Scenario.

16 The total benefits of **Take Alternative A** would be \$23.2 billion, as compared to costs of \$11.1
17 billion. Thus **Take Alternative A** would result in net benefits of \$12.1 billion and is therefore
18 practicable from a cost standpoint.

19 **9.5.1.3.2 Logistics**

20 Under Take Alternative A, sufficient land and other resources would be available, and therefore, the
21 take alternative would meet the logistics criterion. **Take Alternative A** would not require assembly
22 of conservation reserves at a spatial scale that would conflict with urban lands or existing utilities.
23 Sufficient land suitable for habitat restoration exists within the Plan Area.

24 **9.5.1.3.3 Technology**

25 None of the technology or physical components of **Take Alternative A** appears to be incompatible
26 with the AKART standard based on currently available science and engineering criteria¹⁵. For
27 example, this alternative would contemplate the installation of five 3,000 cfs fish-screened intakes,
28 which is consistent with the maximum intake size recommended by the Fish Facility Technical Team
29 and the Value Planning Study and the largest size of intake used in California (DWR 2010a).
30 Accordingly, **Take Alternative A** would be practicable from a technological perspective.

31 **9.5.1.4 Other Environmental Consequences**

32 There are three resource areas for which other environmental consequences would occur under
33 **Take Alternative A**. For one of the three resource areas, the other environmental consequences are
34 the same as under the BDCP Proposed Action. For two resource areas, **Take Alternative A** would
35 have additional other environmental consequences. There are three air quality and greenhouse
36 gases other environmental consequences that would occur under **Take Alternative A** that would
37 not occur under the BDCP Proposed Action.

¹⁵ EIR/EIS Appendix 3A *Identification of Water Conveyance Alternatives for the Bay Delta Conservation Plan Environmental Impact Report/Environmental Impact Statement*.

- 1 • Generation of criteria pollutants in excess of the Yolo-Solano Air Quality Management District
2 (YSAQMD) thresholds during construction of the proposed water conveyance facility (CM1).
3 Construction emissions would exceed YSAQMD’s thresholds for reactive organic gases (ROG)
4 from 2015 to 2018, nitrogen oxides (NO_x) from 2014 to 2020, and particulate matter of 10
5 microns in diameter or less (PM10) in 2016. Emissions of ROG, NO_x, and PM10 generated during
6 construction would exceed YSAQMD’s thresholds.
- 7 • Generation of criteria pollutants in excess of the BAAQMD thresholds during construction of the
8 proposed water conveyance facility. Construction emissions would exceed BAAQMD’s NO_x daily
9 pollutant thresholds from 2014 to 2020 and ROG from 2015 to 2018.
- 10 • Generation of criteria pollutants in the excess of federal de minimis thresholds from
11 construction and operation and maintenance of the proposed water conveyance facility.
12 Sacramento Valley Air Basin (SVAB) federal *de minimis* thresholds would be exceeded for ROG
13 from 2015 to 2018, NO_x from 2014 to 2019, and carbon monoxide from 2015 to 2017. It would
14 exceed San Francisco Bay Area Air Basin (SFBAAB) federal thresholds for NO_x from 2015 to
15 2017 and carbon monoxide in 2016.

16 There is one other species environmental consequence that would occur under **Take Alternative A**
17 that would not occur under the BDCP Proposed Action. Under **Take Alternative A**, water operations
18 would have significant and unavoidable effects on rearing habitat for non-covered aquatic species of
19 primary management concern. This take alternative would cause a substantial reduction in
20 hardhead habitat. Flows would be substantially lower during the majority of the year-round juvenile
21 and adult rearing period in the American River and in one third of the period in the Feather River.

22 **9.5.1.5 Conclusions**

23 **Take Alternative A** is generally consistent with the overall goal of the BDCP. This take alternative
24 would provide a higher level of water supply reliability than the BDCP Proposed Action, but a
25 likelihood for additional take due to the increased number of north Delta intakes and a much larger
26 surface footprint of the west canal, relative to the BDCP Proposed Action.

- 27 • **Take Alternative A** would be practicable based on the following conclusions.
 - 28 ○ The total benefits of **Take Alternative A** would be \$23.2 billion, as compared to costs of
29 \$11.1 billion. Thus **Take Alternative A** would result in net benefits of \$12.1 billion and is
30 therefore practicable from a cost standpoint.
 - 31 ○ Obtaining and accessing sufficient appropriate lands and other resources necessary to
32 implement **Take Alternative A** would be logistically practicable.
 - 33 ○ **Take Alternative A** would be practicable from a technical perspective. It meets the AKART
34 standard.
- 35 • **Take Alternative A** would result in more take than the BDCP Proposed Action, based on the
36 following conclusions.
 - 37 ○ Take would be reduced for 4 covered terrestrial wildlife species, and increased for 18
38 covered terrestrial wildlife species due to the location of conveyance and diversion facilities
39 relative to modeled habitat. Take would not be measurably different from the BDCP
40 Proposed Action for 5 covered terrestrial wildlife species.

- 1 ○ Take of 9 covered fish species would be increased due to the increased number of intakes
- 2 and the greater diversion of water and fish into the interior Delta
- 3 ○ Water quality improvements in the south Delta would be increased because of less reliance
- 4 on south Delta diversions than the BDCP Proposed Action.
- 5 ● **Take Alternative A** would result in three other environmental consequences associated with
- 6 air quality and greenhouse gases and one related to effects on non-covered aquatic species:
- 7 ○ It would result in emissions of criteria pollutants in the excess of federal de minimis
- 8 thresholds from construction and operation and maintenance of the proposed water
- 9 conveyance facility. It would also generate emissions of ROG, NO_x, and PM10 that would
- 10 exceed YSAQMD’s thresholds during construction.
- 11 ○ It would generate criteria pollutants (NO_x) in excess of the BAAQMD thresholds during
- 12 construction of the proposed water conveyance facility.
- 13 ○ It would generate criteria pollutants (NO_x and CO) in the excess of federal de minimis
- 14 thresholds from construction and operation and maintenance of the proposed water
- 15 conveyance facility.
- 16 ○ Water operations would have significant and unavoidable effects on rearing habitat for non-
- 17 covered aquatic species of primary management concern.

18 **9.5.2 Take Alternative B: Tunnels 6,000 cfs**

19 **Take Alternative B: Tunnels 6,000 cfs** would involve construction of a dual conveyance facilities

20 alignment with a pipelines and tunnels alignment and two intakes. The capacity of the isolated

21 conveyance facility would be 6,000 cfs.

22 **9.5.2.1 Effects on Covered Species**

23 **9.5.2.1.1 Covered Fish**

24 **Construction**

25 Construction at the north Delta intakes, fish diversion structures, restoration sites, conservation

26 hatcheries, and nonphysical barriers may result in a number of adverse effects on the covered

27 species, including disturbance from in-water construction activity and hydrodynamic changes,

28 physical injury from pile-driving sound and vibration, exposure to contaminants, and elevated

29 turbidity. The two intakes of **Take Alternative B** would result in a lower potential for effects than

30 the three intakes for the BDCP Proposed Action. For example, **Take Alternative B** could require

31 about 35% less pile driving, dredging, and aquatic habitat alteration than the BDCP Proposed Action.

32 These construction activities would result in fewer effects on fish from underwater sound, fish

33 handling and stranding, and water quality impairment (e.g., increased turbidity and contaminants).

34 The effects would likely include less stress, injury, and/or mortality to the covered species. The total

35 permanent in-water footprint of the two intakes would be about 3.4 acres (1.6 acres smaller under

36 the BDCP Proposed Action), and the total length of permanent in-water bank alteration (about 4,060

37 feet) would be about 2,300 feet (36%) less than the BDCP Proposed Action.

38 The water conveyance facilities (pipelines and tunnels alignment) would be about the same for

39 **Take Alternative B** as for the BDCP Proposed Action, resulting in similar effects. This would require

1 similar construction activities, and the same number (and locations) of barge landings to support
2 the tunnel construction. Therefore, the associated pile driving, fish handling, and potential water
3 quality effects would also be similar.

4 Measurable differences in construction effects between **Take Alternative B** and the BDCP Proposed
5 Action would vary by fish species.

6 ***Delta Smelt***

7 Construction effects would be less for **Take Alternative B**, compared with the BDCP Proposed
8 Action. The differences would be small, and perhaps not measurable, because delta smelt occur
9 primarily downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011), which is about 20
10 miles downstream of the intake construction locations (Table 9-10). However, intake construction
11 activities would extend further downstream under the BDCP Proposed Action than under **Take**
12 **Alternative B**, resulting in a greater potential to overlap with the distribution of delta smelt.

13 ***Longfin Smelt***

14 As with delta smelt, potential construction effects on longfin smelt would be less for **Take**
15 **Alternative B** than for the BDCP Proposed Action because one less intake would be constructed,
16 and the location of this construction would be further away from the typical downstream
17 distribution of longfin smelt. However, the longfin smelt distribution would minimize the potential
18 effects of both take alternatives, resulting in fewer differences in overall effects (Table 9-14).

19 ***Chinook Salmon***

20 Chinook salmon would experience measurably fewer effects resulting from pile driving, fish
21 stranding/handling, and reductions in water quality, under **Take Alternative B**, compared with the
22 BDCP Proposed Action (Table 9-15 through Table 9-17).

23 ***Steelhead***

24 As with Chinook salmon, steelhead would likely experience fewer effects resulting from construction
25 activities under **Take Alternative B**, compared with the BDCP Proposed Action (Table 9-18).

26 ***Sacramento Splittail***

27 Construction effects would be about 33% lower than the BDCP Proposed Action for a number of
28 effect mechanisms, due to one less intake constructed.

29 ***Sturgeon***

30 Green and white sturgeon would experience measurably greater effects from fish
31 stranding/handling and reductions in water quality under **Take Alternative B** than under the BDCP
32 Proposed Action (Table 9-20).

33 ***Lamprey***

34 Pacific and river lamprey would experience measurably greater effects from fish stranding/handling
35 and reductions in water quality under **Take Alternative B** than under the BDCP Proposed Action
36 (Table 9-21).

1 Maintenance

2 The reduced number of water intake facilities in the north Delta for **Take Alternative B** would
3 result in proportionally fewer maintenance activities relative to the BDCP Proposed Action. While
4 most of the potential effects of would be associated with periodic maintenance dredging activities,
5 some additional effects on covered fish species could occur from increased predation and periodic
6 decreases in water quality. The effects of maintenance dredging would be similar to the construction
7 dredging effects discussed above: about 36% less for **Take Alternative B** than for the BDCP
8 Proposed Action. In addition, the periodic need for maintenance dredging would result in greater
9 effects than the one-time dredging during the construction phase. The effects of other in-water
10 maintenance activities (e.g., screen cleaning), would be small, with immeasurable differences
11 between **Take Alternative B** and the BDCP Proposed Action.

12 Operations

13 **Take Alternative B** would follow Operational Scenario A, while the BDCP Proposed Action would
14 follow Operational Scenario H, with four potential operational sub-scenarios depending on the
15 outcome of the decision tree process for spring outflow and Fall X2.

16 **Take Alternative B** uses two intakes in the north Delta that can convey up to 6,000 cfs, while the
17 BDCP Proposed Action consists of three intakes and can convey up to 9,000 cfs. **Take Alternative B**
18 would have about a 34% shorter intake screen length than the BDCP Proposed Action, which is
19 expected to result in a proportionally lower potential for entrainment and impingement effects on
20 the covered species.

21 Average annual early long-term exports under **Take Alternative B** are anticipated to be 4.49 MAF,
22 while the BDCP Proposed Action would have anticipated exports ranging from about 4.71 to about
23 5.59 MAF annually. Average annual outflows would typically be greater for the operational
24 scenarios under the BDCP Proposed Action (between 0.11 and 0.97 MAF greater) than under **Take**
25 **Alternative B**. However, **Take Alternative B** would result in less average annual outflow than
26 existing conditions (averaging about 0.23 MAF less).

27 A lower percentage of average annual water exports would occur at the south Delta facilities under
28 the four operational sub-scenarios of the BDCP Proposed Action (51%) than under **Take**
29 **Alternative B** (59%). However, the annual exports from the south Delta facilities under **Take**
30 **Alternative B** (about 2.66 MAF) would be within the range of the sub-scenarios of the BDCP
31 Proposed Action (2.40 to 2.85 MAF). **Take Alternative B** would result in greater annual outflow
32 (15.92 MAF) than existing conditions (15.53 MAF) on average.

33 The effects of operations on fish entrainment or spawning, rearing, and migration conditions vary by
34 fish species.

35 Delta Smelt

36 Delta smelt typically occur downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011),
37 which is about 20 miles downstream of the north Delta intakes. The primary difference between the
38 BDCP Proposed Action and **Take Alternative B** on delta smelt would be the effects on rearing
39 habitat conditions. **Take Alternative B** would have a negative effect on rearing habitat, while the
40 BDCP Proposed Action would have a somewhat beneficial effect. No measurable differences are
41 expected with the potential effects on entrainment, and spawning and migration habitat conditions
42 between **Take Alternative B** and the BDCP Proposed Action.

1 **Longfin Smelt**

2 Effects on longfin smelt would be greater for **Take Alternative B**, compared with the BDCP
 3 Proposed Action. **Take Alternative B** would have negative flow-related effects on longfin smelt
 4 entrainment, rearing and migration habitat conditions, while no adverse effects would occur under
 5 the BDCP Proposed Action. In addition, the BDCP Proposed Action would have beneficial effects on
 6 entrainment of longfin smelt. However, the differences in overall effects would be limited because
 7 longfin smelt occur primarily downstream of the north Delta intake facilities.

8 **Chinook Salmon**

9 **Take Alternative B** would likely have measurable beneficial effects on entrainment of the winter-
 10 run Chinook salmon species, while the BDCP Proposed Action would primarily benefit the
 11 entrainment of spring-run Chinook salmon. Adverse effects are expected on spawning and rearing
 12 conditions for winter-run fish, and rearing and migration conditions for fall- and late fall-run
 13 Chinook salmon. Negative effects are also projected for spring-run migration conditions, and fall-
 14 and late fall-run Chinook salmon spawning conditions, although these effects are expected to be due
 15 to future climate change, sea level rise, and/or changes in water demand.

16 **Steelhead**

17 As with Chinook salmon, **Take Alternative B** would have somewhat negative effects on steelhead
 18 rearing conditions, while no adverse effects are expected with regard to entrainment, spawning, or
 19 migration conditions.

20 **Sacramento Splittail**

21 No adverse effects are expected under **Take Alternative B** with regard to entrainment, spawning,
 22 rearing, or migration conditions for Sacramento splittail. Similar effects are expected for the BDCP
 23 Proposed Action, except that the BDCP Proposed Action would have beneficial effects on migration
 24 conditions.

25 **Sturgeon**

26 While **Take Alternative B** would have slightly beneficial effects on green sturgeon entrainment
 27 relative to the BDCP Proposed Action, negative effects are expected on spawning, rearing, and,
 28 migration conditions. **Take Alternative B** would have negative effects on white sturgeon migration
 29 conditions, while no adverse effects on white sturgeon are expected under the BDCP Proposed
 30 Action.

31 **Lamprey**

32 **Take Alternative B** would have adverse effects on Pacific lamprey spawning and migration
 33 conditions relative to the BDCP Proposed Action. While no adverse effects are expected for Pacific
 34 lamprey rearing, and river lamprey rearing and migration conditions, these effects are projected to
 35 be due to future climate change, sea level rise, and/or changes in water demand.

36 **9.5.2.1.2 Covered Mammals**

37 Modeled habitat for covered mammal species would be permanently, temporarily, and periodically
 38 affected by the implementation of the conservation measures under **Take Alternative B**, in
 39 particular the conveyance facilities construction (CM1), tidal natural communities restoration

1 (CM4), and floodplain restoration (CM5). The greatest potential for take of covered mammals
 2 resulting from the implementation of **Take Alternative B** would be for San Joaquin kit fox and
 3 Riparian brush rabbit. **Take Alternative B** has greater potential for take of riparian brush rabbit
 4 and San Joaquin kit fox than the BDCP Proposed Action. As seen Table 9-22, **Take Alternative B** has
 5 the same potential for take of riparian woodrat, salt marsh harvest mouse, and Suisun shrew as the
 6 BDCP Proposed Action. The differences in facilities between **Take Alternative B** and the BDCP
 7 Proposed Action are outside of the habitats of the covered mammals.

8 **9.5.2.1.3 Covered Birds**

9 Modeled habitat for covered bird species would be permanently and temporarily affected by the
 10 implementation of the conservation measures under **Take Alternative B**, in particular the
 11 conveyance facilities construction (CM1) and tidal natural communities restoration (CM4). Modeled
 12 habitat for Swainson’s hawk, white-tailed kite, tricolored blackbird, and western burrowing owl
 13 would be periodically affected by Yolo Bypass operations (CM2) and floodplain restoration
 14 (CM5).The greatest potential for take of covered bird species from **Take Alternative B** would be in
 15 the near-term from the loss of riparian habitat. Although the BDCP Proposed Action would result in
 16 5,000 acres of valley/foothill riparian natural community restoration and 750 acres of protection,
 17 the time it takes for riparian trees to mature would result in temporary loss of habitat for covered
 18 birds that use riparian habitats (Swainson’s hawk, white-tailed kite, least Bell’s vireo, western
 19 yellow-billed cuckoo, and yellow-breasted chat). Another source of potential take would be the
 20 installation of new transmission lines to power the construction and operations of the conveyance
 21 facilities (CM1). During the winter months, most covered species, in particular greater sandhill
 22 crane, would have a greater potential to collide with transmission lines because of decreased
 23 visibility at night and due to fog.

24 As seen in Table 9-22, **Take Alternative B** differs from the BDCP Proposed Action by having less
 25 potential for take of species that use grassland and agricultural habitats (Swainson’s hawk,
 26 tricolored blackbird, greater sandhill crane, white-tailed kite and western burrowing owl). **Take**
 27 **Alternative B** would have less potential as the BDCP Proposed Action for take of species that occur
 28 entirely in riparian habitats (least Bell’s vireo, western yellow-billed cuckoo, and yellow breasted
 29 chat) and species that use emergent wetlands (California black rail). **Take Alternative B** would
 30 have the same potential for take of the California clapper rail and Suisun song sparrow as the BDCP
 31 Proposed Action. All of these differences are due to having different and one fewer intakes along the
 32 Sacramento River than the BDCP Proposed Action would have.

33 Relative to **Take Alternatives A, C, E, and H**, **Take Alternative B** would have less potential for take
 34 of those species that use grassland and agricultural habitats (Swainson’s hawk, white-tailed kite,
 35 tricolored blackbird, greater sandhill crane, and western burrowing owl) because Take Alternative B
 36 would have fewer intakes (**Take Alternatives C, E, and H**), less surface disturbance due to canal
 37 construction (**Take Alternative A**), and less floodplain and tidal restoration (**Take Alternative H**).
 38 **Take Alternative B** would result in greater potential for take of these species than **Take**
 39 **Alternatives D and G** because **Take Alternative B** would involve more tidal restoration. **Take**
 40 **Alternative B** also would have greater potential take of these species than **Take Alternative F**
 41 because of impacts associated with construction Take Alternative B’s intakes along the Sacramento
 42 River.

43 **Take Alternative B** would have less potential for take of species that only use riparian habitats
 44 (least Bell’s vireo, western yellow-billed cuckoo, and yellow breasted chat) than **Take Alternatives**

1 **C, E, F, and H** as a result of Take Alternative B having fewer intakes (**Take Alternatives C, E, and H**),
 2 less impacts on existing levees (**Take Alternative F**), and less tidal and floodplain restoration (**Take**
 3 **Alternative H**). **Take Alternative B** would have greater potential for take of these species relative
 4 to **Take Alternatives A, D, and G** as a result of **Take Alternative B**'s location of conveyance
 5 alignment and intakes along the Sacramento River (**Take Alternative A**) and having more tidal
 6 restoration (**Take Alternatives D and G**).

7 **Take Alternative B** would have less potential for take of California black rail relative to **Take**
 8 **Alternatives F and H** due to differences in the conveyance alignment and the amount of floodplain
 9 and tidal restoration, respectively. **Take Alternative B** would have a greater potential for take of
 10 this species relative to **Take Alternatives D, and G** as a result of having more tidal restoration than
 11 **Take Alternative D and G**. **Take Alternative B** would have the same potential for take of black rail
 12 as **Take Alternatives A, C, and E**.

13 **Take Alternative B** would have differing potentials for take of California clapper rail compared
 14 with the other alternatives depending on the amount of tidal restoration. It would have the same
 15 potential for take as **Take Alternatives A, C, E, and F**, greater potential for take than **Take**
 16 **Alternative D and G**, and less potential for take than **Take Alternative H**.

17 **Take Alternative B** would have less potential for take of Suisun song sparrow than **Take**
 18 **Alternative H** and greater potential for take than **Take Alternatives D and G** because of differences
 19 in the amount of tidal restoration. **Take Alternative B** would have the same potential for take of
 20 this species as **Take Alternatives A, C, E, and F** because they all have the same amounts of tidal
 21 restoration.

22 In general, the effects on covered bird species from **Take Alternative B** would be offset over time,
 23 through the implementation of the conservation measures.

24 **9.5.2.1.4 Covered Reptile and Amphibians**

25 Modeled habitat for covered reptiles and amphibians would be permanently, temporarily, and
 26 periodically affected by the implementation of the conservation measures under **Take Alternative**
 27 **B**, in particular the conveyance facility construction (CM1), Yolo Bypass operations (CM2), and tidal
 28 natural communities restoration (CM4).

29 As seen in Table 9-24, **Take Alternative B** has less potential for take of giant garter snake and
 30 western pond turtle and greater potential for take of California red-legged frog and tiger salamander
 31 than that of the BDCP Proposed Action. Relative to the other take alternatives, differences in take are
 32 attributable to either the conveyance alignments (**Take Alternatives A and F**), the number and
 33 location of intakes (**Take Alternatives C and E**), or the amounts of tidal restoration (**Take**
 34 **Alternatives D, G, and H**).

35 **9.5.2.1.5 Covered Invertebrates**

36 Modeled habitat for covered invertebrates would be permanently, temporarily, and periodically
 37 affected by the implementation of the conservation measures under **Take Alternative B**, in
 38 particular conveyance facilities construction (CM1) and tidal natural communities restoration
 39 (CM4). The tidal restoration would impact a large amount of modeled vernal pool crustacean habitat;
 40 however, this habitat is classified as degraded vernal pool complex and there are no known records
 41 of covered vernal pool crustaceans in these areas. The tidal natural communities restoration (CM4)

1 would result in large impacts on modeled habitat for valley elderberry longhorn beetle. There are no
 2 documented occurrences of this species in these areas, though they do likely support the species’
 3 host plant (elderberry shrubs). As seen in Table 9-25, **Take Alternative B** has the same potential for
 4 take of vernal pool plant species as that of the BDCP Proposed Action and relative to the other take
 5 alternatives. **Take Alternative B** has less potential for take of valley elderberry longhorn beetle
 6 than the BDCP Proposed Action. Relative to other take alternatives, **Take Alternative B** would have
 7 the same potential for take of vernal pool crustaceans as Take Alternatives **C, E, D, F, and G**.
 8 Differences in the level of take valley elderberry longhorn beetle resulting from **Take Alternative B**
 9 relative to the other take alternatives are attributable to either the conveyance alignments (**Take**
 10 **Alternatives A and F**), the number and location of intakes (**Take Alternatives C and E**), or the
 11 amounts of tidal restoration (**Take Alternatives D, G, and H**).

12 **9.5.2.2 Consistency with BDCP Goal**

13 **Take Alternative B** is consistent with the BDCP overall goal to provide “a comprehensive
 14 conservation strategy for the Sacramento-San Joaquin River Delta designed to restore and protect
 15 ecosystem health, water supply and water quality within a stable regulatory framework.” This take
 16 alternative would have the same amount of habitat restoration as the BDCP Proposed Action. As
 17 with **Take Alternative A**, all other conservation components except CM1 would be the same as the
 18 BDCP Proposed Action and would support the goal of ecosystem protection and restoration;
 19 supporting long-term survival of covered species that depend on these habitats.

20 **Take Alternative B** would convey less water from the north Delta (two intakes instead of three),
 21 relying more heavily on south Delta intakes than **Take Alternative A** or the BDCP Proposed Action.
 22 Early long-term total project water deliveries for this take alternative would be 4.49 MAF annually,
 23 which is less than the BDCP Proposed Action (between 4.71 and 5.59 MAF under the high-outflow
 24 scenario). The fewer number of north Delta intakes, relative to the BDCP Proposed Action would limit
 25 the flexibility in diverting water during tidal cycles that result in a change in velocities at different
 26 locations in the Sacramento River, including periods when the velocities are less than the sweep-
 27 velocity criteria. This take alternative would be less beneficial for improving water supply reliability
 28 and the routing, timing, or flow of water through the Delta than the BDCP Proposed Action. This take
 29 alternative poses a greater potential for take of aquatic species than the BDCP Proposed Action as a
 30 result of the higher level of south Delta pumping facility operations (59% total project water
 31 deliveries versus 51% for the BDCP Proposed Action).

32 **9.5.2.3 Practicability**

33 **9.5.2.3.1 Cost**

34 Relative to the Existing Conveyance High-Outflow Scenario, **Take Alternative B** would reduce the
 35 frequency and magnitude of water shortages, reduce the need to invest in water supply alternatives,
 36 reduce operations costs including energy costs of water conveyance and distribution, improve water
 37 quality, and reduce seismic risk.

38 The total cost of **Take Alternative B** would have a present value of \$12.1 billion, which is \$1.1
 39 billion less than the cost of the BDCP Proposed Action (Appendix 9.A, *Economic Benefits of the*
 40 *BDCP and Take Alternatives*). **Take Alternative B** would result in annual project water deliveries at
 41 the early long-term of 4.49 MAF for the state and federal contractors south of the Delta. This figure
 42 is greater than the mean annual yield of 3.45 MAF in the Existing Conveyance High-Outflow

1 Scenario. Increased Delta exports would result in smaller and less frequent water supply shortages
 2 experienced by urban and agricultural water users. Relative to the Existing Conveyance High-
 3 Outflow Scenario, **Take Alternative B** would reduce the amount of agricultural groundwater
 4 pumping, resulting in less dry-year fallowing, and would impact operations costs in both the urban
 5 and agricultural sectors.

6 **Take Alternative B** would reduce seismic risks and improve water quality relative to the Existing
 7 Conveyance High-Outflow Scenario. With a 6,000 cfs isolated conveyance facility, post-earthquake
 8 water supplies could be maintained at a level of 2.9 MAF. Mean water supplies following an
 9 earthquake in the Existing Conveyance High-Outflow Scenario are 1.0 MAF.

10 With respect to water quality, 41% of state and federal project supplies would originate in the north
 11 Delta (as compared to 49% for the BDCP Proposed Action). As a result, project water deliveries
 12 would be less saline under **Take Alternative B** than under the Existing Conveyance High-Outflow
 13 Scenario.

14 The total benefits of **Take Alternative B** would be \$14.4 billion, as compared to costs of \$12.3
 15 billion. Thus **Take Alternative B** would result in net benefits of \$2.1 billion. This alternative is not
 16 practicable from a cost standpoint because benefits exceed costs, but fall below the 20% hurdle rate.

17 **9.5.2.3.2 Logistics**

18 Obtaining and accessing sufficient appropriate lands and other resources necessary to implement
 19 **Take Alternative B** would be logistically practicable. **Take Alternative B** would not require
 20 assembly of conservation reserves at a spatial scale that would conflict with urban lands or existing
 21 utilities. Sufficient land suitable for habitat restoration exists within the Plan Area. Logistics of
 22 implementing **Take Alternative B** would be the same as the BDCP Proposed Action.

23 **9.5.2.3.3 Technology**

24 **Take Alternative B** would be practicable from a technological perspective; it meets the AKART
 25 standard. Technology used for **Take Alternative B** would be the same as for the BDCP Proposed
 26 Action.

27 **9.5.2.4 Other Environmental Consequences**

28 There are no resource areas for which other environmental consequences would occur for **Take**
 29 **Alternative B**. Unlike the BDCP Proposed Action, **Take Alternative B** would not have any other
 30 environmental consequence for land use.

31 **9.5.2.5 Conclusions**

32 **Take Alternative B** is generally consistent with the overall goal of the BDCP. Due to heavier reliance
 33 on south Delta intakes, this take alternative would provide a lower level of water supply reliability
 34 and a lower level of ecosystem protection and restoration for aquatic species, compared to the BDCP
 35 Proposed Action.

- 36 ● **Take Alternative B** would be practicable based on the following conclusions.
 - 37 ○ The total benefits of **Take Alternative B** would be \$14.4 billion, compared to costs of \$12.3
 - 38 billion. Thus **Take Alternative B** would result in net benefits of \$2.1 billion, but is not

- 1 practicable from a cost standpoint because it just barely misses the hurdle rate of 20% net
 2 benefit to cost ratio required for practicability.
- 3 ○ Obtaining and accessing sufficient appropriate lands and other resources necessary to
 4 implement **Take Alternative B** would be logistically practicable; logistics would be similar
 5 to the BDCP Proposed Action.
 - 6 ○ **Take Alternative B** would be practicable from a technological perspective. It meets the
 7 AKART standard.
 - 8 ● **Take Alternative B** would result in a greater potential for take than the BDCP Proposed Action,
 9 based on the following conclusions.
 - 10 ○ Take would be increased for 8 covered aquatic species, decreased for 2 covered aquatic
 11 species, and not measurably different for one covered aquatic species.
 - 12 ○ Take would be increased for 4 covered terrestrial wildlife species, decreased for 12 covered
 13 wildlife species, but not measurably different for 11 covered wildlife species.
 - 14 ○ Despite a fewer number of north Delta intakes, increased take of the eight aquatic species
 15 would be because of greater entrainment, impingement, and predation due to greater
 16 reliance on the south Delta facilities (63% of total project water deliveries), compared to
 17 51% for the BDCP Proposed Action.
 - 18 ● Other environmental consequences would be the same for **Take Alternative B** as for the BDCP
 19 Proposed Action. However, unlike the BDCP Proposed Action, **Take Alternative B** would not
 20 have any other environmental consequence for land use.

21 **9.5.3 Take Alternative C: Tunnels 15,000 cfs**

22 **Take Alternative C: Tunnels 15,000 cfs** would involve construction of dual conveyance facilities
 23 with a tunnel/ pipeline and five intakes. The capacity of the isolated conveyance facility would be
 24 15,000 cfs.

25 **9.5.3.1 Effects on Covered Species**

26 **9.5.3.1.1 Covered Fish**

27 **Construction**

28 The five intakes constructed under **Take Alternative C** would result in a greater potential for effects
 29 than the three intakes for the BDCP Proposed Action. For example, **Take Alternative C** could
 30 require about 79% more pile driving, dredging, and aquatic habitat alteration than the BDCP
 31 Proposed Action. These construction activities would result in greater effects on fish from
 32 underwater sound, fish handling and stranding, and water quality impairment (e.g., increased
 33 turbidity and contaminants). The effects would likely include greater stress, injury, and/or mortality
 34 to the covered species. The total permanent in-water footprint of the five intakes would be about 7.9
 35 acres (2.9 acres [58%] larger under **Take Alternative C** than under the BDCP Proposed Action), and
 36 the total length of permanent in-water bank alteration (about 9,780 feet) would be about 3,420 feet
 37 (54%) more than under the BDCP Proposed Action.

38 The water conveyance facilities (pipelines and tunnels alignment) would be about the same for
 39 **Take Alternative C** as for the BDCP Proposed Action, resulting in similar effects. This would require

1 similar construction activities and the same number and locations of barge landings to support the
2 tunnel construction. Therefore, the associated pile driving, fish handling, and potential water quality
3 effects would also be similar.

4 Measurable differences in construction effects between **Take Alternative C** and the BDCP Proposed
5 Action would vary by fish species.

6 ***Delta Smelt***

7 Construction effects would be greater for **Take Alternative C** than for the BDCP Proposed Action.
8 The differences would be small, and perhaps not measurable, because delta smelt occur primarily
9 downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011), which is about 20 miles
10 downstream of the intake construction locations (Table 9-10).

11 ***Longfin Smelt***

12 As with delta smelt, potential construction effects on longfin smelt would be greater for **Take**
13 **Alternative C** than for the BDCP Proposed Action because of the construction two additional
14 intakes. The differences would be small, and perhaps not measurable, because longfin smelt occur
15 primarily downstream of Rio Vista (Moyle 2002), which is more than 20 miles downstream of the
16 intake construction locations (Table 9-14).

17 ***Chinook Salmon***

18 Chinook salmon would experience measurably greater effects from pile driving, fish
19 stranding/handling, and reductions in water quality under **Take Alternative C** than under the BDCP
20 Proposed Action (Table 9-15 through Table 9-17).

21 ***Steelhead***

22 Steelhead would experience greater effects resulting from construction activities under **Take**
23 **Alternative C** than under the BDCP Proposed Action (Table 9-18). Steelhead would be marginally
24 less vulnerable to impacts than Chinook salmon because of steelheads' larger size and shorter
25 period of presence in Delta waters. Thus, steelhead would have a slightly lower potential for effects
26 than Chinook salmon, but a greater potential for effects than the smelts, which typically occur about
27 20 miles downstream of the intake construction areas.

28 ***Sacramento Splittail***

29 Construction effects could be about 68% greater for **Take Alternative C** than for the BDCP
30 Proposed Action, based on two additional intakes constructed in the north Delta area.

31 ***Sturgeon***

32 Green and white sturgeon would experience measurably greater effects from fish
33 stranding/handling and reductions in water quality under **Take Alternative C** than under the BDCP
34 Proposed Action (Table 9-20).

35 ***Lamprey***

36 Pacific and river lamprey would experience measurably greater effects resulting from fish
37 stranding/handling and reductions in water quality under **Take Alternative C** than under the BDCP
38 Proposed Action (Table 9-21).

1 **Maintenance**

2 The increased number of water intake facilities in the north Delta for **Take Alternative C** would
3 result in proportionally greater maintenance activities relative to the BDCP Proposed Action. While
4 most of the potential effects would be associated with periodic maintenance dredging activities,
5 some additional effects on covered fish species could result from increased predation and periodic
6 decreases in water quality. The effects of maintenance dredging would be similar to the construction
7 dredging effects discussed above—about 54% greater for **Take Alternative C** than for the BDCP
8 Proposed Action. In addition, the periodic need for maintenance dredging would result in greater
9 effects than the one-time dredging during the construction phase. The effects of other in-water
10 maintenance activities (e.g., screen cleaning), would be small, with likely immeasurable differences
11 between **Take Alternative C** and the BDCP Proposed Action.

12 **Operations**

13 **Take Alternative C** would follow Operational Scenario A, while the BDCP Proposed Action would
14 follow Operational Scenario H, with four potential operational sub-scenarios depending on the
15 outcome of the decision tree process for spring outflow and Fall X2.

16 **Take Alternative C** uses five intakes in the north Delta that can convey up to 15,000 cfs, while the
17 BDCP Proposed Action consists of three intakes and can only convey up to 9,000 cfs. **Take**
18 **Alternative C** would have about a 54% greater intake screen length than the BDCP Proposed Action,
19 which is expected to result in a proportionally greater potential for entrainment and impingement
20 effects on the covered species.

21 Average annual exports under **Take Alternative C** are anticipated to be 5.01 MAF (in the early long-
22 term), while the BDCP Proposed Action would range from about 4.71 to 5.59 MAF annually. Average
23 annual outflows would typically be greater for the operational scenarios under the BDCP Proposed
24 Action (between 0.21 and 1.07 MAF greater) than under **Take Alternative C**. **Take Alternative C**
25 would result in slightly higher annual average outflow (15.81 MAF) than existing conditions (15.53
26 MAF on average). A greater percentage of average annual water exports would occur at the south
27 Delta facilities under the four operational sub-scenarios of the BDCP Proposed Action (51%) than
28 under **Take Alternative C** (48%).

29 The effects of operations on fish entrainment or spawning, rearing, and migration conditions vary by
30 fish species.

31 **Delta Smelt**

32 Delta smelt typically occur downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011),
33 which is about 20 miles downstream of the north Delta intakes. The primary difference between the
34 BDCP Proposed Action and **Take Alternative C** on delta smelt would be the effects on rearing
35 habitat conditions. **Take Alternative C** would have a negative effect on rearing habitat, while the
36 BDCP Proposed Action would have a somewhat beneficial effect. No measurable differences are
37 expected with the potential effects on entrainment, and spawning and migration habitat conditions
38 between **Take Alternative C** and the BDCP Proposed Action.

39 **Longfin Smelt**

40 Effects of **Take Alternative C** on longfin smelt would be greater compared with the BDCP Proposed
41 Action. **Take Alternative C** would have adverse effects on longfin smelt rearing and migration

1 habitat conditions, while no adverse effects would occur under the BDCP Proposed Action. In
 2 addition, the BDCP Proposed Action would have beneficial effects on entrainment of longfin smelt,
 3 although the differences in overall effects would be limited because longfin smelt occur primarily
 4 downstream of Rio Vista, over 20 miles downstream of the north Delta intake facilities (Moyle
 5 2002).

6 ***Chinook Salmon***

7 **Take Alternative C** would have measurably beneficial effects on entrainment of the Chinook
 8 salmon species, while the BDCP Proposed Action would primarily benefit the entrainment of spring-
 9 run Chinook salmon. **Take Alternative C** would also have a negative effect on spring-run Chinook
 10 salmon spawning conditions, although this is projected to be due to future climate change, sea level
 11 rise, and/or changes in water demand. No adverse effects are expected with regard to spawning,
 12 rearing, or migration conditions for the other Chinook salmon species.

13 ***Steelhead***

14 As with Chinook salmon, **Take Alternative C** would have beneficial effects on steelhead
 15 entrainment, while no adverse effects are expected with regard to other habitat conditions.

16 ***Sacramento Splittail***

17 No adverse effects would occur under **Take Alternative C** with regard to entrainment, spawning, or
 18 rearing conditions for Sacramento splittail. Beneficial effects on Sacramento splittail migration
 19 conditions would occur under both **Take Alternative C** and the BDCP Proposed Action.

20 ***Sturgeon***

21 **Take Alternative C** would have adverse effects on sturgeon migration conditions, while no adverse
 22 effects are expected under the BDCP Proposed Action. While **Take Alternative C** would also have
 23 negative effects on green sturgeon spawning and rearing conditions, these effects are projected to
 24 be due to future climate change, sea level rise, and/or changes in water demand.

25 ***Lamprey***

26 **Take Alternative C** and the BDCP Proposed Action would have no adverse effects on lamprey
 27 entrainment, spawning, rearing, or migration conditions.

28 **9.5.3.1.2 Covered Mammals**

29 Modeled habitat for covered mammal species would be permanently, temporarily, and periodically
 30 affected by the implementation of the conservation measures under **Take Alternative C**, in
 31 particular the conveyance facilities construction (CM1), tidal natural communities restoration
 32 (CM4), and floodplain restoration (CM5). **Take Alternative C** has greater potential for take of
 33 riparian brush rabbit and San Joaquin kit fox than the BDCP Proposed Action. As seen Table 9-22,
 34 **Take Alternative C** has the same potential for take of riparian woodrat, salt marsh harvest mouse,
 35 and Suisun shrew as the BDCP Proposed Action. The differences in facilities between **Take**
 36 **Alternative C** and the BDCP Proposed Action are outside of the habitats of the covered mammals.

1 **9.5.3.1.3 Covered Birds**

2 Modeled habitat for covered bird species would be permanently and temporarily affected by the
 3 implementation of the conservation measures under **Take Alternative C**, in particular the
 4 conveyance facilities construction (CM1) and tidal natural communities restoration (CM4). Modeled
 5 habitat for Swainson’s hawk, white-tailed kite, tricolored blackbird, and western burrowing owl
 6 would be periodically affected by Yolo Bypass operations (CM2) and floodplain restoration
 7 (CM5). The greatest potential for take of covered bird species from **Take Alternative C** would be in
 8 the near-term as a result of the loss of riparian habitat. Although the BDCP Proposed Action would
 9 result in 5,000 acres of valley/foothill riparian natural community restoration and 750 acres of
 10 protection, the time it takes for riparian trees to mature would result in temporary loss of habitat for
 11 covered birds that use riparian habitats (Swainson’s hawk, white-tailed kite, least Bell’s vireo,
 12 western yellow-billed cuckoo, and yellow-breasted chat). Another source of potential take would be
 13 the installation of new transmission lines to power the construction and operations of the
 14 conveyance facilities (CM1). During the winter months, most covered species, in particular greater
 15 sandhill crane, would have a greater potential to collide with transmission lines because of
 16 decreased visibility due to fog and cloudy skies.

17 As seen in Table 9-23, **Take Alternative C** differs from the BDCP Proposed Action by having less
 18 potential for take of all covered bird species except California clapper rail and Suisun song sparrow,
 19 for which the potential for take is the same as under the BDCP Proposed Action.

20 **Take Alternatives C and E** would have the same potential for take for all covered wildlife species
 21 because they have the same conveyance footprint and restoration.

22 Relative to **Take Alternatives B, D, F, and G**, **Take Alternative C** would have a greater potential for
 23 take of those protected bird species that use grassland and agricultural habitats (Swainson’s hawk,
 24 white-tailed kite, tricolored blackbird, greater sand hill crane, and western burrowing owl). **Take**
 25 **Alternative C** would have less potential for take of the remaining protected bird species than **Take**
 26 **Alternatives A and H** because of differences in conveyance alignment (**Take Alternative A**) and the
 27 amounts of tidal and floodplain restoration (**Take Alternative H**).

28 **Take Alternative C** would have greater potential for take of species that only use riparian habitats
 29 (least Bell’s vireo, western yellow-billed cuckoo, and yellow breasted chat) than **Take Alternatives**
 30 **B, D, and G** because **Take Alternative C**’s five intakes along the Sacramento River impact riparian
 31 habitat. **Take Alternative C** would have less potential for take of these species than **Take**
 32 **Alternative H**, which has substantially more impacts associated with increased channel margin
 33 enhancement and tidal and floodplain restoration. **Take Alternative C** would result in less potential
 34 for take of yellow breasted, least Bell’s vireo, and western yellow-billed cuckoo than **Take**
 35 **Alternative F**.

36 **Take Alternative C** would have less potential for take of California black rail relative to **Take**
 37 **Alternatives F and H** due to differences in the conveyance alignment and the amount of floodplain
 38 and tidal restoration, respectively. **Take Alternative C** would have a greater potential for take of
 39 this species relative to **Take Alternatives D, and G** because of having more tidal restoration than
 40 **Take Alternatives D and G**. **Take Alternative C** would have less potential for take of California black
 41 rail than **Take Alternative A**. This alternative would have the same potential for take of California
 42 black rail as **Take Alternative B**.

1 **Take Alternative C** would have less potential for take of California clapper rail than **Take**
 2 **Alternatives H** because of the location and amounts of tidal restoration. **Take Alternative C** would
 3 have a greater potential for take than **Take Alternatives D** and **G** because **Take Alternative C** has
 4 more effects on habitat resulting from tidal restoration. **Take Alternative C** would have the same
 5 potential for take of California clapper rail as **Take Alternatives A, B, and F**.

6 **Take Alternative C** would have less potential for take of Suisun song sparrow than **Take**
 7 **Alternative H** and greater potential for take than **Take Alternatives D** and **G** because of differences
 8 in the amount of tidal restoration. **Take Alternative C** would have the same potential for take of this
 9 species as **Take Alternatives A, B, and F** because they all have the same amounts of tidal
 10 restoration.

11 **9.5.3.1.4 Covered Reptiles and Amphibians**

12 Modeled habitat for covered reptiles and amphibians would be permanently, temporarily, and
 13 periodically affected by the implementation of the conservation measures under Take Alternative C,
 14 in particular the conveyance facilities construction (CM1), Yolo Bypass operations (CM2), and tidal
 15 natural communities restoration (CM4).

16 As seen in Table 9-24, **Take Alternative C** differs from the BDCP Proposed Action by having a less
 17 potential for take of giant garter snake and western pond turtle. However, **Take Alternative C** has a
 18 greater potential for take of California red-legged frog and California tiger salamander.

19 **Take Alternatives C** and **E** would have the same potential for take for all covered wildlife species
 20 because they have the same conveyance footprint and restoration.

21 **Take Alternative C** has less potential for take of giant garter snake than **Take Alternative H**, which
 22 has more tidal and floodplain restoration. **Take Alternative C** has a greater potential for take of this
 23 species than **Take Alternatives D** and **G** because **Take Alternative C** has more tidal restoration
 24 than **Take Alternatives D** and **G**. **Take Alternative C** has less potential for take than **Take**
 25 **Alternatives A** and **F** and has greater potential for take than **Take Alternative B**.

26 **Take Alternative C** has less potential for take of western pond turtle than **Take Alternatives A, F**
 27 and **H** because of location and number of intakes, differences in the conveyance alignment for **Take**
 28 **Alternative F**, and because **Take Alternative H** has more tidal and floodplain restoration and
 29 channel margin enhancement. **Take Alternative C** has greater potential for take of western pond
 30 turtle than **Take Alternatives D** and **G** the acreage of tidal restoration (**Take Alternatives D** and
 31 **G**). **Take Alternative C** also has greater potential of western pond turtle for take than **Take**
 32 **Alternative B**.

33 **Take Alternative C** has greater potential for take of California red-legged frog than **Take**
 34 **Alternative A** because of location and number of intakes. **Take Alternative C** has a greater
 35 potential for take of the species than **Take Alternative F** because a larger forebay would be
 36 constructed for **Take Alternative C**. **Take Alternative C** would have the same potential for take of
 37 California red-legged frog as **Take Alternatives B, D, and G**. **Take Alternative C** has less potential
 38 for take than **Take Alternative H** because of the greater amounts of tidal restoration.

39 **Take Alternative C** has less potential for take of California tiger salamander than **Take Alternative**
 40 **H** because of greater amounts of tidal restoration under **Take Alternative H**. **Take Alternative C**
 41 has a greater potential for take than **Take Alternatives A, D, F, and G** because of differences in the
 42 conveyance alignment (**Take Alternative A and F**) and differences in the amounts of tidal

1 restoration (**Take Alternatives D and G**). **Take Alternative C** has the same potential for take of
 2 California tiger salamander as **Take Alternative B**.

3 The effects on covered reptile and amphibian species from **Take Alternative A** would be offset over
 4 time, through the implementation of the conservation measures.

5 **9.5.3.1.5 Covered Invertebrates**

6 Modeled habitat for covered invertebrates would be permanently, temporarily, and periodically
 7 affected by the implementation of the conservation measures under **Take Alternative C**, in
 8 particular conveyance facilities construction (CM1) and tidal natural communities restoration
 9 (CM4). The tidal restoration would impact a large amount of modeled vernal pool crustacean habitat;
 10 however, this habitat is classified as degraded vernal pool complex and there are no known records
 11 of covered vernal pool crustaceans in these areas. The tidal natural communities restoration (CM4)
 12 would result in large impacts on modeled habitat for valley elderberry longhorn beetle. There are no
 13 documented occurrences of this species in these areas, though they do likely support the species'
 14 host plant (elderberry shrubs).

15 As seen in Table 9-25, **Take Alternative C** has the same potential for take of the valley elderberry
 16 longhorn beetle and vernal pool crustaceans as the BDCP Proposed Action.

17 **Take Alternative C** has less potential for take of valley elderberry longhorn beetle than **Take**
 18 **Alternative H** because **Take Alternative C** has less tidal and floodplain restoration and channel
 19 margin enhancement. **Take Alternative C** has greater potential for take of this species than **Take**
 20 **Alternatives A, B, D, and G** because of the location and number of intakes (**Take Alternatives A**
 21 **and B**), the conveyance alignment (**Take Alternatives A**), and the amount of tidal restoration (**Take**
 22 **Alternatives D and G**). **Take Alternative C** has less potential for take of valley elderberry longhorn
 23 beetle than **Take Alternative F**.

24 **Take Alternative C** has less potential for take of vernal pool crustaceans than **Take Alternatives A**
 25 **and H** because of differences in the conveyance alignment and amount of tidal restoration,
 26 respectively. **Take Alternative C** has more potential for take of these species than **Take**
 27 **Alternatives D and G** because **Take Alternative C** would restore more tidal habitat. **Take**
 28 **Alternative C** has the same potential for take of these species as **Take Alternatives B and F**.

29 The effects on covered invertebrates resulting from **Take Alternative C** would be offset over time,
 30 through the implementation of the conservation measures.

31 **9.5.3.2 Consistency with BDCP Goal**

32 **Take Alternative C** is consistent with the BDCP overall goal to provide “a comprehensive
 33 conservation strategy for the Sacramento-San Joaquin River Delta designed to restore and protect
 34 ecosystem health, water supply and water quality within a stable regulatory framework.” This take
 35 alternative would have the same amount of habitat restoration as the BDCP Proposed Action and
 36 conservation components under **Take Alternative C** would be the same as the BDCP Proposed
 37 Action, with the exception of CM1. **Take Alternative C** would supply more water during wet years
 38 due to the greater number of intakes (five versus three for the BDCP Proposed Action), which
 39 translates directly to a higher level of water intake and conveyance capacity. Early long-term mean
 40 total project water deliveries for this take alternative would be 5.01 MAF annually, which would be
 41 within the range expected for the BDCP Proposed Action, at 4.71 to 5.59 MAF under the high-

1 outflow scenario. Under Take Alternative C, 48% of mean total project water deliveries would be
2 diverted through south Delta intakes compared to 51% under the BDCP Proposed Action. The
3 operations scenario would be the same as **Take Alternative A**. As a result, **Take Alternative C**
4 would deliver a similar balance between the BDCP overall goals. This take alternative provides a
5 higher level of water supply reliability than the BDCP Proposed Action, but a lower level of
6 ecosystem restoration and protection for both terrestrial and aquatic species.

7 **9.5.3.3 Practicability**

8 **9.5.3.3.1 Cost**

9 Relative to the Existing Conveyance High-Outflow Scenario, **Take Alternative C** would reduce the
10 frequency and magnitude of water shortages, reduce the need to invest in water supply alternatives,
11 reduce operations costs including energy costs of water conveyance and distribution, improve water
12 quality, and reduce seismic risk.

13 The total cost of **Take Alternative C** would be a present value of \$15.6 billion, which is \$2.2 billion
14 more than the total cost of the BDCP Proposed Action (Appendix 9.A, *Economic Benefits of the BDCP*
15 *and Take Alternatives*). **Take Alternative C** would result in mean annual project water deliveries at
16 the early long-term (ELT) of 5.01 MAF for the state and federal contractors south of the Delta. This
17 figure is greater than the mean yield of 3.45 MAF in the Existing Conveyance High-Outflow Scenario.
18 Increased Delta exports would result in smaller and less frequent water supply shortages
19 experienced by urban and agricultural water users. Relative to the Existing Conveyance High-
20 Outflow Scenario, **Take Alternative C** would reduce the amount of agricultural groundwater
21 pumping, resulting in less dry-year fallowing, and would impact operations costs in both the urban
22 and agricultural sectors.

23 **Take Alternative C** would reduce seismic risks and improve water quality relative to the Existing
24 Conveyance High-Outflow Scenario. With a 15,000 cfs isolated conveyance facility, post-earthquake
25 water supplies could be maintained at a level of 4.5 MAF. Mean water supplies following an
26 earthquake in the Existing Conveyance High-Outflow Scenario are 1.0 MAF.

27 With respect to water quality, 52% of state and federal project supplies would originate in the north
28 Delta (as compared to 49% for the BDCP Proposed Action). As a result, project water deliveries
29 would be less saline under **Take Alternative C** than under the Existing Conveyance High-Outflow
30 Scenario.

31 The total benefits of **Take Alternative C** would be \$23.2 billion, as compared to costs of \$15.6
32 billion. Thus **Take Alternative C** would result in net benefits of \$7.5 billion and is practicable from a
33 cost standpoint.

34 **9.5.3.3.2 Logistics**

35 Obtaining and accessing sufficient appropriate lands and other resources necessary to implement
36 **Take Alternative C** would be logistically practicable. **Take Alternative C** would not require
37 assembly of conservation reserves at a spatial scale that would conflict with urban lands or existing
38 utilities. Sufficient land suitable for habitat restoration exists within the Plan Area.

1 **9.5.3.3 Technology**

2 **Take Alternative C** would be practicable from a technological perspective; it meets the AKART
 3 standard. Technology used for **Take Alternative C** would be the same as for the BDCP Proposed
 4 Action.

5 **9.5.3.4 Other Environmental Consequences**

6 There are two resource areas for which other environmental consequences would occur under **Take**
 7 **Alternative C**. For one resource area, the other environmental consequences are the same as under
 8 the BDCP Proposed Action. For one resource area, **Take Alternative C** would have additional other
 9 environmental consequences. Under **Take Alternative C**, water operations would have significant
 10 and unavoidable effects on rearing habitat for non-covered aquatic species of primary management
 11 concern. This take alternative would cause a substantial reduction in hardhead habitat. Flows would
 12 be substantially lower during the majority of the year-round juvenile and adult rearing period in the
 13 American River and in one third of the period in the Feather River.

14 **9.5.3.5 Conclusions**

15 **Take Alternative C** is generally consistent with the overall goal. This take alternative provides a
 16 higher level of water supply reliability than the BDCP Proposed Action, but a lower level of
 17 ecosystem protection for aquatic species because it relies more heavily on south Delta intakes.

- 18 ● **Take Alternative C** would be practicable based on the following conclusions.
 - 19 ○ The total benefits of **Take Alternative C** would be \$23.2 billion, as compared to costs of
 20 \$15.6 billion. Thus **Take Alternative C** would result in net benefits of \$7.5 billion and is
 21 practicable from a cost standpoint.
 - 22 ○ Obtaining and accessing sufficient appropriate lands and other resources necessary to
 23 implement **Take Alternative C** would be logistically practicable;; logistics would be similar
 24 to the BDCP Proposed Action.
 - 25 ○ **Alternative C** would be practicable from a technological perspective. It meets the AKART
 26 standard.
- 27 ● **Take Alternative C** would result in more take than the BDCP Proposed Action, based on the
 28 following conclusion.
 - 29 ○ Take would be greater for 10 covered fish species and not measurably different for one
 30 other fish species, but not reduced for any covered fish species based on location and
 31 footprint of conveyance facilities, and greater number of intakes.
 - 32 ○ Take would be increased for 4 covered terrestrial wildlife species, decreased for 11 covered
 33 wildlife species and not measurably different for 12 terrestrial species.
- 34 ● Water operations would have significant and unavoidable effects on rearing habitat for non-
 35 covered aquatic species of primary management concern.

36 **9.5.4 Take Alternative D: Tunnels 3,000 cfs**

37 **Take Alternative D: Tunnels 3,000 cfs** would involve construction of a dual conveyance facility
 38 with dual bore tunnels and one intake. The capacity of the new conveyance would be 3,000 cfs.

1 **9.5.4.1 Effects on Covered Species**

2 **9.5.4.1.1 Covered Fish**

3 **Construction**

4 The single intake structure constructed under **Take Alternative D** would result in substantially
5 lower potential for effects than the three intakes for the BDCP Proposed Action. For example, **Take**
6 **Alternative D** could require about 70% less pile driving, dredging, and aquatic habitat alteration
7 than the BDCP Proposed Action. These construction activities would result in fewer effects on fish
8 from underwater sound, fish handling and stranding, and water quality impairment (e.g., increased
9 turbidity and contaminants). The effects would likely include less stress, injury, and/or mortality to
10 the covered species. The total permanent in-water footprint of the intake would be about 1.3 acres
11 (3.7 acres (74%) smaller under **Take Alternative D** than under the BDCP Proposed Action), and the
12 total length of permanent in-water bank alteration (about 1,660 feet) would be about 4,700 feet
13 (74%) less than under the BDCP Proposed Action.

14 The water conveyance facilities (tunnels/pipelines) would be about the same for **Take Alternative**
15 **D** as for the BDCP Proposed Action, resulting in similar effects. This would require similar
16 construction activities and the same number and locations of barge landings to support construction
17 of the tunnels. Therefore, the associated pile driving, fish handling, and potential water quality
18 effects would also be similar.

19 Measurable differences in construction effects between **Take Alternative D** and the BDCP Proposed
20 Action would vary by fish species.

21 ***Delta Smelt***

22 Construction effects would be less for **Take Alternative D** than for the BDCP Proposed Action. The
23 differences would be small, and perhaps not measurable, because delta smelt occur primarily
24 downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011), which is about 20 miles
25 downstream of the intake construction locations (Table 9-10). However, intake construction
26 activities would extend further downstream under the BDCP Proposed Action than under **Take**
27 **Alternative D**, resulting in a greater potential to overlap with the distribution of delta smelt.

28 ***Longfin Smelt***

29 As with delta smelt, potential construction effects on longfin smelt would be less for **Take**
30 **Alternative D** than for the BDCP Proposed Action, with two fewer intakes constructed, and the
31 location of this construction farther away from the typical downstream distribution of longfin smelt.
32 However, the longfin smelt distribution would minimize the potential effects of both alternatives,
33 resulting in fewer differences in overall effects (Table 9-14).

34 ***Chinook Salmon***

35 Chinook salmon would experience measurably fewer effects from pile driving, fish
36 stranding/handling, and reductions in water quality under **Take Alternative D** than under the
37 BDCP Proposed Action (Table 9-15 through Table 9-17).

1 Steelhead

2 Steelhead would experience fewer effects from construction activities under **Take Alternative D**
3 than under the BDCP Proposed Action (Table 9-18). Steelhead would also be marginally less
4 vulnerable to impacts than Chinook salmon because of steelheads' larger size and shorter period of
5 presence in Delta waters. Thus steelhead would have a slightly lower potential for effects than
6 Chinook salmon, but more than the smelts, which typically occur downstream of the intake
7 construction areas.

8 Sacramento Splittail

9 Construction effects would be substantially less for **Take Alternative D** than for the BDCP Proposed
10 Action, due to two fewer intakes constructed in the north Delta region.

11 Sturgeon

12 Green and white sturgeon would experience measurably fewer effects from fish stranding/handling
13 and reductions in water quality under **Take Alternative D** than under the BDCP Proposed Action
14 (Table 9-20).

15 Lamprey

16 Pacific and river lamprey would experience measurably fewer effects from fish stranding/handling
17 and reductions in water quality under **Take Alternative D** than under the BDCP Proposed Action
18 (Table 9-21).

19 Maintenance

20 The reduced number of water intake facilities in the north Delta for **Take Alternative D** would
21 result in proportionally fewer maintenance activities relative to the BDCP Proposed Action. While
22 most of the potential effects would be associated with periodic maintenance dredging activities,
23 some additional effects on covered fish species could occur from increased predation and periodic
24 decreases in water quality. The effects of maintenance dredging would be similar to the construction
25 dredging effects discussed above: about 73% less for **Take Alternative D** than for the BDCP
26 Proposed Action. In addition, the periodic need for maintenance dredging would result in greater
27 effects than the one-time dredging during the construction phase. The effects of other in-water
28 maintenance activities (e.g., screen cleaning) would be small, with immeasurable differences
29 between **Take Alternative D** and the BDCP Proposed Action.

30 Operations

31 **Take Alternative D** would follow Operational Scenario C, while the BDCP Proposed Action would
32 follow Operational Scenario H, with four potential operational sub-scenarios depending on the
33 outcome of the decision tree process for spring outflow and Fall X2.

34 **Take Alternative D** uses only one intake in the north Delta that can convey up to 3,000 cfs, while
35 the BDCP Proposed Action consists of three intakes and can convey up to 9,000 cfs. **Take**
36 **Alternative D** would have about a 75% shorter intake screen length than the BDCP Proposed Action
37 would have, which is expected to result in a proportionally lower potential for entrainment and
38 impingement effects on the covered species.

1 Average annual early long-term exports under **Take Alternative D** are anticipated to be 4.19 MAF,
2 while the BDCP Proposed Action scenarios would have higher average annual exports ranging from
3 4.71 to 5.59 MAF. **Take Alternative D** would result in greater annual outflow (16.19 MAF) than
4 existing conditions (15.53 MAF on average).

5 A lower percentage of average annual water exports would occur at the south Delta facilities under
6 the BDCP Proposed Action (51%) than under **Take Alternative D** (72%). The annual exports from
7 the south Delta facilities under **Take Alternative D** (2.99 MAF) would be higher than under the
8 BDCP Proposed Action (2.40 to 2.85 MAF).

9 The effects of operations on fish entrainment or spawning, rearing and migration conditions vary by
10 fish species.

11 ***Delta Smelt***

12 Delta smelt typically occur downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011),
13 which is about 20 miles downstream of the north Delta intakes. The primary differences between
14 the BDCP Proposed Action and **Take Alternative D** on effects to delta smelt would be the
15 proportional difference in exports from the north and south Delta facilities, and effects on rearing
16 habitat conditions. **Take Alternative D** would have a greater percentage of south Delta exports
17 (72% vs. 51%), which is expect to result in greater entrainment-related losses. **Take Alternative D**
18 would not have a measurable negative effect on rearing habitat, while the BDCP Proposed Action
19 would have a slight beneficial effect. No measurable differences are expected with the potential
20 effects on entrainment, and spawning and migration habitat conditions between **Take Alternative**
21 **D** and the BDCP Proposed Action.

22 ***Longfin Smelt***

23 **Take Alternative D** would have negative effects on longfin smelt rearing and migration conditions,
24 although these effects are projected to be due to future climate change, sea level rise, and/or
25 changes in water demand. While the BDCP Proposed Action would have beneficial effects on
26 entrainment of longfin smelt, **Take Alternative D** would have negative effects due to a greater
27 percentage of exports from the south Delta. However, the overall differences in effects would likely
28 be limited because longfin smelt occur primarily downstream of Rio Vista, over 20 miles
29 downstream of the north Delta intake facilities (Moyle 2002).

30 ***Chinook Salmon***

31 **Take Alternative D** would likely have similar effects on entrainment of Chinook salmon species, as
32 the BDCP Proposed Action. The greater percentage of south Delta exports, compared to the BDCP
33 Proposed Action, would likely offset the entrainment benefits provided by the north Delta intakes.
34 Adverse effects are expected on rearing and migration conditions for fall- and late fall-run Chinook
35 salmon under **Take Alternative D**, while no adverse effects would occur for the BDCP Proposed
36 Action. While **Take Alternative D** would also have negative effects on winter-run spawning and
37 rearing, spring-run rearing, and fall- and late fall-run spawning, these effects are projected to be due
38 to future climate change, sea level rise, and/or changes in water demand, rather than this take
39 alternative.

1 **Steelhead**

2 As with Chinook salmon, **Take Alternative D** would have somewhat negative effects on steelhead
 3 rearing conditions, while no adverse effects are expected with regard to entrainment or conditions.
 4 While negative effects on steelhead migration conditions would result from **Take Alternative D**,
 5 these effects are projected to be due to future climate change, sea level rise, and/or changes in water
 6 demand, rather than this take alternative. As with the Chinook salmon, the greater percentage of
 7 south Delta exports than the BDCP Proposed Action, would likely offset the entrainment benefits
 8 provided by the north Delta intakes.

9 **Sacramento Splittail**

10 No adverse effects are expected under **Take Alternative D** with regard to entrainment, spawning,
 11 or rearing conditions for Sacramento splittail. Somewhat beneficial effects on migration conditions
 12 are expected under both **Take Alternative D** and the BDCP Proposed Action.

13 **Sturgeon**

14 While **Take Alternative D** would have slightly beneficial effects on green and white sturgeon
 15 entrainment relative to the BDCP Proposed Action, negative effects are expected on green sturgeon
 16 spawning, rearing, and migration conditions. **Take Alternative D** would also have negative effects
 17 on white sturgeon migration conditions, while no adverse effects on white sturgeon are expected
 18 under the BDCP Proposed Action.

19 **Lamprey**

20 **Take Alternative D** would have adverse effects on Pacific lamprey spawning conditions relative to
 21 the BDCP Proposed Action. In addition, negative effects on Pacific and river lamprey rearing and
 22 migration conditions are projected because of future climate change, sea level rise, and/or changes
 23 in water demand, rather than this take alternative.

24 **9.5.4.1.2 Covered Mammals**

25 Modeled habitat for covered mammal species would be permanently, temporarily, and periodically
 26 affected by the implementation of the conservation measures under **Take Alternative D**, in
 27 particular the conveyance facilities construction (CM1), tidal natural communities restoration
 28 (CM4), and floodplain restoration (CM5).The greatest potential for take of covered mammals
 29 resulting from the implementation of **Take Alternative D** would be for salt marsh harvest mouse
 30 and Suisun shrew because these species are known to occur within the modeled habitat that would
 31 be affected by implementation (in particular CM4). Riparian brush rabbit, riparian woodrat, and San
 32 Joaquin kit fox, though documented in the Plan Area, are not known to and/or have a lower potential
 33 to occur in areas that would be directly affected by **Take Alternative D**.

34 As seen Table 9-22, **Take Alternative D** has less potential for take of riparian brush rabbit, riparian
 35 woodrat, salt marsh harvest mouse, and Suisun shrew than the BDCP Proposed Action has. These
 36 differences are due to **Take Alternative D** having 25,000 acres less of tidal restoration. **Take**
 37 **Alternative D** has the same potential for take of San Joaquin kit fox.

38 **Take Alternative D** has less potential for take of salt marsh harvest mouse, Suisun shrew, and
 39 riparian brush rabbit than all take alternatives because it has substantially less tidal restoration.

1 **Take Alternative D** has less potential for take of riparian brush rabbit than **Take Alternatives B, C,**
 2 **E, G, H, and I** because it has less tidal restoration. **Take Alternative D** has greater potential for take
 3 of the species than **Take Alternatives A and F** because the alignments of those alternatives would
 4 affect less habitat for the species.

5 **Take Alternative D** has less potential for take of San Joaquin kit fox than **Take Alternative A** and
 6 greater potential for take than **Alternative F** because of differences in conveyance alignments. **Take**
 7 **Alternative D** has the same potential for take of San Joaquin kit fox as **Take Alternatives B, C, E, G,**
 8 **and I.**

9 The effects on covered mammal species resulting from **Take Alternative D** would be offset over
 10 time, through the implementation of the conservation measures.

11 **9.5.4.1.3 Covered Birds**

12 Modeled habitat for covered bird species would be permanently and temporarily affected by the
 13 implementation of the conservation measures under **Take Alternative D**, in particular the
 14 conveyance facilities construction (CM1) and tidal natural communities restoration (CM4). Modeled
 15 habitat for Swainson’s hawk, white-tailed kite, tricolored blackbird, and western burrowing owl
 16 would be periodically affected by Yolo Bypass operations (CM2) and floodplain restoration
 17 (CM5). The greatest potential for take of covered bird species from **Take Alternative D** would be in
 18 the near-term from the loss of riparian habitat. Although the BDCP Proposed Action would result in
 19 5,000 acres of valley/foothill riparian natural community restoration and 750 acres of protection,
 20 the time it takes for riparian trees to mature would result in temporary loss of habitat for covered
 21 birds that use riparian habitats (Swainson’s hawk, white-tailed kite, least Bell’s vireo, western
 22 yellow-billed cuckoo, and yellow-breasted chat). Another source of potential take would be the
 23 installation of new transmission lines to power the construction and operations of the conveyance
 24 facilities (CM1). During the winter months, most covered species, in particular greater sandhill crane,
 25 would have a greater potential to collide with transmission lines because of decreased visibility due
 26 to fog and cloudy skies.

27 **Take Alternative D** has less potential for take of tricolored blackbird, western burrowing owl,
 28 Swainson’s hawk, white-tailed kite, yellow-breasted chat, least Bell’s vireo, western yellow-billed
 29 cuckoo, and California black rail than **Take Alternatives A, B, C, E, F, G, H, and I.** These differences
 30 are due to **Take Alternative D** having substantially less tidal restoration and fewer intakes along
 31 the Sacramento River.

32 **Take Alternative D** has less potential for take of greater sandhill crane than **Take Alternatives B,**
 33 **C, E, G, H, and I** due to having fewer intakes and less tidal restoration. **Take Alternative D** would
 34 have greater potential for take of this species than **Take Alternatives A and F** because of its
 35 conveyance alignment.

36 **Take Alternative D** has less potential for take of California clapper rail than **Take Alternatives G**
 37 **and H** and slightly more of a potential for take than the remaining alternatives due to the location
 38 and amount of tidal restoration.

39 **Take Alternative D** has less potential for take of Suisun song sparrow than all take alternatives due
 40 to the reduced amount of tidal restoration.

41 In general, the effects on covered bird species from **Take Alternative D** would be offset over time,
 42 through the implementation of the conservation measures.

1 **9.5.4.1.4 Covered Reptiles and Amphibians**

2 Modeled habitat for covered reptiles and amphibians would be permanently, temporarily, and
 3 periodically affected by the implementation of the conservation measures under **Take Alternative**
 4 **D**, in particular the conveyance facility construction (CM1), Yolo Bypass operations (CM2), and tidal
 5 natural communities restoration (CM4).

6 As seen in Table 9-24, **Take Alternative D** differs from the BDCP Proposed Action by having less
 7 potential for take of giant garter snake, western pond turtle, and California tiger salamander and the
 8 same potential for take of California red-legged frog. These differences are due to having
 9 substantially less tidal restoration and only one intake.

10 **Take Alternative D** has less potential for take of giant garter snake, western pond turtle, and
 11 California tiger salamander than all of the take alternatives. These differences are due to having
 12 substantially less tidal restoration and only one intake.

13 **Take Alternative D** has less potential for take of California red-legged frog than **Take Alternative**
 14 **A** and greater potential for take of the species than **Take Alternative F** because of differences in
 15 their conveyance alignments. **Take Alternative D** would have the same potential for take of
 16 California red-legged frog as **Take Alternatives B, C, E, G, H, and I**.

17 The effects to covered reptile and amphibian species from **Take Alternative D** would be offset over
 18 time, through the implementation of the conservation measures

19 **9.5.4.1.5 Covered Invertebrates**

20 Modeled habitat for covered invertebrates would be permanently, temporarily, and periodically
 21 affected by the implementation of the conservation measures under **Take Alternative D**, in
 22 particular conveyance facility construction (CM1) and tidal natural communities restoration
 23 (CM4).The tidal restoration would impact modeled vernal pool crustacean habitat; however this
 24 habitat is classified as degraded vernal pool complex and there are no known records of covered
 25 vernal pool crustaceans in these areas. The tidal natural communities restoration (CM4) would
 26 result in large impacts on modeled habitat for valley elderberry longhorn beetle. There are no
 27 documented occurrences of this species in these areas though they do likely support their host plant
 28 (elderberry shrubs).

29 As seen in Table 9-25, **Take Alternative D** has less potential for take of the covered invertebrate
 30 species than the BDCP Proposed Action. These differences are attributable to **Take Alternative D**
 31 having substantially less tidal restoration and only one intake.

32 **Take Alternative D** would also have less potential for take of covered invertebrates than all of the
 33 take alternatives for the same reasons described above.

34 The effects to covered invertebrates from Take Alternative D would be offset over time, through the
 35 implementation of the conservation measures

36 **9.5.4.2 Consistency with BDCP Goal**

37 **Take Alternative D** is not consistent with the BDCP overall goal to provide “a comprehensive
 38 conservation strategy for the Sacramento-San Joaquin River Delta designed to restore and protect
 39 ecosystem health, water supply and water quality within a stable regulatory framework.” This take
 40 alternative includes a substantially reduced amount of habitat restoration compared with the BDCP

1 Proposed Action. Tidal natural communities restoration would be reduced from 65,000 acres to
 2 40,000 acres (consisting of 34,000 acres of subtidal and intertidal habitat and 6,000 acres of upland
 3 transitional habitat to account for sea level rise), which would not meet the BDCP restoration target
 4 for this natural community type. As a result, the extent to which this take alternative would support
 5 restoration of ecosystem health and the conservation of the covered species that depend on these
 6 habitats would be substantially reduced compared with the BDCP Proposed Action.

7 The number of intakes in this take alternative would be reduced to one (compared with three in the
 8 BDCP Proposed Action), which would provide a lower level of north Delta diversion conveyance
 9 capacity and heavier reliance on the south Delta intakes. Under **Take Alternative D**, the average
 10 early long-term total project water deliveries would be 4.19 MAF annually compared to 4.71 to 5.59
 11 MAF for the BDCP Proposed Action. Under Take Alternative D, 72% of mean total project water
 12 deliveries would be diverted through south Delta intakes compared to 51% under the BDCP
 13 Proposed Action. The lower intake capacity in the north Delta and heavier reliance on south Delta
 14 intakes would provide a lower level of water supply reliability, lower water supply water quality
 15 and a lower level of ecosystem restoration than the BDCP Proposed Action. In dry years, the
 16 negative effects of **Take Alternative D** would be magnified by the higher long-term average exports
 17 for south Delta intakes. Entrainment would increase during dry years due to the more landward
 18 distribution of estuarine fishes. This would likely result in more adverse effects on longfin smelt
 19 specifically and may pose a greater potential for take of other aquatic species than the BDCP
 20 Proposed Action. In addition, this take alternative would not provide improved routing, timing, or
 21 flow of water through the Delta to the extent of the BDCP Proposed Action. The 3,000 cfs north Delta
 22 diversion would not provide enough water to use the full 10,300 cfs capacity of the Banks Pumping
 23 Plant.

24 In summary, **Take Alternative D** is not consistent with the overall goal of the BDCP because it
 25 would provide a reduced level of tidal habitat restoration. It would also provide a reduced level of
 26 protection and restoration of ecosystem health and water supply.

27 **9.5.4.3 Practicability**

28 **9.5.4.3.1 Cost**

29 Relative to the Existing Conveyance High-Outflow Scenario, **Take Alternative D** would reduce the
 30 frequency and magnitude of water shortages, reduce the need to invest in water supply alternatives,
 31 reduce operations costs including energy costs of water conveyance and distribution, improve water
 32 quality, and reduce seismic risk.

33 The total cost of **Take Alternative D** would be a present value of \$10.2 billion, which is \$3.2 billion
 34 less than the total cost of the BDCP Proposed Action (Appendix 9.A, *Economic Benefits of the BDCP*
 35 *and Take Alternatives*). **Take Alternative D** would result in mean annual project water deliveries at
 36 the early long-term (ELT) of 4.19 MAF for the state and federal contractors south of the Delta. This
 37 figure is greater than the mean yield of 3.45 MAF annually in the Existing Conveyance High-Outflow
 38 Scenario, but lower than the level of project water deliveries under the BDCP (4.71 MAF). Increased
 39 Delta exports relative to the Existing Conveyance High-Outflow Scenario would result in smaller and
 40 less frequent water supply shortages experienced by urban and agricultural water users. Similarly,
 41 **Take Alternative D** would reduce the amount of agricultural groundwater pumping, resulting in
 42 less dry-year fallowing, and would reduce operations costs in both the urban and agricultural
 43 sectors.

1 **Take Alternative D** would reduce seismic risks and improve water quality relative to the Existing
 2 Conveyance High-Outflow Scenario. With a 3,000 cfs isolated conveyance facility, post-earthquake
 3 water supplies could be maintained at a level of 1.6 MAF annually. This post-earthquake level of
 4 water supplies is less than the 3.8 MAF annually that could be maintained with the 9,000 cfs facility
 5 proposed as part of the BDCP. Mean annual water supplies following an earthquake in the Existing
 6 Conveyance High-Outflow Scenario are 1.0 MAF.

7 With respect to water quality, 28% of state and federal project supplies would originate in the north
 8 Delta (as compared to 49% for the BDCP Proposed Action). As a result, project water deliveries
 9 would be less saline under **Take Alternative D** than under the Existing Conveyance High-Outflow
 10 Scenario.

11 The total benefits of **Take Alternative D** would be \$8.9 billion, as compared to costs of \$10.2 billion.
 12 Thus **Take Alternative D** would result in net losses of \$1.3 billion and is not practicable from a cost
 13 standpoint.

14 **9.5.4.3.2 Logistics**

15 Obtaining and accessing sufficient appropriate lands and other resources necessary to implement
 16 **Take Alternative D** would be logistically practicable. **Take Alternative D** would not require
 17 assembly of conservation reserves at a spatial scale that would conflict with urban lands or existing
 18 utilities. Sufficient land suitable for habitat restoration exists within the Plan Area.

19 **9.5.4.3.3 Technology**

20 **Take Alternative D** would be practicable from a technological perspective; it meets the AKART
 21 standard. Technology used for **Take Alternative D** would be the same as used for the BDCP
 22 Proposed Action.

23 **9.5.4.4 Other Environmental Consequences**

24 There are no resource areas for which other environmental consequences would occur under **Take**
 25 **Alternative D**. Unlike the BDCP Proposed Action, **Take Alternative D** would not result in other
 26 environmental consequences associated with land use.

27 **9.5.4.5 Conclusions**

28 **Take Alternative D** is not consistent with the overall goal of the BDCP because it would provide a
 29 reduced level of tidal habitat restoration. It would also provide a reduced level of protection and
 30 restoration of ecosystem health and water supply. The reduced number of intakes (one instead of
 31 three) would translate directly to a lower level of water intake and north Delta diversion
 32 conveyance capacity and heavier reliance on the south Delta intakes. Tidal natural communities
 33 restoration would be reduced from 65,000 acres to 40,000 acres (with 34,000 acres of subtidal and
 34 intertidal habitat and 6,000 acres of upland transitional habitat), which would not meet the
 35 restoration target for this natural community type.

- 36 • **Take Alternative D** would not be practicable, based on the following conclusions.
 - 37 ○ The total benefits of **Take Alternative D** would be \$8.9 billion, as compared to costs of
 - 38 \$10.2 billion. Thus **Take Alternative D** would result in net losses of \$1.3 billion and is not
 - 39 practicable from a cost standpoint.

- 1 ○ Obtaining and accessing sufficient appropriate lands and other resources necessary to
2 implement **Take Alternative D** would be logistically practicable; logistics would be similar
3 to the BDCP Proposed Action.
- 4 ○ **Alternative D** would be practicable from a technological perspective. It meets the AKART
5 standard.
- 6 ● **Take Alternative D** would result in more overall take of aquatic species, and reduced aquatic
7 habitat restoration, based on the following conclusions.
- 8 ○ It would increase the level of incidental take of 8 covered fish species, but level of incidental
9 take would be decreased for 2 other covered fish species; take would also be decreased for
10 20 covered terrestrial wildlife species.
- 11 ○ It would rely more on south Delta exports, resulting in greater entrainment, impingement,
12 and predation pressures on aquatic species.
- 13 ○ It would include a substantially reduced amount of habitat restoration. Tidal natural
14 communities restoration would be reduced from 65,000 acres to 25,000 acres (consisting of
15 21,000 acres of subtidal and intertidal habitat and 4,000 acres of upland transitional habitat
16 to account for sea level rise), which does not meet the restoration target for this natural
17 community type. As a result, its capacity to provide for the conservation of the covered
18 species that depend on these habitats would be substantially reduced compared with the
19 BDCP Proposed Action. Conservation benefit would be lower for covered fish species, the
20 salt marsh harvest mouse, Suisun shrew, California black rail, California clapper rail, and
21 Suisun song sparrow due to reduced acreage of tidal habitat restoration (62% less than the
22 BDCP Proposed Action).
- 23 ● There are no resource areas for which other environmental consequences would occur under
24 **Take Alternative D**.

25 **9.5.5 Take Alternative E: Isolated 15,000 cfs**

26 **Take Alternative E: Isolated 15,000 cfs** would involve construction of an isolated conveyance
27 facility with a pipelines and tunnels alignment and five intakes. The capacity of the conveyance
28 facility would be 15,000 cfs.

29 **9.5.5.1 Effects on Covered Species**

30 **9.5.5.1.1 Covered Fish**

31 **Construction**

32 The five intakes constructed under **Take Alternative E** would result in a greater potential for effects
33 than the three intakes for the BDCP Proposed Action. The overall effects would be similar to those
34 discussed above for **Take Alternative C**, each with the same five intakes constructed.

35 The water conveyance facilities (pipelines and tunnels alignment) would be about the same for
36 **Take Alternative E**, as the BDCP Proposed Action, resulting in similar effects. This would require
37 similar construction activities, and the same number (and locations) of barge landings to support
38 the tunnel construction. Therefore, the associated pile driving, fish handling, and potential water
39 quality effects would also be similar.

1 Measurable differences in construction effects, between **Take Alternative E** and the BDCP Proposed
2 Action, would vary by fish species (see the discussion for **Take Alternative C** for potential effects by
3 fish species). These construction effects would typically result from greater underwater noise,
4 dredging, and habitat alterations for **Take Alternative E**, relative to the BDCP Proposed Action.

5 **Maintenance**

6 The increased number of water intake facilities in the north Delta for **Take Alternative E** would
7 result in proportionally greater maintenance activities, relative to the BDCP Proposed Action. While
8 most of the potential effects of would be associated with periodic maintenance dredging activities,
9 some additional effects on covered fish species could occur from increased predation and periodic
10 decreases in water quality. The effects of maintenance dredging would be similar to the construction
11 dredging effects discussed above; about 54% greater for **Take Alternative E** than the BDCP
12 Proposed Action. In addition, the periodic need for maintenance dredging would result in greater
13 effects than the one-time dredging occurring during the construction phase. Small and likely un-
14 measurable differences would occur, from other in-water maintenance activities (e.g., screen
15 cleaning), between **Take Alternative E** and the BDCP Proposed Action.

16 **Operations**

17 **Take Alternative E** would follow Operational Scenario D, while the BDCP Proposed Action would
18 follow Operational Scenario H, with four potential operational subscenarios, depending on the
19 outcome of the decision tree process for spring outflow and Fall X2.

20 **Take Alternative E** uses five intakes in the north Delta that can convey up to 15,000 cfs while the
21 BDCP Proposed Action consists of three intakes, and can only convey up to 9,000 cfs. **Take**
22 **Alternative E** would have about a 54% greater intake screen length, compared with the BDCP
23 Proposed Action, which is expected to result in a proportionally greater potential for entrainment
24 and impingement effects on the covered species.

25 Average annual early long-term exports under **Take Alternative E** are anticipated to be 3.40 MAF,
26 which is lower than the range for BDCP Proposed Action (4.71 to 5.59 MAF). Average annual
27 outflows would typically be lower for the operational scenarios under the BDCP Proposed Action
28 (between 0.69 and 1.55 MAF lower) than **Take Alternative E**. In addition, **Take Alternative E**
29 would result in greater annual outflow (16.68 MAF) than existing conditions (15.53 MAF on
30 average).

31 **Take Alternative E** would result in no pumping from the south Delta facilities, while the four
32 operational sub-scenarios of the BDCP Proposed Action would range between about 2.40 and 2.85
33 MAF from the south Delta.

34 The effects on fish entrainment or spawning, rearing and migration conditions vary by fish species.

35 **Delta Smelt**

36 Delta smelt typically occur downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011),
37 which is about 20 miles downstream of the north Delta intakes. The primary difference between the
38 BDCP Proposed Action and **Take Alternative E** on delta smelt, would be the effects on entrainment
39 and rearing habitat conditions. **Take Alternative E** would have a beneficial effect on rearing habitat
40 and entrainment, while the BDCP Proposed Action would have a slightly beneficial effect only on

1 rearing habitat conditions. The potential effects on spawning and migration habitat conditions
2 would be similar between **Take Alternative E** and the BDCP Proposed Action (Table 9-10).

3 ***Longfin Smelt***

4 As with delta smelt, potential effects of **Take Alternative E** on longfin smelt would be greater,
5 compared with the BDCP Proposed Action, although both the BDCP Proposed Action and **Take**
6 **Alternative E** would have beneficial effects on entrainment of longfin smelt (Table 9-14). However,
7 the magnitude of the overall effects would likely be limited because longfin smelt occur primarily
8 downstream of Rio Vista, over 20 miles downstream of the north Delta intake facilities (Moyle
9 2002). **Take Alternative E** would also have negative effects on longfin smelt rearing and migration
10 conditions, these effects are projected to be due to future climate change, sea level rise, and/or
11 changes in water demand, rather than this take alternative.

12 ***Chinook Salmon***

13 **Take Alternative E** would have a beneficial effect on entrainment of the winter-run Chinook
14 salmon, but a negative effect on rearing conditions, while the BDCP Proposed Action would
15 primarily benefit the entrainment of spring-run Chinook salmon. **Take Alternative E** would also
16 have negative effects on spring-run rearing and migration, and fall- and late fall-run spawning,
17 rearing, and migration, these effects are projected to be due to future climate change, sea level rise,
18 and/or changes in water demand, rather than this take alternative (Table 9-15 through Table 9-17).

19 ***Steelhead***

20 While the BDCP Proposed Action would have no measurable effects on steelhead entrainment,
21 spawning, rearing or migration conditions, **Take Alternative E** would have negative effects on
22 spawning, rearing and migration conditions (Table 9-18). However, these effects are projected to be
23 due to future climate change, sea level rise, and/or changes in water demand, rather than this take
24 alternative.

25 ***Sacramento Splittail***

26 No adverse effects are expected under **Take Alternative E**, with regard to splittail entrainment,
27 spawning, rearing, or migration conditions (Table 9-19). However, the BDCP Proposed Action would
28 have a beneficial effect on Sacramento splittail migration conditions.

29 ***Sturgeon***

30 While the BDCP Proposed Action would have no adverse effects on green or white sturgeon, **Take**
31 **Alternative E** would have negative effects on green sturgeon spawning and rearing conditions, and
32 white sturgeon migration conditions. In contrast, **Take Alternative E** would have beneficial effects
33 on entrainment of white sturgeon (Table 9-20).

34 ***Lamprey***

35 While the BDCP Proposed Action would have no adverse effects on lamprey, **Take Alternative E**
36 would have negative effects on Pacific lamprey spawning, rearing, or migration conditions, and river
37 lamprey rearing and migration conditions (Table 9-21). However, these effects are projected to be
38 due to future climate change, sea level rise, and/or changes in water demand, rather than this take
39 alternative.

1 **9.5.5.1.2 Covered Mammals**

2 Modeled habitat for covered mammal species would be permanently, temporarily, and periodically
 3 affected by the implementation of the conservation measures under **Take Alternative E**, in
 4 particular the conveyance facilities construction (CM1), tidal natural communities restoration
 5 (CM4), and floodplain restoration (CM5). **Take Alternative E** has greater potential for take of
 6 riparian brush rabbit and San Joaquin kit fox than the BDCP Proposed Action. As seen Table 9-22,
 7 **Take Alternative E** has the same potential for take of riparian woodrat, salt marsh harvest mouse,
 8 and Suisun shrew as the BDCP Proposed Action. The differences in facilities between **Take**
 9 **Alternative E** and the BDCP Proposed Action are outside of the habitats of the covered mammals.

10 **9.5.5.1.3 Covered Birds**

11 Modeled habitat for covered bird species would be permanently and temporarily affected by the
 12 implementation of the conservation measures under **Take Alternative E**, in particular the
 13 conveyance facilities construction (CM1) and tidal natural communities restoration (CM4). Modeled
 14 habitat for Swainson’s hawk, white-tailed kite, tricolored blackbird, and western burrowing owl
 15 would be periodically affected by Yolo Bypass operations (CM2) and floodplain restoration
 16 (CM5). The greatest potential for take of covered bird species from **Take Alternative E** would be in
 17 the near-term as a result of the loss of riparian habitat. Although the BDCP Proposed Action would
 18 result in 5,000 acres of valley/foothill riparian natural community restoration and 750 acres of
 19 protection, the time it takes for riparian trees to mature would result in temporary loss of habitat for
 20 covered birds that use riparian habitats (Swainson’s hawk, white-tailed kite, least Bell’s vireo,
 21 western yellow-billed cuckoo, and yellow-breasted chat). Another source of potential take would be
 22 the installation of new transmission lines to power the construction and operations of the
 23 conveyance facilities (CM1). During the winter months, most covered species, in particular greater
 24 sandhill crane, would have a greater potential to collide with transmission lines because of
 25 decreased visibility due to fog and cloudy skies.

26 Table 9-23, **Take Alternative E** differs from the BDCP Proposed Action by having less potential for
 27 take of all covered bird species except California clapper rail and Suisun song sparrow, for which the
 28 potential for take is the same as under the BDCP Proposed Action.

29 **Take Alternatives C and E** would have the same potential for take for all covered wildlife species
 30 because they have the same conveyance footprint and restoration.

31 Relative to **Take Alternatives B, D, F, and G**, **Take Alternative E** would have a greater potential for
 32 take of those protected bird species that use grassland and agricultural habitats (Swainson’s hawk,
 33 white-tailed kite, tricolored blackbird, greater sand hill crane, and western burrowing owl). **Take**
 34 **Alternative E** would have less potential for take of the remaining protected bird species than **Take**
 35 **Alternatives A and H** because of differences in conveyance alignment (**Take Alternative A**) and the
 36 amounts of tidal and floodplain restoration (**Take Alternative H**).

37 **Take Alternative E** would have greater potential for take of species that only use riparian habitats
 38 (least Bell’s vireo, western yellow-billed cuckoo, and yellow breasted chat) than **Take Alternatives**
 39 **B, D, and G** because **Take Alternative E**’s five intakes along the Sacramento River impact riparian
 40 habitat. **Take Alternative E** would have less potential for take of these species than **Take**
 41 **Alternative H**, which has substantially more impacts associated with increased channel margin
 42 enhancement and tidal and floodplain restoration. **Take Alternative E** would result in less potential

1 for take of yellow breasted, least Bell’s vireo, and western yellow-billed cuckoo than **Take**
 2 **Alternative F.**

3 **Take Alternative E** would have less potential for take of California black rail relative to **Take**
 4 **Alternatives F and H** due to differences in the conveyance alignment and the amount of floodplain
 5 and tidal restoration, respectively. **Take Alternative E** would have a greater potential for take of
 6 this species relative to **Take Alternatives D and G** because of having more tidal restoration than
 7 **Take Alternatives D and G.** **Take Alternative E** would have less potential for take of California
 8 black rail than **Take Alternative A.** This alternative would have the same potential for take of
 9 California black rail as **Take Alternative B.**

10 **Take Alternative E** would have less potential for take of California clapper rail than **Take**
 11 **Alternatives H** because of the location and amounts of tidal restoration. **Take Alternative E** would
 12 have a greater potential for take than **Take Alternatives D and G** because **Take Alternative C** has
 13 more effects on habitat resulting from tidal restoration. **Take Alternative C** would have the same
 14 potential for take of California clapper rail as **Take Alternatives A, B, and F.**

15 **Take Alternative E** would have less potential for take of Suisun song sparrow than **Take**
 16 **Alternative H** and greater potential for take than **Take Alternatives D and G** because of differences
 17 in the amount of tidal restoration. **Take Alternative E** would have the same potential for take of this
 18 species as **Take Alternatives A, B, and F** because they all have the same amounts of tidal
 19 restoration.

20 **9.5.5.1.4 Covered Reptile and Amphibians**

21 Modeled habitat for covered reptiles and amphibians would be permanently, temporarily, and
 22 periodically affected by the implementation of the conservation measures under Take Alternative C,
 23 in particular the conveyance facilities construction (CM1), Yolo Bypass operations (CM2), and tidal
 24 natural communities restoration (CM4).

25 As seen in Table 9-24, **Take Alternative E** differs from the BDCP Proposed Action by having a less
 26 potential for take of giant garter snake and western pond turtle. However, **Take Alternative E** has a
 27 greater potential for take of California red-legged frog and California tiger salamander.

28 **Take Alternatives C and E** would have the same potential for take for all covered wildlife species
 29 because they have the same conveyance footprint and restoration.

30 **Take Alternative E** has less potential for take of giant garter snake than **Take Alternative H**, which
 31 has more tidal and floodplain restoration. **Take Alternative E** has a greater potential for take of this
 32 species than **Take Alternatives D and G** because **Take Alternative E** has more tidal restoration
 33 than. **Take Alternative E** has less potential for take than **Take Alternatives A and F** and has
 34 greater potential for take than **Take Alternative B.**

35 **Take Alternative E** has less potential for take of western pond turtle than **Take Alternatives A, F**
 36 **and H** because of location and number of intakes, differences in the conveyance alignment for **Take**
 37 **Alternative F**, and because **Take Alternative H** has more tidal and floodplain restoration and
 38 channel margin enhancement. **Take Alternative E** has greater potential for take of western pond
 39 turtle than **Take Alternatives D and G** the acreage of tidal restoration (**Take Alternatives D and**
 40 **G**). **Take Alternative E** also has greater potential of western pond turtle for take than **Take**
 41 **Alternative B.**

1 **Take Alternative E** has greater potential for take of California red-legged frog than **Take**
 2 **Alternative A** because of location and number of intakes. **Take Alternative E** has a greater
 3 potential for take of the species than **Take Alternative F** because a larger forebay would be
 4 constructed for **Take Alternative E**. **Take Alternative E** would have the same potential for take of
 5 California red-legged frog as **Take Alternatives B, D, and G**. **Take Alternative E** has less potential
 6 for take than **Take Alternative H** because of the greater amounts of tidal restoration.

7 **Take Alternative E** has less potential for take of California tiger salamander than **Take Alternative**
 8 **H** because of the greater amounts of tidal restoration under **Take Alternative H**. **Take Alternative**
 9 **E** has a greater potential for take than **Take Alternatives A, D, F, and G** because of differences in the
 10 conveyance alignment (**Take Alternative A and F**) and differences in the amounts of tidal
 11 restoration (**Take Alternatives D and G**). **Take Alternative E** has the same potential for take of
 12 California tiger salamander as **Take Alternative B**.

13 The effects on covered reptile and amphibian species from **Take Alternative E** would be offset over
 14 time, through the implementation of the conservation measures.

15 **9.5.5.1.5 Covered Invertebrates**

16 Modeled habitat for covered invertebrates would be permanently, temporarily, and periodically
 17 affected by the implementation of the conservation measures under **Take Alternative E**, in
 18 particular conveyance facilities construction (CM1) and tidal natural communities restoration
 19 (CM4). The tidal restoration would impact a large amount of modeled vernal pool crustacean habitat;
 20 however, this habitat is classified as degraded vernal pool complex and there are no known records
 21 of covered vernal pool crustaceans in these areas. The tidal natural communities restoration (CM4)
 22 would result in large impacts on modeled habitat for valley elderberry longhorn beetle. There are no
 23 documented occurrences of this species in these areas, though they do likely support the species'
 24 host plant (elderberry shrubs).

25 As seen in Table 9-25, **Take Alternative E** has no measurable difference for take of valley
 26 elderberry longhorn beetle and vernal pool crustaceans as the BDCP Proposed Action.

27 **Take Alternative E** has less potential for take of valley elderberry longhorn beetle than **Take**
 28 **Alternative H** because **Take Alternative E** has less tidal and floodplain restoration and channel
 29 margin enhancement. **Take Alternative E** has greater potential for take of this species than **Take**
 30 **Alternatives A, B, D, and G** because of the location and number of intakes (**Take Alternatives A**
 31 **and B**), the conveyance alignment (**Take Alternatives A**), and the amount of tidal restoration (**Take**
 32 **Alternatives D and G**). **Take Alternative E** has less potential for take of valley elderberry longhorn
 33 beetle than **Take Alternative F**.

34 **Take Alternative E** has less potential for take of vernal pool crustaceans than **Take Alternatives A**
 35 **and H** because of differences in the conveyance alignment and amount of tidal restoration,
 36 respectively. **Take Alternative E** has more potential for take of these species than **Take**
 37 **Alternatives D and G** because **Take Alternative E** would restore more tidal habitat. **Take**
 38 **Alternative E** has the same potential for take of these species as **Take Alternatives B and F**.
 39

40 The effects on covered invertebrates resulting from **Take Alternative E** would be offset over
 41 time, through the implementation of the conservation measures.

1 **9.5.5.2 Consistency with BDCP Goal**

2 **Take Alternative E** is not consistent with the BDCP overall goal to provide “a comprehensive
 3 conservation strategy for the Sacramento-San Joaquin River Delta designed to restore and protect
 4 ecosystem health, water supply and water quality within a stable regulatory framework. This take
 5 alternative would have the same amount of habitat restoration and the same conservation
 6 components, with the exception of CM1, as the BDCP Proposed Action, but would not supply as
 7 much water during wet years as the BDCP Proposed Action. In fact, **Take Alternative E** would
 8 provide the lowest early long-term mean total project water deliveries of all the other take
 9 alternatives (3.40 MAF, including the BDCP Proposed Action (4.71 to 5.59 MAF) and less than the
 10 existing conveyance scenario.

11 The use of multiple north Delta intakes (five versus three) for the isolated conveyance facility
 12 included in **Take Alternative E** would provide flexibility to maintain adequate velocities and
 13 comply with sweep-velocity criteria during periods when tidal direction changes, but south Delta
 14 intakes would no longer be used. Intake water salinity levels would be lower compared with the
 15 BDCP Proposed Action with the elimination of south Delta intake operations. However, mercury,
 16 organic carbon and pesticide concentrations in the aquatic environment are predicted to be higher
 17 than the BDCP proposed project.

18 In summary, **Take Alternative E** would provide similar or increased ecosystem restoration but
 19 significantly lower levels of water supply reliability, relative to the BDCP Proposed Action.

20 **9.5.5.3 Practicability**

21 **9.5.5.3.1 Cost**

22 Relative to the Existing Conveyance High-Outflow Scenario, **Take Alternative E** would increase the
 23 frequency and magnitude of water shortages, increase the need to invest in water supply
 24 alternatives, increase operations costs including energy costs of water conveyance and distribution,
 25 improve water quality, and reduce seismic risk.

26 The total cost of **Take Alternative E** would be a present value of \$15.7 billion, which is \$2.2 billion
 27 more than the total cost of the BDCP Proposed Action (Appendix 9.A, *Economic Benefits of the BDCP*
 28 *and Take Alternatives*). **Take Alternative E** would result in mean annual project water deliveries at
 29 the early long-term (ELT) of 3.40 MAF for the state and federal contractors south of the Delta. This
 30 yield is slightly less than the mean yield of 3.45 MAF in the Existing Conveyance High-Outflow
 31 Scenario. Reduced mean Delta exports would result in larger and more frequent water supply
 32 shortages experienced by urban and agricultural water users. Relative to the Existing Conveyance
 33 High-Outflow Scenario, **Take Alternative E** would increase the amount of agricultural groundwater
 34 pumping, resulting in more dry-year fallowing, and would impact operations costs in both the urban
 35 and agricultural sectors.

36 **Take Alternative E** would reduce seismic risks and improve water quality relative to the Existing
 37 Conveyance High-Outflow Scenario. With a 15,000 cfs isolated conveyance facility, post-earthquake
 38 water supplies could be maintained at a level of 3.40 MAF. Mean water supplies following an
 39 earthquake in the Existing Conveyance High-Outflow Scenario are 1.0 MAF.

40 With respect to water quality, 100% of state and federal project supplies would originate in the
 41 north Delta (as compared to 49% for the BDCP Proposed Action). As a result, project water

1 deliveries would be less saline under **Take Alternative E** than under the Existing Conveyance High-
 2 Outflow Scenario.

3 **Take Alternative E** would result in losses to state and federal water contractors of \$8.7 billion
 4 relative to the Existing Conveyance High-Outflow Scenario. The cost of **Take Alternative E** would be
 5 \$15.7 billion. Thus, **Take Alternative E** would result in net losses of \$24.4 billion and is therefore
 6 not practicable with respect to cost.

7 **9.5.5.3.2 Logistics**

8 Obtaining and accessing sufficient appropriate lands and resources necessary to implement **Take**
 9 **Alternative E** would be logistically practicable. **Take Alternative E** would not require assembly of
 10 conservation reserves at a spatial scale that would conflict with urban lands or existing utilities.
 11 Sufficient land suitable for habitat restoration exists in the Plan Area.

12 **9.5.5.3.3 Technology**

13 **Take Alternative E** would be practicable from a technological perspective; it meets the AKART
 14 standard. Technology used for **Take Alternative E** would be the same as the BDCP Proposed Action.

15 **9.5.5.4 Other Environmental Consequences**

16 There are two resource areas for which other environmental consequences would occur under **Take**
 17 **Alternative E**. For one of the two resource areas, the other environmental consequences are the
 18 same as under the BDCP Proposed Action. For one resource area, **Take Alternative E** would have
 19 additional other environmental consequences.

20 There are three water quality other environmental consequences that would occur under **Take**
 21 **Alternative E** that would not occur under the BDCP Proposed Action.

- 22 ● Effects on mercury concentrations resulting from facilities operations and maintenance (CM1).
 23 Increases in fish tissue mercury concentrations are substantial, and changes in fish tissue
 24 mercury concentrations would make existing mercury-related impairment in the Delta
 25 measurably worse than from the BDCP Proposed Action implementation. This alternative would
 26 increase levels of mercury by frequency, magnitude, and geographic extent such that the
 27 affected environment would be expected to have measurably higher body burdens of mercury in
 28 aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish)
 29 or humans consuming those organisms.
- 30 ● Effects on organic carbon concentrations resulting from facilities operations and maintenance
 31 (CM1). Long-term average DOC concentrations at Banks and Jones pumping plants are predicted
 32 to decrease by as much as 1.9 mg/L, while long-term average DOC concentrations for some Delta
 33 interior locations, including Franks Tract, Rock Slough and Contra Costa Pumping Plant (PP) No.
 34 1, are predicted to increase by as much as 1.5 mg/L. Resultant substantial changes in long-term
 35 average DOC at these Delta interior locations could necessitate changes in water treatment plant
 36 operations or require treatment plant upgrades in order to maintain BDCP compliance, and thus
 37 would constitute an adverse effect on water quality and MUN beneficial uses.
- 38 ● Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1).
 39 Modeled increases in San Joaquin River fraction at Buckley Cove, Franks Tract, Rock Slough, and

1 Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of
2 pesticide-related water quality degradation and related toxicity to aquatic life in the Delta.

3 **9.5.5.5 Conclusions**

4 **Take Alternative E** is generally consistent with the overall goal of the BDCP for Delta ecosystem
5 restoration, but is not consistent with the goal to protect and restore water supply. This take
6 alternative would have the same amount of habitat restoration and the same conservation
7 components as the BDCP Proposed Action, but would provide lower water exports than the existing
8 conveyance scenario. In addition, it would be associated with negative changes to in-Delta water
9 quality.

- 10 ● **Take Alternative E** would not be practicable, based on the following conclusions.
 - 11 ○ **Take Alternative E** would result in losses to state and federal water contractors of \$8.7
12 billion relative to the Existing Conveyance High-Outflow Scenario. The cost of **Take**
13 **Alternative E** would be \$15.7 billion. Thus, **Take Alternative E** would result in net losses of
14 \$24.4 billion and is therefore not practicable with respect to cost.
 - 15 ○ Obtaining and accessing sufficient appropriate lands and resources necessary to implement
16 **Take Alternative E** would be logistically practicable; logistics would be similar to the BDCP
17 Proposed Action.
 - 18 ○ **Alternative E** would be practicable from a technological perspective. It meets the AKART
19 standard.
- 20 ● **Take Alternative E** would results in decreased levels of take based on the following
21 conclusions.
 - 22 ○ Take would be increased for 4 covered terrestrial wildlife species and 2 covered fish species,
23 decreased for 11 covered wildlife species and 9 covered fish species, but not measurably
24 different for 12 covered wildlife species.
 - 25 ○ It would offset higher levels of take at the north Delta intakes by eliminating south Delta
26 exports and the associated high levels of entrainment, impingement, and predation.
- 27 ● **Take Alternative E** would result in three other environmental consequences associated with
28 water quality:
 - 29 ○ Existing mercury-related impairment in the Delta would be measurably worse than from the
30 BDCP Proposed Action implementation.
 - 31 ○ It would result in substantial changes in long-term average DOC at Delta interior locations
32 (including Franks Tract, Rock Slough and Contra Costa PP No. 1) and could necessitate
33 changes in water treatment plant operations or require treatment plant upgrades in order
34 to maintain BDCP compliance.
 - 35 ○ It would have a long-term risk of pesticide-related water quality degradation and related
36 toxicity to aquatic life in the Delta due to modeled increases in San Joaquin River fraction at
37 Buckley Cove, Franks Tract, Rock Slough, and Contra Costa PP No. 1.

1 **9.5.6 Take Alternative F: Through Delta**

2 **Take Alternative F: Through Delta** would involve a through Delta conveyance system with Delta
 3 channel modifications and different intake locations than the BDCP.

4 **9.5.6.1 Effects on Covered Species**

5 **9.5.6.1.1 Covered Fish**

6 **Construction**

7 No new intake structures would be constructed in the north Delta under **Take Alternative F**.
 8 Instead, fish screen structures would be constructed at the upstream end of Delta Cross Channel and
 9 Georgiana Slough, and 14 additional operable gates and five barge landings would be constructed.
 10 Several waterways would be dredged to increase channel capacity in order to convey required
 11 flows, and levees would be constructed or modified; and canals, bridges, and pump stations would
 12 also be constructed.

13 **Take Alternative F** would have a temporary and permanent in-water footprint of 31.4 acres,
 14 compared to 16.2 acres for the BDCP Proposed Action. Dredging under **Take Alternative F** would
 15 total 56.9 acres, compared to 17.1 acres under the BDCP Proposed Action. Therefore, **Take**
 16 **Alternative F** would result in substantially greater potential for in-water construction effects than
 17 the BDCP Proposed Action. These construction activities would result in greater effects on fish from
 18 underwater sound, fish handling and stranding, and water quality impairment (e.g., increased
 19 turbidity and contaminants). The effects would result in greater stress, injury, and/or mortality to
 20 the covered species than the BDCP Proposed Action.

21 No water conveyance facilities (tunnel, pipeline, or canal) would be constructed for **Take**
 22 **Alternative F**. Export water would flow through existing waterways (although flow characteristics
 23 in some reaches would be altered by dredging), but the screening facilities would minimize the
 24 diversion of fish into these waterways along with the export water.

25 Measurable differences in construction effects between **Take Alternative F** and the BDCP Proposed
 26 Action would vary by fish species, but would typically be greater under **Take Alternative F** for all
 27 species.

28 **Delta Smelt**

29 Construction effects would generally be greater for **Take Alternative F** than for the BDCP Proposed
 30 Action, with increased effects from pile driving, fish stranding/handling, reductions in water quality,
 31 habitat alteration, and dredging effects (Table 9-10). The effects are potentially substantial because
 32 many facilities associated with **Take Alternative F** (Figure 9-7) occur well within the species' range,
 33 which is primarily downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011), which is
 34 about 20 miles downstream of most construction locations.

35 **Longfin Smelt**

36 As with delta smelt, potential construction effects on longfin smelt would be greater for **Take**
 37 **Alternative F** than the BDCP Proposed Action, with increased effects from pile driving, fish
 38 stranding/handling, reductions in water quality, habitat alteration, and dredging effects (Table
 39 9-14). The effects are potentially substantial because many facilities associated with **Take**

1 **Alternative F** (Figure 9-7) occur well within the species' range, which is primarily downstream of
2 Rio Vista, over 20 miles downstream of the north Delta intake construction locations (Moyle 2002).

3 ***Chinook Salmon***

4 Chinook salmon would experience greater effects from pile driving, fish stranding/handling,
5 reductions in water quality, dredging, and habitat alterations under **Take Alternative F**, compared
6 with the BDCP Proposed Action (Table 9-15 through Table 9-17).

7 ***Steelhead***

8 Steelhead would experience greater effects from construction activities under **Take Alternative F**,
9 than under the BDCP Proposed Action, particularly from pile driving, dredging, and reductions in
10 water quality (Table 9-18). Steelhead would also be marginally less vulnerable to impacts than
11 Chinook salmon due to their larger size and shorter period of presence in Delta waters. Thus
12 steelhead would have a slightly lower potential for effects than Chinook salmon, but more than the
13 smelts, which typically occur some 20 miles downstream of the north Delta intake construction
14 areas (Moyle 2002; Kimmerer 2004; Merz et al. 2011).

15 ***Sacramento Splittail***

16 Sacramento splittail could experience greater construction-related effects under **Take Alternative**
17 **F** than under the BDCP Proposed Action, based on the overall size and wider distribution of the in-
18 water structures constructed (Table 9-19).

19 ***Sturgeon***

20 Green and white sturgeon would experience greater construction-related effects under **Take**
21 **Alternative F** than under the BDCP Proposed Action, based on the overall extent and distribution of
22 the in-water facilities constructed (Table 9-20).

23 ***Lamprey***

24 Pacific and river lamprey would experience greater construction-related effects under **Take**
25 **Alternative F** than under the BDCP Proposed Action, based on the overall extent and distribution of
26 the in-water facilities constructed (Table 9-21).

27 **Maintenance**

28 The principal potential effects would be associated with periodic maintenance dredging activities.
29 Some additional effects on covered fish species could occur from increased predation and periodic
30 decreases in water quality. The effects of maintenance dredging would be similar to the construction
31 dredging effects discussed above, and would be most substantial for the benthic fishes (sturgeons,
32 and lampreys), with outcomes depending greatly on how effectively these species are screened from
33 the waterways that function as conveyance under **Take Alternative F**. However, the periodic need
34 for maintenance dredging would result in greater effects than the one-time dredging occurring
35 during the construction phase. The effects of other in-water maintenance activities (e.g., screen
36 cleaning), would be small, with likely un-measurable differences between **Take Alternative F** and
37 the BDCP Proposed Action.

1 **Operations**

2 **Take Alternative F** would follow Operational Scenario G, while the BDCP Proposed Action would
3 follow Operational Scenario H, with four potential operational sub-scenarios, depending on the
4 outcome of the decision tree process for spring outflow and Fall X2.

5 **Take Alternative F** uses diversion screens to prevent the diversion of fish from the north Delta to
6 the south Delta export facilities, instead of intakes in the north Delta under the BDCP Proposed
7 Action, and other barriers within the Delta to restrict the movement of fish into various waterways.
8 While **Take Alternative F** would likely reduce the overall entrainment rates of the covered fish
9 species, it would have about a 27% greater cumulative screen length than the BDCP Proposed
10 Action, which is expected to result in a greater potential for impingement and other structure-
11 related effects on the covered species. In addition to the two fish-screened barriers on the
12 Sacramento River, at the Delta Cross Channel and Georgiana Slough (each about 2,800-foot-long),
13 there would be 14 operable gates constructed in the interior Delta. The length of the screens, and
14 absence of refugia, increases the risk of impingement, injury, and predation relative to the BDCP
15 Proposed Action.

16 Conservation benefits from large scale restoration in the east and south Delta would be reduced.
17 Fish migrating through the Sacramento River system would be excluded by the screens and movable
18 barriers from most east and south Delta habitat. Fish migrating through the San Joaquin system,
19 though, would be exposed to and benefit from east and south Delta restoration.

20 Average annual early long-term exports under **Take Alternative F** are anticipated to be 4.17 MAF,
21 while the BDCP Proposed Action would have anticipated exports ranging from 4.71 to 5.59 MAF
22 annually. Average annual outflows would be lower for all the operational sub-scenarios under the
23 BDCP Proposed Action (up to 28% lower) than **Take Alternative F**. Unlike the BDCP Proposed
24 Action, which would provide about 51% of the average annual water exports through the south
25 Delta facilities, **Take Alternative F** would provide 100% of the exports from the south Delta. The
26 annual exports from the south Delta facilities under **Take Alternative F** (4.17 MAF) would be less
27 than existing conditions. **Take Alternative F** would provide average annual outflows of 16.68 MAF,
28 typically greater than existing conditions (15.53 MAF on average).

29 The effects of operations on fish entrainment or spawning, rearing and migration conditions vary by
30 fish species.

31 **Delta Smelt**

32 Delta smelt typically occur downstream of Isleton (Moyle 2002; Kimmerer 2004; Merz et al. 2011),
33 which is about 20 miles downstream of the north Delta intake locations. The primary difference
34 between the BDCP Proposed Action and **Take Alternative F**, on effect to delta smelt, would be the
35 effects of exposure to the longer screen lengths, with potentially greater impingement, descaling and
36 predator interaction effects (Table 9-10). However, **Take Alternative F** would have a beneficial
37 effect on entrainment at the south Delta intakes, compared to the BDCP Proposed Action, because
38 Sacramento River fish would be excluded from entrainment to the south Delta. Both **Take**
39 **Alternative F** and the BDCP Proposed Action would have a slightly beneficial effect on rearing
40 habitat, although the effect would likely not be measurable.

1 Longfin Smelt

2 While **Take Alternative F** and the BDCP Proposed Action would have a beneficial effect on longfin
3 smelt entrainment at the south Delta facilities, the differences in overall effects would likely be
4 limited because longfin smelt occur primarily downstream of Rio Vista, over 20 miles downstream
5 of the north Delta intake facilities (Moyle 2002). **Take Alternative F** would have negative effects on
6 longfin smelt rearing and migration conditions, although these effects are projected to be due to
7 future climate change, sea level rise, and/or changes in water demand, rather than to BDCP (Table
8 9-14).

9 Chinook Salmon

10 **Take Alternative F** would have an adverse effect on migration conditions for fall- and late fall-run
11 Chinook salmon, while the BDCP Proposed Action would primarily benefit spring-run Chinook
12 salmon entrainment, although the benefits would be small, and perhaps not measurable. While the
13 BDCP Proposed Action would have no other measurable effects on Chinook salmon, **Take**
14 **Alternative F** would also have some negative effects on spawning, rearing or migration conditions
15 for one or more of the Chinook salmon species (Table 9-15 through Table 9-17). These effects would
16 be due to climate change, sea level rise, and/or future water demands, but not due to **Take**
17 **Alternative F**.

18 Steelhead

19 **Take Alternative F** would have somewhat negative effects on steelhead spawning, rearing, and
20 migration conditions, although these effects would be due to climate change, sea level rise, and/or
21 future water demands, rather than this take alternative. The BDCP Proposed Action would have no
22 adverse effects on these conditions, with regard to steelhead (Table 9-18).

23 Sacramento Splittail

24 **Take Alternative F** would have beneficial effects on Sacramento splittail entrainment in the south
25 Delta, negative effects from the greater overall diversion screen length, but no adverse effects with
26 regard to spawning, rearing, or migration conditions (Table 9-19). The BDCP Proposed Action would
27 only provide measurable benefits to migration conditions.

28 Sturgeon

29 Compared to the BDCP Proposed Action, **Take Alternative F** would have measurably adverse
30 effects on green sturgeon spawning and rearing conditions (Table 9-20). While **Take Alternative F**
31 would also have negative effects on green sturgeon migration conditions, and white sturgeon
32 spawning and migration conditions, these effects would be due to climate change, sea level rise,
33 and/or future water demands, rather than this take alternative.

34 Lamprey

35 Compared to the BDCP Proposed Action, **Take Alternative F** would have beneficial effects on Pacific
36 and river lamprey entrainment at the south Delta facilities, but negative effects from the greater
37 overall diversion screen length in the north Delta (Table 9-21). While **Take Alternative F** would
38 also have some negative effects on spawning, rearing and migration conditions for both species,
39 these negative effects would be due to future climate change, sea level rise, and/or water demands,
40 rather than this take alternative.

1 **9.5.6.1.2 Covered Mammals**

2 Modeled habitat for covered mammal species would be permanently, temporarily, and periodically
 3 affected by the implementation of the conservation measures under **Take Alternative F**, in
 4 particular the conveyance facility construction (CM1), tidal natural communities restoration (CM4),
 5 and floodplain restoration (CM5). As seen Table 9-22, **Take Alternative F** has less potential for take
 6 of San Joaquin kit fox than the BDCP Proposed Action and a greater potential to affect riparian brush
 7 rabbit and riparian woodrat due to differences in the conveyance facilities. This alternative would
 8 have the same potential for take of salt marsh harvest mouse and Suisun shrew.

9 **Take Alternative F** has less potential for take of San Joaquin kit fox for all take alternatives because
 10 of differences in conveyance facilities.

11 **Take Alternative F** has greater potential for take of riparian brush rabbit and riparian woodrat
 12 than **Take Alternatives A, B, C, D, E, G, and I** because of differences in the conveyance alignment.
 13 **Take Alternative F** would have less potential for take of this species than **Take Alternative H**
 14 because of greater amounts of tidal and floodplain restoration.

15 **Take Alternative F** has less potential for take of salt marsh harvest mouse and Suisun shrew than
 16 **Take Alternative H** and greater potential for take than **Take Alternatives D and G** because of the
 17 amounts of tidal restoration under each alternative. **Take Alternative F** has the same potential for
 18 take of these species as **Take Alternatives A, B, C, E, and I**.

19 The effects to covered mammal species from **Take Alternative F** would be offset, over time, through
 20 the implementation of the conservation measures.

21 **9.5.6.1.3 Covered Birds**

22 Modeled habitat for covered bird species would be permanently and temporarily affected by the
 23 implementation of the conservation measures under **Take Alternative F**, in particular the
 24 conveyance facility construction (CM1) and tidal natural communities restoration (CM4). Modeled
 25 habitat for Swainson’s hawk, white-tailed kite, tricolored blackbird, and western burrowing owl
 26 would be periodically affected by Yolo Bypass operations (CM2) and floodplain restoration
 27 (CM5). The greatest potential for take of covered bird species from **Take Alternative F** would be in
 28 the near term from the loss of riparian habitat. Although the BDCP Proposed Action would result in
 29 5,000 acres of valley/foothill riparian natural community restoration and 750 acres of protection,
 30 the time it takes for riparian trees to mature would result in temporary loss of habitat for covered
 31 birds that use riparian habitats (Swainson’s hawk, white-tailed kite, least Bell’s vireo, western
 32 yellow-billed cuckoo, and yellow-breasted chat). Another source of potential take would be from the
 33 installation of new transmission lines to power the construction and operations of the conveyance
 34 facilities (CM1), though this potential for take under **Take Alternative F** would be reduced relative
 35 to other alternatives. During the winter months, most covered species, in particular greater sandhill
 36 crane would have a greater potential to collide with transmission lines due to decreased visibility
 37 due to fog and cloudy skies.

38 As seen in Table 9-23, **Take Alternative F** differs from the BDCP Proposed Action by having less
 39 potential for take of species that use grassland and agricultural habitats (Swainson’s hawk, white-
 40 tailed kite, tricolored blackbird, greater sandhill crane, and western burrowing owl). **Take**
 41 **Alternative F** has a greater potential for take of species that occur entirely in riparian habitats (least
 42 Bell’s vireo, western yellow-billed cuckoo, and yellow breasted chat) as well as California black rail

1 than the BDCP Proposed Action due to the greater amount of in channel and bank work being done
 2 for **Take Alternative F**. **Take Alternative F** would have the same potential for take of California
 3 clapper rail and Suisun song sparrow as the BDCP Proposed Action because it has the same amounts
 4 of tidal restoration.

5 **Take Alternative F** has less potential for take of covered bird species that use grassland and
 6 agricultural habitats (Swainson’s hawk, white-tailed kite, tricolored blackbird, and western
 7 burrowing owl) than **Take Alternatives A, B, C, E, H, and I** from differences in the conveyance
 8 alignments and the amount of tidal and floodplain restoration (**Take Alternative H**). **Take**
 9 **Alternative F** has a greater potential for take of these species than **Take Alternatives D and G**
 10 because these alternatives have tidal restoration.

11 **Take Alternative F** has less potential for take of greater sandhill crane than all of the take
 12 alternatives primarily because of differences in conveyance alignments.

13 **Take Alternative F** has less potential for take of yellow-breasted chat, least Bell’s vireo, and
 14 western yellow billed cuckoo than **Take Alternative H** because of the amounts of tidal and
 15 floodplain restoration and channel margin enhancement. **Take Alternative F** has a greater potential
 16 for take of these species than **Take Alternatives A, B, D, G, and I** because of differences in
 17 conveyance alignments and the amounts of tidal restoration (**Take Alternatives D and G**). Relative
 18 to **Take Alternatives C and E**, **Take Alternative F** would have greater potential for take of yellow-
 19 breasted chat, least Bell’s vireo, and western yellow-billed cuckoo because the conveyance
 20 alignment for **Take Alternative F**.

21 **Take Alternative F** has less potential for take of Suisun song sparrow than **Take Alternative H** and
 22 greater potential for take than **Take Alternatives D and G** from differences in tidal restoration.
 23 **Take Alternative F** would have the same potential for take as **Take Alternatives A, B, C, E, and I**
 24 because they have the same tidal restoration.

25 **Take Alternative F** has less potential for take of California black rail than **Take Alternative H**
 26 because of differences in tidal restoration. **Take Alternative F** has greater potential for take of this
 27 species than **Take Alternatives A, B, C, D, E, G, and I** because of differences in conveyance
 28 alignments and the amounts of tidal restoration (**Take Alternatives D and G**).

29 **Take Alternative F** would have less potential for take of California clapper rail than **Take**
 30 **Alternatives D and G** because of the location and amounts of tidal restoration. **Take Alternative F**
 31 would have a greater potential for take than **Take Alternative H** because it would affect more
 32 habitat from tidal restoration. **Take Alternative F** would have the same potential for take or
 33 California clapper rail as **Take Alternatives A, B, C, E, and I**.

34 In general, the effects to covered bird species from **Take Alternative F** would be offset over time,
 35 through the implementation of the conservation measures.

36 **9.5.6.1.4 Covered Reptiles and Amphibians**

37 Modeled habitat for covered reptiles and amphibians would be permanently, temporarily, and
 38 periodically affected by the implementation of the conservation measures under **Take Alternative**
 39 **F**, in particular the conveyance facility construction (CM1), Yolo Bypass operations (CM2), and tidal
 40 natural communities restoration (CM4).

1 As seen in Table 9-24, **Take Alternative F** differs from the BDCP Proposed Action by having less
 2 potential for take of western pond turtle, California red-legged frog, and California tiger salamander
 3 and greater potential for take of giant garter snake. These differences are attributable to **Take**
 4 **Alternative F**'s conveyance alignment.

5 **Take Alternative F** has a greater potential for take of giant garter snake than **Take Alternatives A,**
 6 **B, C, D, E, G,** and **I** because of differences in conveyance alignments and the amounts of tidal
 7 restoration (**Take Alternatives D** and **G**). **Take Alternative F** has less potential for take of giant
 8 garter snake than **Take Alternative H** from differences in the amount of tidal restoration.

9 **Take Alternative F** has a greater potential for take of western pond turtle than **Take Alternatives**
 10 **A, B, C, D, E, G,** and **I** due to the large amount of aquatic habitat affected by the in channel work.
 11 **Take Alternative F** has less potential for take than **Take Alternative H** from differences in the
 12 amount of tidal restoration.

13 **Take Alternative F** has less potential for take of California red-legged frog modeled habitat than
 14 **Take Alternatives A, B, C, E, H,** and **I. Alternative F** has greater potential for take of this species
 15 than **Take Alternatives D** and **G** from differences in the amounts of tidal restoration.

16 **Take Alternative F** has less potential for take of California tiger salamander than **Take**
 17 **Alternatives A, B, C, E, H,** and **I** because of the differences in conveyance alignments and the
 18 amounts of tidal restoration. **Take Alternative F** has greater potential for take of this species than
 19 **Take Alternatives D** and **G** from differences in the amounts of tidal restoration.

20 The effects to covered reptile and amphibian species from **Take Alternative F** would be offset over
 21 time, through the implementation of the conservation measures.

22 **9.5.6.1.5 Covered Invertebrates**

23 Modeled habitat for covered invertebrates would be permanently, temporarily, and periodically
 24 affected by the implementation of the conservation measures under **Take Alternative F**, in
 25 particular conveyance facility construction (CM1) and tidal natural communities restoration
 26 (CM4).The tidal restoration would impact a large amount of modeled vernal pool crustacean habitat;
 27 however this habitat is classified as degraded vernal pool complex and there are no known records
 28 of covered vernal pool crustaceans in these areas. The conveyance construction (CM1) and tidal
 29 natural communities restoration (CM4) would result in large impacts on modeled habitat for valley
 30 elderberry longhorn beetle. There are no documented occurrences of this species in these areas
 31 though they do likely support their host plant (elderberry shrubs).

32 As seen in Table 9-25, **Take Alternative F** has a greater potential for take of valley elderberry
 33 longhorn beetle and the same potential for take of vernal pool crustaceans as the BDCP Proposed
 34 Action. The difference in take for valley elderberry longhorn beetle is due to the differences in
 35 conveyance construction.

36 **Take Alternative F** has greater potential for take of valley elderberry longhorn beetle than **Take**
 37 **Alternatives A, B, C, D, E,** and **I** because of differences in conveyance alignments and the amounts of
 38 tidal and floodplain restoration (**Take Alternatives D** and **G**). **Take Alternative F** has less potential
 39 for take than **Take Alternative H** because of differences in the amounts of tidal and floodplain
 40 restoration.

1 **Take Alternative F** has less potential for take of vernal pool crustaceans than **Take Alternatives A**
2 and **H** because of differences in conveyance alignment and the amount of tidal restoration (**Take**
3 **Alternative H**). **Take Alternative F** has greater potential for take of these species than **Take**
4 **Alternatives D** and **G** because of having less tidal restoration than these alternatives. **Take**
5 **Alternative F** has the same potential for take as **Take Alternatives B, C, E, and I**.

6 The effects to covered invertebrates from **Take Alternative F** would be offset over time, through
7 the implementation of the conservation measures.

8 **9.5.6.2 Consistency with BDCP Goal**

9 **Take Alternative F** is not consistent with the BDCP overall goal to provide “a comprehensive
10 conservation strategy for the Sacramento-San Joaquin River Delta designed to restore and protect
11 ecosystem health, water supply and water quality within a stable regulatory framework.” **Take**
12 **Alternative F** would not protect water supplies from flood, storm surge and seismic impacts and as
13 a result would not improve water supply reliability relative to the existing conveyance scenario. It
14 would provide some protection from flooding through levee repairs along the Old and Middle rivers,
15 but water supply operations could be impacted by flooding along the Sacramento River, Mokelumne
16 River, Delta tributaries and San Joaquin River. Operations could be temporarily shut down due to
17 the flooding in these Delta channels or the failure of the adjacent island levees. Depending on the
18 impact of the flooding, operations might not resume until the impacts of the flooding or levee failure
19 were addressed (California Department of Water Resources 2010b).

20 This take alternative would have the same amount of habitat restoration and the same conservation
21 components, with the exception of CM1, as the BDCP Proposed Action. **Take Alternative F** would
22 include two on-bank diversions with fish screens with an intake capacity of 7,500 cfs each,
23 constructed at Delta Cross Channel and Georgiana Slough. Although this take alternative would have
24 a higher total diversion capacity than the BDCP Proposed Action, it would provide lower early long-
25 term mean total project water deliveries (4.17 MAF annually, compared to 4.71 to 5.59 MAF for the
26 BDCP Proposed Action under the high-outflow scenario and low outflow scenario, respectively).
27 However, salinity levels of project deliveries are predicted to be lower than the BDCP Proposed
28 Action. This take alternative would result in an increased level of incidental take of all covered fish
29 species and 8 covered wildlife species. In addition, mercury, organic carbon, pesticide and selenium
30 concentrations in the aquatic environment are predicted to be higher than under the BDCP
31 Proposed Action.

32 **Take Alternative F** would fail to restore and protect ecosystem health because it would continue
33 the most serious existing issues with regard to flow and hydraulics in the Delta (Section 3.4.1.3
34 *Problem Statement*). These issues include frequent reverse flows in the Old and Middle Rivers and
35 the general pattern of north-to-south rather than east-to-west flows through the Delta, both of
36 which produce a variety of adverse effects on covered fish such as false attraction flows for
37 migrating salmonids. The minimization of reverse Old and Middle River flows is one of the principal
38 attributes of the existing BiOps (USFWS 2008, NMFS 2009) and of the BDCP Proposed Action; the
39 loss of this benefit in **Take Alternative F** is one reason that this take alternative is inconsistent with
40 the BDCP goal of restoring and protecting ecosystem health.

41 In summary, **Take Alternative F** would provide a reduced level of water supply reliability and a
42 limited additional level of protection from flooding and seismic risks; the same level of natural
43 community restoration but an increase in levels of incidental take of all covered fish species.

1 **9.5.6.3 Practicability**

2 **9.5.6.3.1 Cost**

3 Relative to the Existing Conveyance High-Outflow Scenario, **Take Alternative F** would reduce the
4 frequency and magnitude of water shortages, reduce the need to invest in water supply alternatives,
5 improve the quality of water exports, and reduce operations costs including energy costs of water
6 conveyance and distribution. **Take Alternative F** would not reduce seismic risks to the state and
7 federal water projects.

8 The total cost of **Take Alternative F** would be a present value of \$5.2 billion, which is \$8.2 billion
9 less than the total cost of the BDCP Proposed Action (Appendix 9.A, *Economic Benefits of the BDCP*
10 *and Take Alternatives*). **Take Alternative F** would result in mean annual project water deliveries at
11 the early long-term (ELT) of 4.17 MAF for the state and federal contractors south of the Delta. This
12 figure is greater than the mean yield of 3.45 MAF in the Existing Conveyance High-Outflow Scenario.
13 Increased Delta exports would result in smaller and less frequent water supply shortages
14 experienced by urban and agricultural water users. Relative to the Existing Conveyance High-
15 Outflow Scenario, **Take Alternative F** would reduce the amount of agricultural groundwater
16 pumping, resulting in less dry-year fallowing, and would impact operations costs in both the urban
17 and agricultural sectors.

18 With respects to water quality, project water deliveries would be less saline under **Take**
19 **Alternative F** than under the Existing Conveyance High-Outflow Scenario. The decrease in salinity
20 stems from the fact that **Take Alternative F** water is exported directly from the Sacramento River
21 and flows are segregated from the San Joaquin River due to the construction of other Delta
22 infrastructure.

23 The total benefits of **Take Alternative F** would be \$12.1 billion, as compared to costs of \$5.2 billion.
24 Thus **Take Alternative F** would result in net benefits of \$6.8 billion and is practicable from a cost
25 standpoint.

26 **9.5.6.3.2 Logistics**

27 Obtaining and accessing sufficient appropriate lands and resources necessary to implement **Take**
28 **Alternative F** would be logistically practicable. **Take Alternative F** would not require assembly of
29 conservation reserves at a spatial scale that would conflict with urban lands or existing utilities.
30 Sufficient land suitable for habitat restoration exists within the Plan Area.

31 **9.5.6.3.3 Technology**

32 **Take Alternative F** would not be practicable from a technological standpoint because it does not
33 meet the AKART standard. **Take Alternative F** proposes the installation of two 7,500 cfs fish
34 screened diversion structures to divert flows at Delta Cross Channel and Georgiana Slough. Fish
35 screens would be installed to prevent fish from entering existing waterways through passive flow
36 velocities (i.e., gravity flow) that would lower than in the BDCP Proposed Action. In order to satisfy
37 the fish protection criteria for maximum fish screen approach velocity to prevent entrainment of
38 Delta smelt, the 7,500 cfs screened intake structures would need to be approximately 2,800 feet long
39 each (assuming 15 ft height), or almost twice the average length of each fish screen in the BDCP
40 Proposed Action. This approach is not consistent with the Fish Facility Technical Team
41 recommendation that the screen length should be minimized to reduce fish exposure to the screen

1 (California Department of Water Resources 2010a). Although the proposed fish screen technology
 2 has been proven (e.g., there are over 10 screened intakes along the Sacramento River or in the
 3 Delta), none are capable of passing 7,500 cfs. Moreover, there are no examples fish-screened
 4 diversion structures of this size elsewhere in California making this an “untried or untested design”.
 5 The largest known existing intake with intakes on the Sacramento River has a reported maximum
 6 capacity of 3,000 cfs (California Department of Water Resources 2010a and 2010b). As a result, due
 7 to the size (total length) of the fish screens, Take Alternative F does not meet the AKART standard.

8 **9.5.6.4 Other Environmental Consequences**

9 There are four resource areas for which other environmental consequences would occur under
 10 **Take Alternative F**. For one of the four resource areas, the other environmental consequences are
 11 the same as under the BDCP Proposed Action. For three resource areas, air quality, water quality
 12 and recreation, **Take Alternative F** would have additional other environmental consequences.

13 There are two air quality environmental consequences that would occur under Take Alternative F
 14 that would not occur under the BDCP Proposed Action.

- 15 • Construction emissions would exceed Sacramento Metropolitan Air Quality Management
 16 District (SMAQMD’s) daily NO_x and fugitive dust thresholds for all years between 2014 and
 17 2020. Generating emissions in excess of local air district thresholds could contribute to or
 18 worsen an existing air quality conditions, even with implementation of environmental
 19 commitments.
- 20 • Construction of the water conveyance features would involve the operation of thousands of
 21 pieces of mobile and stationary diesel-fueled construction equipment for multiple years in close
 22 proximity to sensitive receptors. The emissions generated during Take Alternative F
 23 construction would exceed its cancer thresholds, and thus expose receptors to substantial
 24 pollutant concentrations and health threats.

25 There are four water quality environmental consequences that would occur under **Take**
 26 **Alternative F** that would not occur under the BDCP Proposed Action.

- 27 • Effects on mercury concentrations resulting from facilities operations and maintenance (CM1).
 28 Increases in fish tissue mercury concentrations are substantial, and changes in fish tissue
 29 mercury concentrations would make existing mercury-related impairment in the Delta
 30 measurably worse than from the BDCP Proposed Action. This alternative would increase levels
 31 of mercury by frequency, magnitude, and geographic extent such that the affected environment
 32 would be expected to have measurably higher body burdens of mercury in aquatic organisms,
 33 thereby substantially increasing the health risks to wildlife (including fish) or humans
 34 consuming those organisms.
- 35 • Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to
 36 decrease by as much as 1.9 mg/L, while long-term average DOC concentrations for some Delta
 37 interior locations, including Franks Tract, Rock Slough and Contra Costa PP No. 1, are predicted
 38 to increase by as much as 0.9 mg/L. Resultant substantial changes in long-term average DOC at
 39 these Delta interior locations could necessitate changes in water treatment plant operations or
 40 require treatment plant upgrades in order to maintain BDCP compliance, and thus would
 41 constitute an adverse effect on water quality and MUN beneficial uses.
- 42 • Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1).
 43 Modeled increases in San Joaquin River fraction at Buckley Cove, Franks Tract, Rock Slough, and

1 Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of
 2 pesticide-related water quality degradation and related toxicity to aquatic life in the Delta.

- 3 ● Effects on selenium concentrations resulting from facilities operations and maintenance (CM1).
 4 Small to moderate changes in selenium concentrations would occur in water and minimal
 5 changes in selenium concentrations in biota at the Export Service Area locations. Selenium
 6 concentrations in water and biota generally would decrease in the late long term and would not
 7 exceed ecological benchmarks at either location. This small positive change in selenium
 8 concentrations in the late long term would be expected to slightly decrease the frequency with
 9 which applicable benchmarks would be exceeded or slightly improve the quality of water at the
 10 Export Service Area locations, with regard to selenium. Modeled selenium concentrations in
 11 water would increase at Rock Slough, Franks Tract, and Contra Costa PP No. 1, decreasing the
 12 available assimilative capacity by more than 10% at each of those locations; and selenium
 13 concentrations in whole-body fish and in bird eggs (invertebrate and fish diets) at those
 14 locations would increase so that Level of Concern benchmarks for biota that are not exceeded
 15 under baseline conditions would be exceeded at Rock Slough and Contra Costa PP No. 1 (and
 16 approach exceedance at Franks Tract).

17 In addition, there is one other environmental consequence associated with recreation. Construction
 18 of **Take Alternative F** fish screens and intakes would result in the direct permanent loss of three
 19 well-established recreation facilities: Boathouse Marina, Walnut Grove public guest dock, and Boon
 20 Dox guest dock. Mitigation would provide funding for a recreational opportunity
 21 downstream/upstream in the same area for the same regional recreational users. However, these
 22 effects would still be adverse due to the permanent loss of these recreation facilities.

23 9.5.6.5 Conclusions

24 **Take Alternative F** is not consistent with the overall goal of the BDCP. Although this take
 25 alternative would have a higher total diversion capacity than the BDCP Proposed Action, it would
 26 result in less water supply, not protect water supply from flooding and seismic risks, and would
 27 result in increased levels of incidental take of all covered fish species.

- 28 ● **Take Alternative F** would not be practicable, based on the following conclusions.
 - 29 ○ The total benefits of **Take Alternative F** would be \$12.1 billion, as compared to costs of \$5.2
 30 billion. Thus **Take Alternative F** would result in net benefits of \$6.8 billion and is
 31 practicable from a cost standpoint.
 - 32 ○ Obtaining and accessing sufficient appropriate lands and resources necessary to implement
 33 **Take Alternative F** would be logistically practicable.
 - 34 ○ **Take Alternative F** would not be practicable from a technological perspective; it does not
 35 meet AKART. It proposes two 7,500 cfs intakes to divert flows at Delta Cross Channel and
 36 Georgiana Slough, which is not consistent with the Fish Facility Technical Team and the
 37 Value Planning Study conclusions regarding maximum intake size. A 7,500 cfs intake is more
 38 than twice the size of any other intake in California. **Take Alternative F** also requires
 39 installation of new operable barriers to maintain flow and water quality in the water supply
 40 corridor. This is not a proven technology and thus does not meet the AKART standard
- 41 ● **Take Alternative F** would result in increased levels of take, based on the following conclusions.

- 1 ○ Take would be increased for all covered fish species and 8 covered terrestrial wildlife
- 2 species, but reduced for 9 covered terrestrial wildlife species. Take would not be
- 3 measurably different for 10 other covered wildlife species.
- 4 ○ Take of aquatic species would be increased due to the larger footprint of in-water and
- 5 dredging impacts associated with construction and maintenance (94% and 233% increase
- 6 respectively relative to the BDCP Proposed Action. In addition, there would be operations-
- 7 related effects on green sturgeon and fall-/late fall-run Chinook salmon from upstream
- 8 reservoir operations.
- 9 ○ Some migrating and resident fish would benefit less from large-scale restoration in the east
- 10 or south Delta due to the operable barriers, which would redirect fish out of the south Delta
- 11 away from operating intakes.
- 12 ● **Take Alternative F** would result in seven other environmental consequences: two associated
- 13 with air quality, four associated with water quality, and one associated with recreation:
- 14 ○ Construction emissions would exceed SMAQMD’s daily NO_x and fugitive dust thresholds.
- 15 ○ The emissions from construction equipment would exceed cancer thresholds, and thus
- 16 expose receptors to substantial pollutant concentrations and health threats.
- 17 ○ Existing mercury-related impairment in the Delta would be measurably worse than from the
- 18 implementation of the BDCP Proposed Action.
- 19 ○ It would result in substantial changes in long-term average DOC at Delta interior locations
- 20 (including Franks Tract, Rock Slough and Contra Costa PP No. 1) and could necessitate
- 21 changes in water treatment plant operations or require treatment plant upgrades in order
- 22 to maintain BDCP compliance.
- 23 ○ It would have a long-term risk of pesticide-related water quality degradation and related
- 24 toxicity to aquatic life in the Delta due to modeled increases in San Joaquin River fraction at
- 25 Buckley Cove, Franks Tract, Rock Slough, and Contra Costa PP No. 1.
- 26 ○ Small to moderate changes in selenium concentrations would occur in water and minimal
- 27 changes in selenium concentrations in biota at the Export Service Area locations.
- 28 ○ Construction of fish screens and intakes would result in the direct permanent loss of well-
- 29 established recreation facilities at Boathouse Marina, Walnut Grove public guest dock, and
- 30 Boon Dox guest dock.

31 **9.5.7 Take Alternative G: Less Tidal Restoration**

32 **Take Alternative G: Less Tidal Restoration** would involve construction of a dual conveyance
 33 facility with pipelines, tunnels, and three intakes. The capacity of the isolated conveyance facility
 34 would be 9,000 cfs. This take alternative would reduce tidal natural communities restoration to
 35 50,000 acres.

1 **9.5.7.1 Effects on Covered Species**

2 **9.5.7.1.1 Covered Fish**

3 **Construction**

4 The construction activities associated with **Take Alternative G** are the same as the BDCP Proposed
5 Action, except for a reduced amount of construction related to tidal habitat restoration. This
6 includes the same intakes, barge landings, and tunnels/pipelines alignment. Therefore, the effects of
7 constructing the intakes, barge landings, and conveyance facilities would be the same as for the
8 BDCP Proposed Action. However, the effects of habitat restoration activities would likely result in
9 slightly less effects from fish handling/stranding and water quality impairment (e.g., increased
10 turbidity and contaminants). Overall, no measurable differences in construction effects would occur
11 for the various covered fish species, between **Take Alternative G** and the BDCP Proposed Action.

12 **Maintenance**

13 As with the construction activities, the maintenance activities would be about the same for **Take**
14 **Alternative G** and the BDCP Proposed Action.

15 **Operations**

16 **Take Alternative G** would follow the same operational scenario as the BDCP Proposed Action,
17 including the same four potential operational outcomes of the decision tree process for spring
18 outflow and Fall X2. Therefore, operational effect would be the same as for the BDCP Proposed
19 Action (Table 9-10, and Table 9-14 through Table 9-21). As with the BDCP Proposed Action, **Take**
20 **Alternative G** would provide 51% of the average annual water exports through the south Delta
21 facilities. Average annual outflows would range from 15.42 to 16.14 MAF under the BDCP Proposed
22 Action, and typically greater than existing conditions (15.53 MAF on average).

23 **Take Alternative G** would also have the same effects on fish, as the BDCP Proposed Action.
24 Therefore, **Take Alternative G** would result in slightly beneficial effects on longfin smelt
25 entrainment and Sacramento splittail migration. While beneficial result are expected with regard to
26 delta smelt rearing and spring-run Chinook salmon entrainment, these effects are due largely to the
27 effects of future climate change, sea level rise, and/or changes in water demand, rather than this
28 take alternative.

29 **9.5.7.1.2 Covered Mammals**

30 Modeled habitat for covered mammal species would be permanently, temporarily, and periodically
31 affected by the implementation of the conservation measures under **Take Alternative G**, in
32 particular the conveyance facility construction (CM1), tidal natural communities restoration (CM4),
33 and floodplain restoration (CM5). Of the covered mammals, salt marsh harvest mouse and Suisun
34 shrew would have the greatest potential for take from the implementation of **Take Alternative G**
35 because these species are known to occur within the modeled habitat that would be affected by
36 implementation (in particular CM4). Riparian brush rabbit, riparian woodrat, and San Joaquin kit
37 fox, though documented in the Plan Area, are not known to and/or have a lower potential to occur in
38 areas that would be directly affected by **Take Alternative G**.

39 As seen Table 9-22, **Take Alternative G** has less potential for take of riparian brush rabbit, riparian
40 woodrat, salt marsh harvest mouse, and Suisun shrew than the BDCP Proposed Action. These

1 differences are due to **Take Alternative G** having 15,000 acres less of tidal restoration. **Take**
 2 **Alternative G** has the same potential for take of San Joaquin kit fox.

3 **Take Alternative G** has less potential for take of San Joaquin kit fox, salt marsh harvest mouse,
 4 Suisun shrew, and riparian woodrat than all take alternatives because it has substantially less tidal
 5 restoration.

6 **Take Alternative G** has less potential for take of riparian brush rabbit than **Take Alternatives A, B,**
 7 **C, E, F, H, and I** because it has less tidal restoration. **Take Alternative G** has greater potential for
 8 take of the species than **Take Alternative D** because of the amount of tidal restoration.

9 The effects to covered mammal species from **Take Alternative G** would be offset over time, through
 10 the implementation of the conservation measures.

11 **9.5.7.1.3 Covered Birds**

12 Modeled habitat for covered bird species would be permanently and temporarily affected by the
 13 implementation of the conservation measures under **Take Alternative G**, in particular the
 14 conveyance facility construction (CM1) and tidal natural communities restoration (CM4). Modeled
 15 habitat for Swainson’s hawk, white-tailed kite, tricolored blackbird, and western burrowing owl
 16 would be periodically affected by Yolo Bypass operations (CM2) and floodplain restoration
 17 (CM5). The greatest potential for take of covered bird species from **Take Alternative G** would be in
 18 the near term from the loss of riparian habitat. Although the BDCP Proposed Action would result in
 19 5,000 acres of valley/foothill riparian natural community restoration and 750 acres of protection,
 20 the time it takes for riparian trees to mature would result in temporary loss of habitat for covered
 21 birds that use riparian habitats (Swainson’s hawk, white-tailed kite, least Bell’s vireo, western
 22 yellow-billed cuckoo, and yellow-breasted chat). Another source of potential take would be from the
 23 installation of new transmission lines to power the construction and operations of the conveyance
 24 facilities (CM1). During the winter months, most covered species, in particular greater sandhill crane
 25 would have a greater potential to collide with transmission lines due to decreased visibility due to
 26 fog and cloudy skies.

27 As seen in Table 9-23, **Take Alternative G** differs from the BDCP Proposed Action by having less
 28 potential for take for all covered bird species because of having 15,000 less acres of tidal restoration.

29 **Take Alternative G** has less potential for take of greater sandhill crane, tricolored blackbird,
 30 western burrowing owl, Swainson’s hawk, white-tailed kite, yellow-breasted chat, least Bell’s vireo,
 31 western yellow-billed cuckoo, California clapper rail, and California black rail compared to **Take**
 32 **Alternatives A, B, C, E, F, H, and I** because of having less tidal restoration. **Take Alternative G** has a
 33 greater potential for take of these species than **Take Alternative D** because it has more tidal
 34 restoration.

35 **Take Alternative G** has less potential for take of Suisun song sparrow than **Take Alternatives A, B,**
 36 **C, E, F, H, and I** and greater potential for take than **Take Alternative D** because of the amount tidal
 37 restoration under **Take Alternative G**.

38 In general, the effects to covered bird species from **Take Alternative G** would be offset over time,
 39 through the implementation of the conservation measures.

1 **9.5.7.1.4 Covered Reptile and Amphibians**

2 Modeled habitat for covered reptiles and amphibians would be permanently, temporarily, and
 3 periodically affected by the implementation of the conservation measures under **Take Alternative**
 4 **G**, in particular the conveyance facility construction (CM1), Yolo Bypass operations (CM2), and tidal
 5 natural communities restoration (CM4).

6 As seen in Table 9-24, **Take Alternative G** differs from the BDCP Proposed Action by having less
 7 potential for take of giant garter snake, western pond turtle, and California tiger salamander and the
 8 same potential for take of California red-legged frog. These differences are due to having less tidal
 9 restoration.

10 **Take Alternative G** has less potential for take of giant garter snake, western pond turtle, California
 11 red-legged frog, and California tiger salamander than **Take Alternatives A, B, C, E, F, H, and I** and
 12 greater potential for take than **Take Alternative D**. These differences are due to having the amounts
 13 respective tidal restoration.

14 The effects to covered reptile and amphibian species from **Take Alternative G** would be offset over
 15 time, through the implementation of the conservation measures.

16 **9.5.7.1.5 Covered Invertebrates**

17 Modeled habitat for covered invertebrates would be permanently, temporarily, and periodically
 18 affected by the implementation of the conservation measures under **Take Alternative G**, in
 19 particular conveyance facility construction (CM1) and tidal natural communities restoration
 20 (CM4).The tidal restoration would impact modeled vernal pool crustacean habitat; however this
 21 habitat is classified as degraded vernal pool complex and there are no known records of covered
 22 vernal pool crustaceans in these areas. The tidal natural communities restoration (CM4) would
 23 result in large impacts on modeled habitat for valley elderberry longhorn beetle. There are no
 24 documented occurrences of this species in these areas though they do likely support their host plant
 25 (elderberry shrubs).

26 As seen in Table 9-25, **Take Alternative G** has less potential for take of the covered invertebrate
 27 species than the BDCP Proposed Action. These differences are attributable to **Take Alternative G**
 28 having less tidal restoration.

29 **Take Alternative G** has less potential for take of covered invertebrates than **Take Alternatives A,**
 30 **B, C, E, F, H, and I** because of the amount of tidal restoration. **Take Alternative G** has a greater
 31 potential for take of covered invertebrates than **Take Alternative D** because it has greater amounts
 32 of tidal restoration.

33 The effects to covered invertebrates from **Take Alternative G** would be offset over time, through
 34 the implementation of the conservation measures.

35 **9.5.7.2 Consistency with BDCP Goal**

36 **Take Alternative G** is not consistent with the BDCP overall goal to provide “a comprehensive
 37 conservation strategy for the Sacramento-San Joaquin River Delta designed to restore and protect
 38 ecosystem health, water supply and water quality within a stable regulatory framework.” This take
 39 alternative includes a reduced amount of habitat restoration compared with the BDCP Proposed
 40 Action. Tidal natural communities restoration would be reduced from 65,000 acres to 50,000 acres

1 (with 43,000 acres of subtidal and intertidal habitat and 7,000 acres of upland transitional habitat),
 2 which does not meet the BDCP restoration target for this natural community type, and conservation
 3 of covered species that depend on these habitats would be reduced relative to the BDCP Proposed
 4 Action.

5 **9.5.7.3 Practicability**

6 **9.5.7.3.1 Cost**

7 Relative to the Existing Conveyance High-Outflow Scenario, **Take Alternative G** would reduce the
 8 frequency and magnitude of water shortages, reduce the need to invest in water supply alternatives,
 9 reduce operations costs including energy costs of water conveyance and distribution, improve water
 10 quality, and reduce seismic risk.

11 The total cost of **Take Alternative G** would be a present value of \$13.4 billion, which is \$0.04 billion
 12 less than the total cost of the BDCP Proposed Action (Appendix 9.A, *Economic Benefits of the BDCP*
 13 *and Take Alternatives*). **Take Alternative G** would result in mean annual project water deliveries at
 14 the early long-term (ELT) of 4.71 MAF for the state and federal contractors south of the Delta. This
 15 figure is greater than the mean yield of 3.45 MAF in the Existing Conveyance High-Outflow Scenario.
 16 Increased Delta exports would result in smaller and less frequent water supply shortages
 17 experienced by urban and agricultural water users. Relative to the Existing Conveyance High-
 18 Outflow Scenario, **Take Alternative G** would reduce the amount of agricultural groundwater
 19 pumping, resulting in less dry-year fallowing, and would impact operations costs in both the urban
 20 and agricultural sectors.

21 **Take Alternative G** would reduce seismic risks and improve water quality relative to the Existing
 22 Conveyance High-Outflow Scenario. With a 9,000 cfs isolated conveyance facility, post-earthquake
 23 water supplies could be maintained at a level of 3.8 MAF. Mean water supplies following an
 24 earthquake in the Existing Conveyance High-Outflow Scenario are 1.0 MAF.

25 With respect to water quality, 49% of state and federal project supplies would originate in the north
 26 Delta (as compared to 49% for the BDCP Proposed Action). As a result, project water deliveries
 27 would have similar salinity levels under **Take Alternative G** than under the Existing Conveyance
 28 High-Outflow Scenario.

29 The total benefits of **Take Alternative G** would be \$18.0 billion, as compared to costs of \$13.4
 30 billion. Thus **Take Alternative G** would result in net benefits of \$4.6 billion and is practicable from a
 31 cost standpoint.

32 **9.5.7.3.2 Logistics**

33 Obtaining and accessing sufficient appropriate lands and other resources necessary to implement
 34 **Take Alternative G** would be logistically practicable. **Take Alternative G** would not require
 35 assembly of conservation reserves at a spatial scale that would conflict with urban lands or existing
 36 utilities. Sufficient land suitable for habitat restoration exists within the Plan Area.

37 **9.5.7.3.3 Technology**

38 **Take Alternative G** would be practicable from a technological perspective; it meets the AKART
 39 standard. Technology used for **Take Alternative G** would be the same as the BDCP Proposed Action.

1 **9.5.7.4 Other Environmental Consequences**

2 There is one resource area for which other environmental consequences would occur under **Take**
3 **Alternative G** and it is the same as under the BDCP Proposed Action.

4 **9.5.7.5 Conclusions**

5 **Take Alternative G** is not consistent with the overall goal of the BDCP. Water supply reliability
6 would be the same as the BDCP Proposed Action, but this take alternative would provide a reduced
7 level of ecosystem restoration.

- 8 ● **Take Alternative G** would be practicable, based on the following conclusions.
 - 9 ○ The total benefits of **Take Alternative G** would be \$18 billion, as compared to costs of \$13.4
10 billion. Thus **Take Alternative G** would result in net benefits of \$4.6 billion and is
11 practicable from a cost standpoint.
 - 12 ○ Obtaining and accessing sufficient appropriate lands and other resources necessary to
13 implement **Take Alternative G** would be logistically practicable; logistics would be similar
14 to the BDCP Proposed Action.
 - 15 ○ **Take Alternative G** would be practicable from a technological perspective. It meets the
16 AKART standard.
- 17 ● **Take Alternative G** would result in similar levels of take of aquatic species relative to the BDCP
18 Proposed Action, but lower levels of take for many covered terrestrial species, because of
19 reduced habitat restoration. These results are based on the following conclusions.
 - 20 ○ It would not increase the level of incidental take on any covered fish or wildlife species, and
21 would reduce take for 20 covered terrestrial wildlife species as a result of less tidal natural
22 communities restoration. Incidental take would not be measurably different for any of the
23 11 covered fish species.
 - 24 ○ It would reduce tidal natural communities restoration from 65,000 acres to 50,000 acres,
25 which would not meet the restoration target for this natural community type.
 - 26 ○ Conservation benefit would be lower for covered fish species, the salt marsh harvest mouse,
27 Suisun shrew, California black rail, California clapper rail, and Suisun song sparrow due to
28 reduced acreage of tidal habitat restoration (23% less than the BDCP Proposed Action).
- 29 ● **Take Alternative G** would result in no other environmental consequences different than the
30 BDCP Proposed Action:

31 **9.5.8 Take Alternative H: More Restoration**

32 **Take Alternative H: More Restoration** would involve construction of a dual conveyance facility
33 with a pipelines, tunnels, and three intakes. The capacity of the conveyance facility would be 9,000
34 cfs. This take alternative would increase tidal natural communities restoration to 75,000 acres,
35 seasonally inundated floodplain restoration to 20,000 acres, and channel margin enhancement to 40
36 linear miles.

1 **9.5.8.1 Effects on Covered Species**

2 **9.5.8.1.1 Covered Fish**

3 **Construction**

4 The construction activities associated with **Take Alternative H** are the same as the BDCP Proposed
5 Action, except for substantial increases in the amount of tidal, floodplain, and channel margin
6 habitat restored. This includes the same intakes, barge landings, and pipelines and tunnels
7 alignment. Therefore, the effects of constructing the intakes, barge landings, and conveyance
8 facilities would be the same as for the BDCP Proposed Action. However, the effects of habitat
9 restoration activities would result in a greater potential for effects from fish handling/stranding and
10 water quality impairment (e.g., increased turbidity and contaminants).

11 No measurable differences in construction effects would occur for the various covered fish species,
12 between **Take Alternative H** and the BDCP Proposed Action.

13 **Maintenance**

14 As with the construction activities, the maintenance activities would be the same for **Take**
15 **Alternative H** and the BDCP Proposed Action.

16 **Operations**

17 **Take Alternative H** would follow the same operational scenario as the BDCP Proposed Action,
18 including the same four potential operational outcomes of the decision tree process for spring
19 outflow and Fall X2. Therefore, operational effects would be the same as for the BDCP Proposed
20 Action, and those discussed above for **Take Alternative G**.

21 **Take Alternative H** would also have the same effects on fish, as the BDCP Proposed Action (Table
22 9-10, and Table 9-14 through Table 9-21). Therefore, **Take Alternative H** would result in
23 measurably beneficial effects on longfin smelt entrainment and Sacramento splittail migration.
24 While beneficial result are expected with regard to delta smelt rearing and spring-run Chinook
25 salmon entrainment, these effects are due largely to the effects of future climate change, sea level
26 rise, and/or changes in water demand, rather than this take alternative.

27 **9.5.8.1.2 Covered Mammals**

28 Modeled habitat for covered mammal species would be permanently, temporarily, and periodically
29 affected by the implementation of the conservation measures under **Take Alternative H**, in
30 particular the conveyance facility construction (CM1), tidal natural communities restoration (CM4),
31 and floodplain restoration (CM5). Of the covered mammals, salt marsh harvest mouse and Suisun
32 shrew would have the greatest potential for take from the implementation of **Take Alternative H**
33 because these species are known to occur within the modeled habitat that would be affected by
34 implementation (in particular CM4).

35 As seen Table 9-22, **Take Alternative H** has a greater potential for take of riparian brush rabbit,
36 riparian woodrat, Suisun shrew, and salt marsh harvest mouse than the BDCP Proposed Action
37 because of the amounts tidal and floodplain restoration. **Take Alternative H** has the same potential
38 for take of San Joaquin kit fox as the BDCP Proposed Action.

1 **Take Alternative H** has greater potential for take over all other alternatives of riparian woodrat,
 2 riparian brush rabbit salt marsh harvest mouse, and Suisun shrew because of having greater
 3 amounts of tidal and floodplain restoration. Take Alternative H has more potential for take of San
 4 Joaquin kit fox than Alternative F, but has less potential for take of San Joaquin kit fox than **Take**
 5 **Alternatives A, B, C, and E.**

6 The effects to covered mammal species from **Take Alternative H** would be offset over time, through
 7 the implementation of the conservation measures.

8 **9.5.8.1.3 Covered Birds**

9 Modeled habitat for covered bird species would be permanently and temporarily affected by the
 10 implementation of the conservation measures under **Take Alternative H**, in particular the
 11 conveyance facility construction (CM1) and tidal natural communities restoration (CM4). Modeled
 12 habitat for Swainson’s hawk, white-tailed kite, tricolored blackbird, and western burrowing owl
 13 would be periodically affected by Yolo Bypass operations (CM2) and floodplain restoration
 14 (CM5). The greatest potential for take of covered bird species from **Take Alternative H** would be in
 15 the near term from the loss of riparian habitat. Although the take alternative would result in 5,000
 16 acres of valley/foothill riparian natural community restoration and 750 acres of protection, the time
 17 it takes for riparian trees to mature would result in temporary loss of habitat for covered birds that
 18 use riparian habitats (Swainson’s hawk, white-tailed kite, least Bell’s vireo, western yellow-billed
 19 cuckoo, and yellow-breasted chat). Another source of potential take would be from the installation
 20 of new transmission lines to power the construction and operations of the conveyance facilities
 21 (CM1). During the winter months, most covered species, in particular greater sandhill crane would
 22 have a greater potential to collide with transmission lines due to decreased visibility due to fog and
 23 cloudy skies.

24 As seen in Table 9-23, **Take Alternative H** has a greater potential for take of all covered bird species
 25 than the BDCP Proposed Action because of having greater amounts of tidal and floodplain
 26 restoration.

27 **Take Alternative H** has a greater potential for take of all covered bird species than all other take
 28 alternatives because this alternative would have greater amounts of tidal and floodplain restoration.

29 In general, the effects to covered bird species from **Take Alternative H** would be offset over time,
 30 through the implementation of the conservation measures.

31 **9.5.8.1.4 Covered Reptile and Amphibians**

32 Modeled habitat for covered reptiles and amphibians would be permanently, temporarily, and
 33 periodically affected by the implementation of the conservation measures under **Take Alternative**
 34 **H**, in particular the conveyance facility construction (CM1), Yolo Bypass operations (CM2), and tidal
 35 natural communities restoration (CM4).

36 As seen in Table 9-24, **Take Alternative H** has a greater potential for take of giant garter snake,
 37 western pond turtle, and California tiger salamander than the BDCP Proposed Action because of
 38 having greater amounts of tidal and floodplain restoration. **Take Alternative H** has the same
 39 potential for take of California red-legged frog as the BDCP Proposed Action.

1 **Take Alternative H** has a greater potential for take of giant garter snake, western pond turtle, and
 2 California tiger salamander than all of the take alternatives because of having greater amounts of
 3 tidal and floodplain restoration.

4 The effects to covered reptile and amphibian species from **Take Alternative H** would be offset over
 5 time, through the implementation of the conservation measures.

6 **9.5.8.1.5 Covered Invertebrates**

7 Modeled habitat for covered invertebrates would be permanently, temporarily, and periodically
 8 affected by the implementation of the conservation measures under **Take Alternative H**, in
 9 particular conveyance facility construction (CM1) and tidal natural communities restoration
 10 (CM4).The tidal restoration would impact a large amount of modeled vernal pool crustacean habitat.
 11 The tidal natural communities restoration (CM4) would result in large impacts on modeled habitat
 12 for valley elderberry longhorn beetle.

13 As seen in Table 9-25, **Take Alternative H** has a greater potential for take of the covered
 14 invertebrate species than the BDCP Proposed Action because of the greater amounts of tidal and
 15 floodplain restoration.

16 **Take Alternative H** has a greater potential for take of the covered invertebrates than all of the take
 17 alternatives because of the greater amounts of tidal and floodplain restoration.

18 The effects to covered invertebrates from **Take Alternative H** would be offset over time, through
 19 the implementation of the conservation measures.

20 **9.5.8.2 Consistency with BDCP Goal**

21 **Take Alternative H** is consistent with the BDCP overall goal to provide “a comprehensive
 22 conservation strategy for the Sacramento-San Joaquin River Delta designed to restore and protect
 23 ecosystem health, water supply and water quality within a stable regulatory framework.”
 24 Conservation components under **Take Alternative H** would be similar to those for the BDCP
 25 Proposed Action, but the area restored would be increased: tidal natural communities restoration
 26 (CM4) would increase from 65,000 acres to 75,000 acres (a 15% increase, consisting of an estimated
 27 63,000 acres of subtidal and intertidal habitat and 12,000 acres of upland transitional habitat to
 28 account for sea level rise); seasonally inundated floodplain restoration (CM5) would increase from
 29 10,000 acres to 20,000 acres (100% increase); and linear miles of channel margin enhancement
 30 (CM6) would increase from 20 linear miles to 40 linear miles (100% increase). Restoration of these
 31 natural communities would also increase the effects on terrestrial species or other uses that
 32 currently rely on the existing habitat, such as the Swainson’s hawk, the giant garter snake and the
 33 greater sandhill crane and agricultural uses. However, mercury, organic carbon, and pesticide
 34 concentrations in the aquatic environment are predicted to be higher than the BDCP proposed
 35 project.

36 In summary, **Take Alternative H** would provide a higher level of ecosystem restoration, and the
 37 same level of water supply as the BDCP Proposed Action.

1 **9.5.8.3 Practicability**

2 **9.5.8.3.1 Cost**

3 The cost and benefits of **Take Alternative H** are similar to **Take Alternative G** (Appendix 9.A,
4 *Economic Benefits of the BDCP and Take Alternatives*). Therefore, **Take Alternative H** is practicable
5 from a cost standpoint.

6 **9.5.8.3.2 Logistics**

7 Obtaining and accessing lands and other resources necessary to implement **Take Alternative H**
8 would not be logistically practicable for the reasons described below. Under **Take Alternative H**,
9 sufficient land suitable for this amount of habitat restoration does not exist within the Plan Area due
10 to existing and foreseeable constraints associated with climate, streamflow, and land suitability (e.g.,
11 elevation and soils). As such, a take alternative that proposes 75,000 acres of tidal habitat
12 restoration (consisting of an estimated 63,000 acres of subtidal and intertidal habitat and 12,000
13 acres of upland transitional habitat to account for sea level rise) and 20,000 acres of inundated
14 floodplain restoration is not practicable.

15 The BDCP Steering Committee established a tidal habitat restoration target of 65,000 acres because
16 1) it can be reasonably achieved based on the extent and estimated availability of lands that were
17 rated with moderate or high suitability for tidal habitat restoration, and 2) it restores enough tidal
18 natural communities historically present in Delta to mitigate for the impacts of the covered activities
19 and contribute to the recovery of the covered species (Appendix 3.A, *Background on the Process of*
20 *Developing the BDCP Conservation Measures*).

21 Locations suitable for tidal habitat restoration are primarily cultivated land or grasslands. Restoring
22 a larger proportion of the Delta than 65,000 acres as tidal natural communities would interfere
23 more with existing beneficial land uses including existing communities and critical infrastructure
24 such as major roads, pipelines, gas fields, transmission lines, and railroads (Delta Habitat
25 Conservation and Conveyance Program 2012; Appendix 3.A, *Background on the Process of*
26 *Developing the BDCP Conservation Measures*). Furthermore, hydrodynamic and physical modeling
27 (Appendix 3.A, *Background on the Process of Developing the BDCP Conservation Measures*; and Delta
28 Habitat Conservation and Conveyance Program 2012) indicates that 65,000 acres of tidal natural
29 communities and associated upland transition area is at or near the limit of what is physically and
30 logistically feasible in the Plan Area due to:

- 31 ● Parcel size (areas with many small parcels are not feasible to acquire due to the large number of
32 individual landowners).
- 33 ● Surface elevation suitable for restoration of intertidal areas (e.g., much of the central Delta has
34 subsided more than 10-15 feet below mean sea level and could only be restored to subtidal
35 zones with substantial fill).
- 36 ● Location of suitable areas for tidal natural community restoration (e.g., restoration in the east
37 Delta has limited to no benefits for covered fish because the species do not occur there).

38 As a result of these physical and land use constraints, increasing restoration of tidal natural
39 communities and associated upland transitional areas to 75,000 acres is therefore considered not
40 practicable.

1 The primary opportunities for increasing floodplain habitats would involve setting back levees along
 2 Old, Middle, and San Joaquin Rivers. Restoration of 10,000 acres of seasonally inundated floodplain
 3 could be accommodated in this area by setting back levees by up to approximately 1,500 feet on
 4 each side of these river channels. The extent of setback could be reduced or increased by either
 5 increasing or decreasing the length of levees that are set back. However, increasing the extent of
 6 restored floodplain was not deemed practicable because of insufficient flood flows. Flow needed to
 7 inundate twice the floodplain area would likely only occur at very low frequencies thus resulting in a
 8 minimal increase in benefits for covered fish species (Appendix 3.A, *Background on the Process of*
 9 *Developing the BDCP Conservation Measures*). As a result, although the setback area could be
 10 increased the additional investment and land use conversion would result in minimal additional
 11 ecological benefits because it would be rarely inundated.

12 Based on these considerations, **Take Alternative H** is considered not logistically practicable.

13 **9.5.8.3 Technology**

14 **Take Alternative H** would be technologically practicable; it meets the AKART standard. Technology
 15 used for **Take Alternative H** would be the same as the BDCP Proposed Action.

16 **9.5.8.4 Other Environmental Consequences**

17 There are two resource areas for which other environmental consequences would occur under **Take**
 18 **Alternative H**. For one of the two resource areas, the other environmental consequences are the
 19 same as under the BDCP Proposed Action. For one resource area, **Take Alternative H** would have
 20 additional other environmental consequences.

21 There are three water quality other environmental consequences that would occur under **Take**
 22 **Alternative H** that would not occur under the BDCP Proposed Action.

- 23 ● Effects on mercury concentrations resulting from facilities operations and maintenance (CM1).
 24 Increases in fish tissue mercury concentrations are substantial, and changes in fish tissue
 25 mercury concentrations would make existing mercury-related impairment in the Delta
 26 measurably worse than from BDCP implementation. This alternative would increase levels of
 27 mercury by frequency, magnitude, and geographic extent such that the affected environment
 28 would be expected to have measurably higher body burdens of mercury in aquatic organisms,
 29 thereby substantially increasing the health risks to wildlife (including fish) or humans
 30 consuming those organisms.
- 31 ● Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to
 32 decrease by as much as 1.4 mg/L, while long-term average DOC concentrations for some Delta
 33 interior locations, including Franks Tract, Rock Slough and Contra Costa PP No. 1, are predicted
 34 to increase by as much as 1.0 mg/L. The resultant substantial changes in long-term average DOC
 35 at these Delta interior locations could necessitate changes in water treatment plant operations
 36 or require treatment plant upgrades in order to maintain BDCP compliance, and thus would
 37 constitute an adverse effect on water quality and MUN beneficial uses.
- 38 ● Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1).
 39 Modeled increases in San Joaquin River fraction at Buckley Cove, Franks Tract, Rock Slough, and
 40 Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of
 41 pesticide-related water quality degradation and related toxicity to aquatic life in the Delta.

1 9.5.8.5 Conclusions

2 **Take Alternative H** is consistent with the overall goal of the BDCP. Water supply reliability would
3 be the same as the BDCP Proposed Action, but this take alternative would provide an increased level
4 of ecosystem restoration.

- 5 ● **Take Alternative H** would not be practicable, based on the following conclusions.
 - 6 ○ The cost and benefits of **Take Alternative H** are similar to **Take Alternative G**. Therefore,
7 **Take Alternative H** is practicable from a cost standpoint.
 - 8 ○ **Take Alternative H** would not be practicable from a logistical perspective. The increased
9 acreage of tidal natural community restoration would not be feasible due to physical, land
10 use, and other logistical constraints. In addition, doubling inundated floodplain restoration
11 would not be practicable because the additional floodplain would rarely be inundated,
12 resulting in minimal additional ecological benefits to aquatic species with substantial
13 additional cost.
 - 14 ○ **Take Alternative H** would be practicable from a technological perspective. It meets the
15 AKART standard.
- 16 ● **Take Alternative H** would have increased levels of take, based on the following conclusions.
 - 17 ○ It would provide more conservation benefit to fish species as a result of increased habitat
18 restoration, with reduced incidental take for all 11 covered fish species.
 - 19 ○ It would result in lower entrainment, impingement, and predation of aquatic species.
 - 20 ○ It would have a greater potential for take on 21 of the covered terrestrial wildlife species
21 because of more tidal natural communities restoration, and not measurably different for one
22 wildlife species.
 - 23 ○ Higher levels of tidal habitat restoration (15% more than the BDCP Proposed Action),
24 floodplain restoration (100% more), and channel margin enhancement (100% more) would
25 result in a higher level of conservation benefit to covered fish species, the brush rabbit,
26 riparian woodrat valley elderberry longhorn beetle, least Bell's vireo, Swainson's hawk,
27 western yellow-billed cuckoo, white-tailed kite, yellow breasted chat, and California black
28 rail.
- 29 ● **Take Alternative H** would result in three other environmental consequences associated with
30 water quality:
 - 31 ○ Existing mercury-related impairment in the Delta would be measurably worse than from
32 implementation of the BDCP Proposed Action.
 - 33 ○ It would result in substantial changes in long-term average DOC at Delta interior locations
34 (including Franks Tract, Rock Slough and Contra Costa PP No. 1) and could necessitate
35 changes in water treatment plant operations or require treatment plant upgrades in order
36 to maintain BDCP compliance.
 - 37 ○ It would have a long-term risk of pesticide-related water quality degradation and related
38 toxicity to aquatic life in the Delta due to modeled increases in San Joaquin River fraction at
39 Buckley Cove, Franks Tract, Rock Slough, and Contra Costa PP No. 1.

1 **9.5.9 Take Alternative I: Modified Spring Outflow**

2 **Take Alternative I: Modified Spring Outflow** would involve construction of a dual conveyance
3 facility with a pipelines and tunnels alignment and three intakes. The capacity of the conveyance
4 facility would be 9,000 cfs. **Take Alternative I** differs from the BDCP in that it assumes the spring
5 outflow criteria is fixed at 44,500 cfs for March, April, and May in 50% of years.

6 **9.5.9.1 Effects on Covered Species**

7 **9.5.9.1.1 Covered Fish**

8 **Construction**

9 The construction activities associated with **Take Alternative I** are the same as the BDCP Proposed
10 Action, including the same intakes, barge landings, a pipelines and tunnels alignment, and the same
11 amount of habitat restoration. Therefore, no measurable differences in construction effects would
12 occur for the various covered fish species, between **Take Alternative I** and the BDCP Proposed
13 Action (Table 9-10, and Table 9-14 through Table 9-21).

14 **Maintenance**

15 As with the construction activities, the maintenance activities would be about the same for **Take**
16 **Alternative I** as the BDCP Proposed Action.

17 **Operations**

18 **Take Alternative I** would follow a similar operational scenario as the BDCP Proposed Action,
19 including the Fall X2 decision tree process, except that it would provide an additional 9,500 cfs of
20 flow in the spring for March, April, and May in 50% of years intended to achieve the longfin smelt
21 abundance objectives of the BDCP. Average annual early long-term exports (4.34 MAF) under Take
22 Alternative I would be less than the BDCP Proposed Action (between 4.71 and 5.59 MAF). **Take**
23 **Alternative I** would provide 49% of the average annual water exports through the south Delta
24 facilities, compared to 51% for the BDCP Proposed Action.

25 **Take Alternative I** would have similar effects on covered fish in the Plan Area as the BDCP
26 Proposed Action except for additional flow-related conservation benefits to longfin smelt and other
27 species migrating downstream in the spring. In addition to providing higher flows to benefit longfin
28 smelt, **Take Alternative I** would meet the south Delta entrainment criteria, seasonal delta smelt
29 outflow criteria, but would not consistently meet all of the salmonid flow criteria. Failure to meet
30 these criteria would primarily be due to the additional water needing to be released from upstream
31 reservoirs, to satisfy the modified spring outflow criteria, resulting in substantial reductions in fall
32 (September) storage levels in Folsom, Trinity, and Oroville reservoirs. A slight reduction would also
33 occur in the Shasta Reservoir September storage, although not to the point of worsening the Shasta
34 cold water pool RPA baseline. These reservoir releases would increase spring flows in American,
35 Feather, and Trinity Rivers, but decrease summer and fall flows, thereby potentially adversely
36 affecting juvenile winter-run Chinook salmon and sturgeon.

1 **9.5.9.1.2 Covered Mammals**

2 Implementation of the conservation measures under **Take Alternative I**, including CM1 would have
 3 the same effect to modeled habitat for covered mammal species as the BDCP Proposed Action (Table
 4 9-22).

5 **9.5.9.1.3 Covered Birds**

6 Implementation of the conservation measures under **Take Alternative I**, including CM1 would have
 7 the same effect to modeled habitat for covered bird species as the BDCP Proposed Action (Table
 8 9-23).

9 **9.5.9.1.4 Covered Reptile and Amphibians**

10 Implementation of the conservation measures under **Take Alternative I**, including CM1 would have
 11 the same effect to modeled habitat for covered reptiles and amphibian species as the BDCP
 12 Proposed Action (Table 9-24).

13 **9.5.9.1.5 Covered Invertebrates**

14 Implementation of the conservation measures under **Take Alternative I**, including CM1 would have
 15 the same effect to modeled habitat for covered invertebrates species as the BDCP Proposed Action
 16 (Table 9-25).

17 **9.5.9.2 Consistency with BDCP Goal**

18 **Take Alternative I** is not consistent with the BDCP overall goal to provide “a comprehensive
 19 conservation strategy for the Sacramento-San Joaquin River Delta designed to restore and protect
 20 ecosystem health, water supply and water quality within a stable regulatory framework.” The
 21 defined geographic scope of BDCP is limited to the statutory Delta, Suisun Marsh, and Yolo Bypass.
 22 **Take Alternative I** would substantially change the boundary of the Plan Area by requiring
 23 substantial changes in operations of the Shasta, Trinity, Folsom, and Oroville reservoirs to satisfy
 24 spring outflow requirements. As such, take authorization would be required for the additional
 25 actions related to significant change to reservoir operations, which would have the effect of greatly
 26 expanding the regulatory scope and purpose of the BDCP.

27 In addition to expanding the scope of the BDCP, **Take Alternative I** would adversely affect water
 28 quality and other beneficial uses. High spring releases under Take Alternative I would result in
 29 reduced long-term storage which has the potential to affect cold water pool and flow conditions in
 30 drier years. For example, changes in Trinity River storage can have long-term effects on Trinity
 31 River flow, and may conflict with the Record of Decision for the Trinity River Mainstem Fishery
 32 Restoration Final Environmental Impact Statement / Environmental Impact Report (U.S.
 33 Department of Interior 2000), intended to restore fisheries to the Trinity River. Satisfying the spring
 34 outflow criteria of this take alternative would increase spring flows in the American, Feather, and
 35 Trinity Rivers, substantially reduce summer flows, and reduce long--term storage in these
 36 reservoirs. The reduced storage would result in more difficult cold-water pool management in the
 37 Feather and Lower American Rivers. Under **Take Alternative I**, substantial reductions in summer
 38 Trinity River and Feather River flows, and moderate reductions in American River flows, would
 39 result in elevated water temperatures in these rivers in the summer and early fall, negatively

1 affecting several covered fish species (e.g., winter-run steelhead and sturgeon). These unacceptable
2 adverse effects to covered fish outside the Delta are inconsistent with the overall BDCP goal.

3 **9.5.9.3 Practicability**

4 **9.5.9.3.1 Cost**

5 Relative to the Existing Conveyance High-Outflow Scenario, **Take Alternative I** would reduce the
6 frequency and magnitude of water shortages, reduce the need to invest in water supply alternatives,
7 reduce operations costs including energy costs of water conveyance and distribution, improve water
8 quality, and reduce seismic risk. **Take Alternative I** would not be practicable from a cost
9 standpoint.

10 The total cost of **Take Alternative I** would be a present value of \$13.5 billion, which is the same as
11 the total cost of the BDCP Proposed Action (Appendix 9.A, *Economic Benefits of the BDCP and Take*
12 *Alternatives*). **Take Alternative I** would result in mean annual project water deliveries at the early
13 long-term (ELT) of 4.34 MAF for the state and federal contractors south of the Delta. This figure is
14 0.89 MAF more than the mean yield of 3.45 MAF in the Existing Conveyance High-Outflow Scenario.
15 Increased Delta exports would result in smaller and less frequent water supply shortages
16 experienced by urban and agricultural water users. Relative to the Existing Conveyance High-
17 Outflow Scenario, **Take Alternative I** would reduce the amount of agricultural groundwater
18 pumping, resulting in less dry-year fallowing, and would impact operations costs in both the urban
19 and agricultural sectors.

20 **Take Alternative I** would reduce seismic risks and improve water quality relative to the Existing
21 Conveyance High-Outflow Scenario. With a 9,000 cfs isolated conveyance facility, post-earthquake
22 water supplies could be maintained at a level of 3.8 MAF. Mean water supplies following an
23 earthquake in the Existing Conveyance High-Outflow Scenario are 1.0 MAF.

24 With respect to water quality, 51% of state and federal project supplies would originate in the north
25 Delta (as compared to 49% for the BDCP Proposed Action). As a result, project water deliveries
26 would be less saline under **Take Alternative I** than under the Existing Conveyance High-Outflow
27 Scenario.

28 The total benefits of **Take Alternative I** would be \$13.4 billion, as compared to costs of \$13.5
29 billion. Thus **Take Alternative I** would result in net losses of \$0.1 billion. This take alternative is not
30 practicable from a cost standpoint.

31 **9.5.9.3.2 Logistics**

32 Obtaining and accessing sufficient appropriate lands and other resources necessary to implement
33 **Take Alternative I** would be logistically practicable. **Take Alternative I** would not require
34 assembly of conservation reserves at a spatial scale that would conflict with urban lands or existing
35 utilities. Sufficient land suitable for habitat restoration exists within the Plan Area.

36 **9.5.9.3.3 Technology**

37 **Take Alternative I** would be practicable from a technological perspective. Technology used for
38 **Take Alternative I** would be the same as for the BDCP Proposed Action.

1 **9.5.9.4 Other Environmental Consequences**

2 There are four resource areas for which other environmental consequences would occur under
 3 **Take Alternative I**. One would be the same as under the BDCP Proposed Action. **Take Alternative I**
 4 would substantially reduce flows in the Trinity River and Feather River, and cause moderate
 5 reductions in American River flows. These flow reductions would likely result in elevated water
 6 temperatures in the summer and early fall. Also, reduction in Trinity Reservoir storage could have
 7 harmful outcomes for fish in the Trinity River from reduced summer and fall flows. These adverse
 8 physical effects could adversely affect other native species (not covered species) in these river
 9 reaches. In addition water quality upstream of the Delta is expected to be adversely affected by
 10 **Take Alternative I**. Additional adverse effects from changes in operations of Trinity, Shasta, Folsom,
 11 and Oroville could result to energy resources (e.g., from losses of hydroelectric generating potential)
 12 and recreation (e.g., from reductions in reservoir levels in the spring instead of in the summer),
 13 although the extent and timing of these effects are unknown.

14 **9.5.9.5 Conclusions**

15 **Take Alternative I** is not consistent with the overall goal of the BDCP. **Take Alternative I** would
 16 change the boundary of the Plan area beyond the defined geographic scope of BDCP, by relying on
 17 the reservoir capacity of Shasta, Trinity, Folsom, and Oroville reservoirs. **Take Alternative I** would
 18 also result in elevated water temperatures in the Trinity, Shasta, and American rivers during the
 19 summer and early fall. As a result, **Take Alternative I** would not satisfy the BDCP goal to restore
 20 and protect water quality.

- 21 ● **Take Alternative I** would not be practicable, based on the following conclusions.
 - 22 ○ The total benefits of **Take Alternative I** would be \$13.4 billion, as compared to costs of
 - 23 \$13.5 billion. Thus, **Take Alternative I** would result in net losses of \$0.1 billion and is not
 - 24 practicable from a cost standpoint because benefits would not exceed costs.
 - 25 ○ **Take Alternative I** would be practicable from a logistical perspective. Restoration targets
 - 26 are the same as under the BDCP Proposed Action.
 - 27 ○ **Take Alternative I** would be practicable from a technological perspective. It meets the
 - 28 AKART standard.
 - 29 ● **Take Alternative I** would result in increased conservation benefits for some aquatic species in
 - 30 the Plan Area, relative to the BDCP Proposed Action, due to the increased flows during the
 - 31 spring, which would provide the following benefits.
 - 32 ○ Increased conservation benefits for five covered fish species, due to increased flows and
 - 33 reduced entrainment, impingement, and predation of aquatic species occurring near the
 - 34 intake sites.
 - 35 ○ No measurable differences in take are expected for any of the 27 covered terrestrial wildlife
 - 36 or aquatic species, within the Plan Area
 - 37 ○ Increased rearing habitat in the Delta due to increased spring inundation.
 - 38 ● Despite the benefits provided to fish occurring in the Plan Area from the fixed spring flows
 - 39 described above, **Take Alternative I** would result in changes to upstream reservoir operations.
 - 40 These changes are expected to increase the take of a number of fish species, including some
 - 41 covered fish species, which occur in the Plan Area during other times of the year.

- 1 • **Take Alternative I** would result in other environmental consequences different than the BDCP
 2 Proposed Action including water quality, other species, and potentially energy resources and
 3 recreation.

4 9.6 Summary

5 This chapter provides an assessment of alternatives to the BDCP Proposed Action that may reduce
 6 take of the covered fish and wildlife species, and an explanation of why those alternatives were not
 7 selected. Nine take alternatives, labeled A through I, were developed to include a range of
 8 approaches to advance the Plan’s overall goal to provide “a comprehensive conservation strategy for
 9 the Sacramento-San Joaquin River Delta designed to restore and protect ecosystem health, water
 10 supply and water quality within a stable regulatory framework.” The take alternatives are similar to
 11 but not the same as many of the EIR/EIS alternatives. These nine take alternatives vary in terms of
 12 the design and capacity of the new water conveyance facility, water operations, and the amount of
 13 restoration. The take alternatives were designed to vary in as few ways as possible from the BDCP
 14 Proposed Action to facilitate comparisons.

15 The nine take alternatives are evaluated against the following five primary criteria:

- 16 1. Does the take alternative reduce take of covered species?
- 17 2. Does the take alternative increase conservation benefit to covered species?
- 18 3. Is the take alternative consistent with the BDCP overall goal?
- 19 4. Is the take alternative practicable in terms of water contractor costs, logistics, and technical
 20 feasibility?
- 21 5. Are there additional significant and unavoidable adverse effects to other resources?

22 Details of these criteria are described in Section 9.3, *Methods of Analysis*. Summaries of the results of
 23 this analysis are presented in Table 9-31, Table 9-32, and Table 9-33.

24 **Take Assessment. Take Alternatives G and I** reduce take of covered fish and wildlife species
 25 without increasing take of other covered species. **Take Alternative D** reduces take for the greatest
 26 number of species (22) because of the reduction in tidal natural community restoration. However,
 27 that take alternative also increases incidental take of 8 covered fish species and reduces the
 28 conservation benefits to covered fish species from the reduced habitat restoration. **Take**
 29 **Alternative I** may increase conservation benefit to five of the covered fish species within the Plan
 30 Area due to its spring outflow requirements, although the expected reductions in subsequent
 31 summer and fall flows could increase the take of several covered species, including juvenile winter-
 32 run Chinook salmon and sturgeon. All other take alternatives increase take of some covered fish and
 33 wildlife species and decrease take of others.

34 **Consistency with Overall BDCP Goal. Take Alternatives A, B, C, and H** are generally consistent
 35 with the overall goal to protect and restore ecosystem health, water supply, and water quality
 36 within a stable regulatory framework. **Take Alternatives A, B and C** would satisfy the overall goal
 37 less effectively than the BDCP Proposed Action, but for the purpose of this analysis are nonetheless
 38 considered to be consistent with the goal. **Take Alternatives D, E, F, G, and I** are not consistent with
 39 the overall goal of the BDCP. **Take Alternatives D and G** would not be consistent with the overall
 40 goal because they would provide reduced levels of tidal natural community restoration. **Take**

1 **Alternative E** is not consistent with the goal of BDCP because it would provide less water than the
 2 existing conveyance scenario. **Take Alternative F** is not consistent with the goal of BDCP because it
 3 does not increase water supply reliability relative to the existing condition scenario and because the
 4 level of incidental take would increase for all covered fish species. **Take Alternative I** is not
 5 consistent with the geographic scope or the range of covered activities addressed by the BDCP, and
 6 it would not satisfy the portion of the overall goal related to restoring and protecting water quality,
 7 due to elevated water temperatures in some areas upstream of the Plan Area.

8 **Practicability.** **Take Alternatives A, C, and G** are practicable based on the analysis of cost relative
 9 to benefits, logistics, and technology. **Take Alternatives B, D, E, and I** are not practicable based on
 10 the analysis of cost relative to benefits. **Take Alternative H** is impracticable due to logistics: the
 11 increased acreage targets for tidal natural community restoration and inundated floodplain are
 12 considered not feasible. **Take Alternative F** was deemed impracticable due to technical
 13 infeasibility.

14 **Other Environmental Consequences.** Only **Take Alternatives B, and D** have no additional
 15 significant and unavoidable adverse effects on other resources. All of the remaining take alternatives
 16 have at least one additional significant and unavoidable adverse effects on other resources,
 17 compared to the BDCP Proposed Action. For example, **Take Alternative A** has substantial additional
 18 adverse effects on air quality and greenhouse gas emissions due to substantially greater
 19 construction needs. **Take Alternative A and B** have adverse effects on rearing habitat for non-
 20 covered aquatic species of primary management concern. **Take Alternatives E, F, H, and I** have
 21 additional adverse effects on water quality either within or outside the Plan Area, and **Take**
 22 **Alternative F** has additional adverse effects on recreation. **Take Alternative I** also has additional
 23 potential adverse effects on recreation and hydropower generation in some upstream reservoirs,
 24 and potentially on water supply north of the Delta.

25 **Summary by Take Alternative.** A summary of the analysis by take alternative is provided below
 26 and in Table 9-31, Table 9-32, and Table 9-33.

27 **Take Alternative A** would increase the levels of incidental take of 10 covered fish species and 18
 28 covered wildlife species, although it would also reduce the level of incidental take of 4 other covered
 29 wildlife species, compared with the BDCP Proposed Action (Table 9-31). While **Take Alternative A**
 30 would provide a higher level of water supply reliability than the BDCP Proposed Action, it would
 31 provide a lower level of ecosystem protection and restoration for aquatic species due to the
 32 increased number and size of facilities in the North Delta relative to the BDCP Proposed Action. In
 33 addition to increasing the take of a number of fish and wildlife species, **Take Alternative A** would
 34 not result in a measurable increase in conservation benefits compared to the BDCP Proposed Action.

35 **Take Alternative A** would be practicable on the basis of cost, logistics and technology (Table 9-32
 36 and Table 9-33). **Take Alternative A** would exceed three air quality and greenhouse gas emissions
 37 thresholds during construction and operations, resulting in significant adverse and unavoidable
 38 effects, and would have adverse effects on rearing habitat for non-covered aquatic species of
 39 primary management concern. (Table 9-33). Overall, **Take Alternative A** would increase take for 28
 40 covered fish and wildlife species, in some cases substantially. For this reason, it was not selected as
 41 the proposed action.

42 **Take Alternative B** would result in increased levels of incidental take of 8 covered fish species and
 43 4 covered terrestrial species, although it would also reduce the level of incidental take of 2 other
 44 covered fish and 12 other covered terrestrial species, compared with the BDCP Proposed Action

1 (Table 9-31). **Take Alternative B** would convey less water from the north Delta (two intakes
 2 instead of three and different operating criteria), than the BDCP Proposed Action, and would rely
 3 more heavily on south Delta intakes. **Take Alternative B** would result in a lower potential for
 4 construction effects than the BDCP Proposed Action, with about 30% less pile driving, dredging, and
 5 aquatic habitat alteration associated with construction of CM1 than the BDCP Proposed Action.
 6 However, due to the increased reliance on the south Delta intakes, **Take Alternative B** would result
 7 in greater take from increased risk of entrainment, impingement, and predation associated with the
 8 greater reliance on south Delta intakes. **Take Alternative B** would not result in a measurable
 9 change in conservation benefits compared to the BDCP Proposed Action.

10 **Take Alternative B** would not be practicable on the basis of cost since contractor benefits exceed
 11 costs, but not by a margin sufficient to meet the standards of cost practicability. This alternative
 12 would be practicable on the basis of logistics, and technology (Table 9-32 and Table 9-33). The other
 13 environmental consequences are similar to the BDCP Proposed Action, except for fewer water
 14 quality and hydrodynamic improvements because of heavier reliance on south Delta intakes (Table
 15 9-33). Overall, **Take Alternative B** is consistent with the goal of BDCP, although it may provide a
 16 lower level of water supply reliability than the BDCP Proposed Action and also a lower level of
 17 ecosystem restoration for aquatic species. Overall, **Take Alternative B** increases take for 12
 18 covered fish and wildlife species and does not provide any additional conservation benefit. In
 19 addition, project deliveries would be lower than the BDCP Proposed Action and it would not be
 20 practicable from a cost standpoint. For these reasons, it was not selected as the proposed action.

21 **Take Alternative C** would result in increased levels of incidental take for 10 covered fish species
 22 and 4 covered wildlife species compared with the BDCP Proposed Action (Table 9-31). This
 23 increased take results from more construction impact in and adjacent to the Sacramento River. **Take**
 24 **Alternative C** could require about 79% more in-water construction activities (pile driving,
 25 dredging, and riparian disturbance area) and greater upland disturbance areas, associated with a
 26 greater number of intakes than the BDCP Proposed Action. Finally, **Take Alternative C** would not
 27 result in a measurable increase in conservation benefits compared to the BDCP Proposed Action.

28 **Take Alternative C** is consistent with the goal of BDCP: It would provide a higher level of water
 29 supply reliability than the BDCP Proposed Action but a lower level of ecosystem protection and
 30 restoration for aquatic species (Table 9-33). **Take Alternative C** would be practicable on the basis
 31 of cost, logistics, and technology (Table 9-32 and Table 9-33). The other environmental
 32 consequences are similar to the BDCP Proposed Action except **Take Alternative B** would have
 33 adverse effects on rearing habitat for non-covered aquatic species of primary management concern.
 34 Overall, **Take Alternative C** increases take for 14 covered fish and wildlife species, in some cases
 35 substantially, and does not reduce take of any covered species. For this reason, it was not selected as
 36 the proposed action.

37 **Take Alternative D** would result in higher levels of incidental take for 8 covered fish species but a
 38 decrease in the amount of take of two covered fish species and 20 covered wildlife species, relative
 39 to the BDCP proposed actions (Table 9-31). **Take Alternative D** could require about 70% less in-
 40 water construction activities (pile driving, dredging, and riparian disturbance area) and less upland
 41 disturbance areas, than the BDCP Proposed Action, resulting in less construction effects. With two
 42 fewer intakes than the BDCP Proposed Action, **Take Alternative D** would result in a lower level of
 43 north Delta diversion capacity and 21% greater reliance on the south Delta intakes, on average
 44 (72% vs. 51% south Delta diversion for the BDCP Proposed Action). The increased level of take of
 45 covered fish species would result from increased risk of entrainment, impingement, and predation
 46 associated with the greater reliance on south Delta intakes. In addition, **Take Alternative D** would

1 reduce the overall conservation benefits compared to the BDCP Proposed Action because it would
2 have 38% less tidal natural community restoration. Tidal natural community restoration would be
3 reduced from 65,000 acres to 40,000 acres (including an estimated 34,000 acres of subtidal and
4 intertidal habitat and 6,000 acres of upland transitional habitat). This reduced amount would not
5 meet the restoration target for this natural community type, and would provide fewer overall
6 ecosystem benefits to fish and terrestrial species than the BDCP Proposed Action (Table 9-32).
7 Water quality improvements in the south Delta would be less than the BDCP Proposed Action
8 because of heavier reliance on south Delta intakes.

9 **Take Alternative D** would result in net losses of \$1.1 billion and is therefore not practicable from a
10 cost standpoint (Table 9-32 and Table 9-33). In addition, **Take Alternative D** is not consistent with
11 the overall goal of the BDCP due to reduced tidal natural community restoration. Therefore, this take
12 alternative would reduce water supply reliability and would likely fail to provide the maximum level
13 of mitigation practicable as required by ESA Section 10. (Table 9-32 and Table 9-33). Other
14 environmental consequences would be the same or similar for **Alternative D** as the BDCP Proposed
15 Action. Overall, **Take Alternative D** increases the level of incidental take of eight covered fish
16 species, provides less conservation benefit, is inconsistent with the overall goal of BDCP, and is not
17 practicable from a cost standpoint. For these reasons, **Take Alternative D** was not selected as the
18 proposed action.

19 **Take Alternative E** would result in higher levels of take of 2 covered fish and 4 covered wildlife
20 species and it would reduce take of 9 covered fish species relative to the BDCP Proposed Action
21 (Table 9-31). In addition, **Take Alternative E** would not result in a measurable increase in
22 conservation benefits compared to the BDCP Proposed Action. **Take Alternative E** could require
23 about 79% more in-water construction activities (pile driving, dredging, and riparian disturbance
24 area) and greater upland disturbance areas, associated with the increased number of intakes, than
25 the BDCP Proposed Action (Table 9-5). Eliminating south Delta pumping would eliminate the
26 associated levels of entrainment, impingement, and predation and the associated incidental take of
27 covered fish species in that location. The reduction in take in the south Delta may be offset by a
28 potential increase in impingement and predation due to the larger facility in the north Delta.

29 **Take Alternative E** would provide annual water deliveries 1.31 MAF lower than the BDCP
30 Proposed Action; slightly lower than the annual water deliveries provided in the Existing
31 Conveyance High-Outflow Scenario (Table 9-32). As a result, Take Alternative E would result in net
32 losses of \$22.9 billion. It would not be practicable from a cost standpoint, and would provide lower
33 water reliability than the BDCP Proposed Action (Table 9-32 and Table 9-33). Furthermore, **Take**
34 **Alternative E** is not consistent with the overall goal of the BDCP because it would provide limited
35 water supply benefits relative to the Existing Conveyance High-Outflow Scenario. **Take Alternative**
36 **E** is also predicted to exceed three water quality thresholds during operations and maintenance,
37 resulting in adverse and unavoidable effects. Overall, **Take Alternative E** is not practicable from a
38 cost standpoint, is not consistent with the goal of BDCP, and is predicted to exceed three water
39 quality thresholds during operations and maintenance. For these reasons **Take Alternative E** was
40 not selected as the proposed action.

41 **Take Alternative F** would result in an increased level of take for all of the covered fish species. Most
42 of the effects would be from construction activities, while the effects on green sturgeon and fall-/late
43 fall-run Chinook are from upstream reservoir operations. Incidental take would be reduced for 9
44 covered wildlife species and increased for 8 covered wildlife species compared to the BDCP
45 Proposed Action (Table 9-31). **Take Alternative F** would have a substantially greater in-water
46 construction footprint and dredging requirements than the BDCP Proposed Action, resulting in

1 substantially greater potential for effects. The longer fish screens at the diversion structures,
2 compared to the north Delta intake screens for the BDCP Proposed Action, are expected to result in
3 an increase in entrainment, impingement and predation levels. **Take Alternative F** would also not
4 result in a measurable increase in conservation benefits compared to the BDCP Proposed Action.

5 **Take Alternative F** is not consistent with the overall BDCP goal, it would not protect water supply
6 from flooding and seismic risk and would increase levels of incidental take of covered fish species.

7 **Take Alternative F** would be practicable from a cost standpoint, allowing greater exports than the
8 Existing Conveyance High-Outflow Scenario and providing benefits to agricultural and urban
9 contractors that are likely to be in excess of capital and operations costs (Table 9-32 and Table
10 9-33). However, it would not be technically feasible due to the large size of screens used. **Take**
11 **Alternative F** would also exceed four water quality thresholds during operations and maintenance,
12 resulting in unavoidable adverse effects and would permanently displace existing well-established
13 public use or private commercial recreation facility available for public access as a result of the
14 location of the proposed water conveyance facilities. Overall, **Take Alternative F** is not practicable
15 from a technical perspective, is not consistent with the goal of BDCP, would increase take of all
16 covered fish species and 8 terrestrial species and is predicted to result in adverse water quality
17 effects. For these reasons, **Take Alternative F** was not selected as the proposed action.

18 **Take Alternative G** would result in the same level of incidental take of aquatic species as the BDCP
19 Proposed Action, but a reduced level of conservation benefit to these species. The level of incidental
20 take would be reduced for 20 covered wildlife species compared to the BDCP proposed actions with
21 no increase in take (Table 9-31). Water supply reliability under **Take Alternative G** would be the
22 same as the BDCP Proposed Action, but this take alternative would provide a reduced level of
23 ecosystem restoration and associated benefits. As a result, it is not consistent with the overall goal of
24 the BDCP and would fail to provide the maximum level of mitigation practicable (Table 9-33).

25 **Take Alternative G** would be practicable on the basis of cost, logistics, and technology, allowing the
26 same level of project exports and net economic benefits as the BDCP Proposed Action (Table 9-32
27 and Table 9-33). Overall, **Take Alternative G** is not consistent with the goal of BDCP, would provide
28 a reduced level of ecosystem restoration and would likely fail to provide the maximum level of
29 mitigation practicable. For these reasons, **Take Alternative G** was not selected as the proposed
30 action.

31 **Take Alternative H** would result in reduced levels of incidental take for all covered fish species, but
32 increased take for 21 covered terrestrial species compared to the BDCP Proposed Action (Table
33 9-31). **Take Alternative H** would result in a measurable increase in overall conservation benefits
34 compared to the BDCP Proposed Action, due to the increased level of habitat restoration. **Take**
35 **Alternative H** would provide equivalent water supply reliability but greater levels of ecosystem
36 restoration, compared to the BDCP Proposed Action. In addition to the enhanced water supply
37 reliability afforded by **Take Alternative H**, this alternative also would provide seismic risk
38 reduction and water quality benefits. Therefore, **Take Alternative H** is consistent with the overall
39 BDCP goal.

40 **Take Alternative H** would be practicable from a cost and technology standpoint, but it would not
41 be logistically practicable (Table 9-32 and Table 9-33). The greater amount of tidal natural
42 community restoration in **Take Alternative H** would not be feasible due to physical constraints
43 associated with existing beneficial land uses. In addition, doubling seasonally inundated floodplain
44 restoration would not be practicable because the additional restored floodplain area would rarely
45 be inundated, resulting in minimal additional ecological benefits to aquatic species. **Take**

1 **Alternative H** would also pose greater water quality concerns during construction and operations
2 than the BDCP Proposed Action. Overall, **Take Alternative H** would not be logistically practicable
3 due to the substantial increase in tidal wetland restoration and would increase incidental take of
4 covered wildlife species. For these reasons, **Take Alternative H** was not selected as the proposed
5 action.

6 **Take Alternative I** would have similar effects on covered fish in the Plan Area as the BDCP
7 Proposed Action except for additional flow-related benefits to longfin smelt and salmonids
8 migrating downstream in the spring. This additional spring outflow may increase conservation
9 benefit to five covered fish species as compared to the BDCP Proposed Action within the Plan Area.
10 However, changes in water quality conditions upstream of the Plan Area could increase incidental
11 take of juvenile salmon and sturgeon in upstream areas (Table 9-31). There would be no change in
12 take of covered wildlife species associated with this take alternative.

13 **Take Alternative I** would not be practicable from a cost perspective. The total benefits of **Take**
14 **Alternative I** would be \$13.4 billion, as compared to costs of \$13.5 billion, resulting in net benefits
15 of -\$0.1 billion (2% of cost). Benefits would not exceed costs and therefore the take alternative
16 would not be practicable from a cost perspective (Table 9-32). **Take Alternative I** is not consistent
17 with the overall goal of the BDCP. **Take Alternative I** would change the boundary of the Plan Area
18 beyond the defined geographic scope of the BDCP, by substantially modifying the operations of
19 Shasta, Trinity, Folsom, and Oroville Reservoirs. **Take Alternative I** would also result in elevated
20 water temperatures in the Feather and American Rivers during the summer and early fall. As a
21 result, **Take Alternative I** would not satisfy the BDCP goal to restore and protect water quality.
22 **Take Alternative I** also has additional potential adverse effects on recreation and hydropower
23 generation in some upstream reservoirs, and potentially on water supply north of the Delta. **Take**
24 **Alternative I** is not practicable from a cost perspective and is not consistent with the overall goal of
25 BDCP. For these reasons, **Take Alternative I** was not selected as the proposed action.

26 Based on this assessment, the BDCP Proposed Action would result in the lowest level of incidental
27 take of the covered fish and wildlife species without reducing the benefits to the species. The BDCP
28 Proposed Action is consistent with the overall goal of BDCP. It is also practicable and would
29 minimize other environmental consequences (Table 9-33). The BDCP Proposed Action would also
30 provide the maximum practicable level of impact minimization and mitigation.

1 **Table 9-31. Summary of Take Assessment Relative to the BDCP Proposed Action**

Species Group	Take Alternatives								
	A: W Canal 15,000 cfs	B: Tunnels 6,000 cfs	C: Tunnels 15,000 cfs	D: Tunnels 3,000 cfs	E: Isolated 15,000 cfs	F: Through Delta	G: Less Tidal Restoration	H: More Restoration	I: Fixed spring Outflow
Covered Fish (11 total)									
Increase in take	10	8	10	8	2	11	0	0	0 ^a
Decrease in take	0	2	0	2	9	0	0	11	0 ^b
Covered Mammals (5 total)									
Increase in take	1	2	2	0	2	2	0	4	0
Decrease in take	1	0	0	4	0	1	4	0	0
Covered Birds (11 total)									
Increase in take	8	0	0	0	0	4	0	11	0
Decrease in take	1	9	9	11	9	5	11	0	0
Covered Reptiles and Amphibians (4 total)									
Increase in take	3	2	2	0	2	1	0	3	0
Decrease in take	1	2	2	4	2	3	4	0	0
Covered Invertebrates (7 total)									
Increase in take	6	0	0	0	0	1	0	7	0
Decrease in take	1	1	0	1	0	0	1	0	0
Total Covered Fish and Wildlife Species (38 total)									
Increase in take	28	12	14	8	6	19	0	21	0
Decrease in take	4	14	11	22	20	9	20	11	0
Notes:									
^a Decreased upstream summer and fall flows potentially increase take of juvenile winter-run Chinook salmon and sturgeon.									
^b While there is no expected change in the level of take, five protected fish species are expected to have greater conservation benefit from this take alternative.									

2

1 **Table 9-32. Summary of State and Federal Water Contractor Economic Benefits and Cost Relative to the Existing Conveyance High-**
 2 **Outflow Scenario^a**

	North Delta Facility Size (cfs)	Total Average Annual Water Deliveries (MAF)	Total Benefits ^{a, b}	Total Incremental Cost ^{a, c}	Net Benefits ^a
Take Alternative					
BDCP Proposed Action High-Outflow Scenario	9,000	4.705	\$18,011	\$13,472	\$4,540
BDCP Proposed Action Low-Outflow Scenario ^d	9,000	5.591	\$18,826	\$13,487	\$5,339
A: W Canal 5 Intakes	15,000	5.009	\$23,187	\$11,110	\$12,076
B: Tunnels 2 Intakes	6,000	4.487	\$14,445	\$12,347	\$2,098
C: Tunnels 5 Intakes	15,000	5.009	\$23,187	\$15,641	\$7,545
D: Tunnel 1 Intake	3,000	4.188	\$8,923	\$10,240	-\$1,317
E: Isolated 5 Intakes	15,000	3.399	-\$8,697	\$15,711	-\$24,407
F: Through Delta	N/A ^e	4.172	\$12,060	\$5,233	\$6,826
G: Less Tidal Restoration	9,000	4.705	\$18,011	\$13,432	\$4,579
H: More Restoration	9,000	4.705	\$18,011	\$13,505	\$4,506
I: Modified Spring Outflow	9,000	4.338	\$13,417	\$13,472	-\$55
Analytical Benchmarks: Existing Conveyance Scenarios^f					
Existing Conveyance High-Outflow Scenario	N/A	3.446			
Existing Conveyance Low-Outflow Scenario	N/A	3.889			
Notes:					
<p>^a All values are in millions of 2012 dollars, discounted to present value using 3% real discount rate. Construction is assumed to begin in 2015 with operations assumed to begin in 2025. Cost and benefits are calculated out to year 2075 (10 years past the 50-year permit term).</p> <p>^b Total economic benefits to the state and federal water contractors (see Appendix 9.A, <i>Economic Benefits of the BDCP and Take Alternatives</i>, for details). Values exclude additional economic benefits to the public at large, described in the BDCP Statewide Economic Impact Report.</p> <p>^c Total incremental cost to the state and federal water contractors excludes costs that would be expected without BDCP. Examples include the 8,000 acres of tidal wetland restoration required by the USFWS 2008 BiOp. See Appendix 9.B, <i>Take Alternative Cost Estimation</i>, for details.</p> <p>^d Benefits for the BDCP Proposed Action Low-Outflow Scenario are calculated relative to the Existing Conveyance Low-Outflow Scenario, which assumes Scenario 6 operations, no Fall X2, no north Delta diversions.</p> <p>^e Two 7,500 cfs diversions would be constructed in the North Delta: one each at the Delta Cross Channel and Georgiana Slough.</p> <p>^f Existing Conveyance High-Outflow and Low-Outflow Scenarios are applied only to the cost practicability test for the purposes of the cost comparison. See methods section for details and definitions.</p> <p>cfs = cubic feet per second; MAF = million acre-feet</p>					

3

1 **Table 9-33. Summary of Take Alternative Assessment**

Take Alternative ^a	Reduces Take of Some Covered Species Without Increasing Take of Others?	Increases Conservation Benefit to Some Covered Species Without Decreasing Benefits to Others? ^{c,d}	Consistent with BDCP Overall Goal? ^e	Practicability Assessment			No Additional Significant Unavoidable Adverse Effects? ^g
				Do Water Contractor Benefits Exceed Cost? ^f	Logistically Feasible?	Technically Feasible?	
BDCP Proposed Action	N/A	N/A	Yes	Yes	Yes	Yes	N/A
A: W Canal 15,000 cfs	No	N/C	Yes	Yes	Yes	Yes	No
B: Tunnels 6,000 cfs	No	N/C	Yes	No	Yes	Yes	Yes
C: Tunnels 15,000 cfs	No	N/C	Yes	Yes	Yes	Yes	No
D: Tunnels 3,000 cfs	No	No	No	No	Yes	Yes	Yes
E: Isolated 15,000 cfs	No	N/C	No	No	Yes	Yes	No
F: Through Delta	No	N/C	No	Yes	Yes	No	No
G: Less Tidal Restoration	Yes	No	No	Yes	Yes	Yes	Yes
H: More Restoration	No	Yes	Yes	Yes	No	Yes	No
I: Modified Spring Outflow	Yes	Yes	No	No	Yes	Yes	No

Notes:

^a Take alternatives fail if answer is “No” to one or more questions.

^b For details see Table 9-31, *Summary of Take Assessment Relative to the BDCP Proposed Action*

^c In some cases, take alternatives also increase or reduce benefits to some covered species. For example, Take Alternative G reduces benefits to covered fish due to less tidal natural community restoration. Take Alternative H increases benefits to some covered fish due to more restoration of several aquatic natural communities but increases take on some covered terrestrial species.

^d For details, see Table 9-6, *Permanent Effects by Natural Community and Take Alternative Relative to the BDCP Proposed Action*.

^e For details, see Table 9-8, *Differences in Consistency of Take Alternatives with BDCP Goals Compared with the BDCP Proposed Action*.

^f For details, see Table 9-32, *Summary of State and Federal Water Contractor Economic Benefits and Costs*

^g For details, see Table 9-9, *Other Environmental Consequences that Vary Between Take Alternatives*.

N/A = not applicable as a comparison to the BDCP Proposed Action.

N/C = no measurable change in benefits compared to the BDCP Proposed Action. See text for details.

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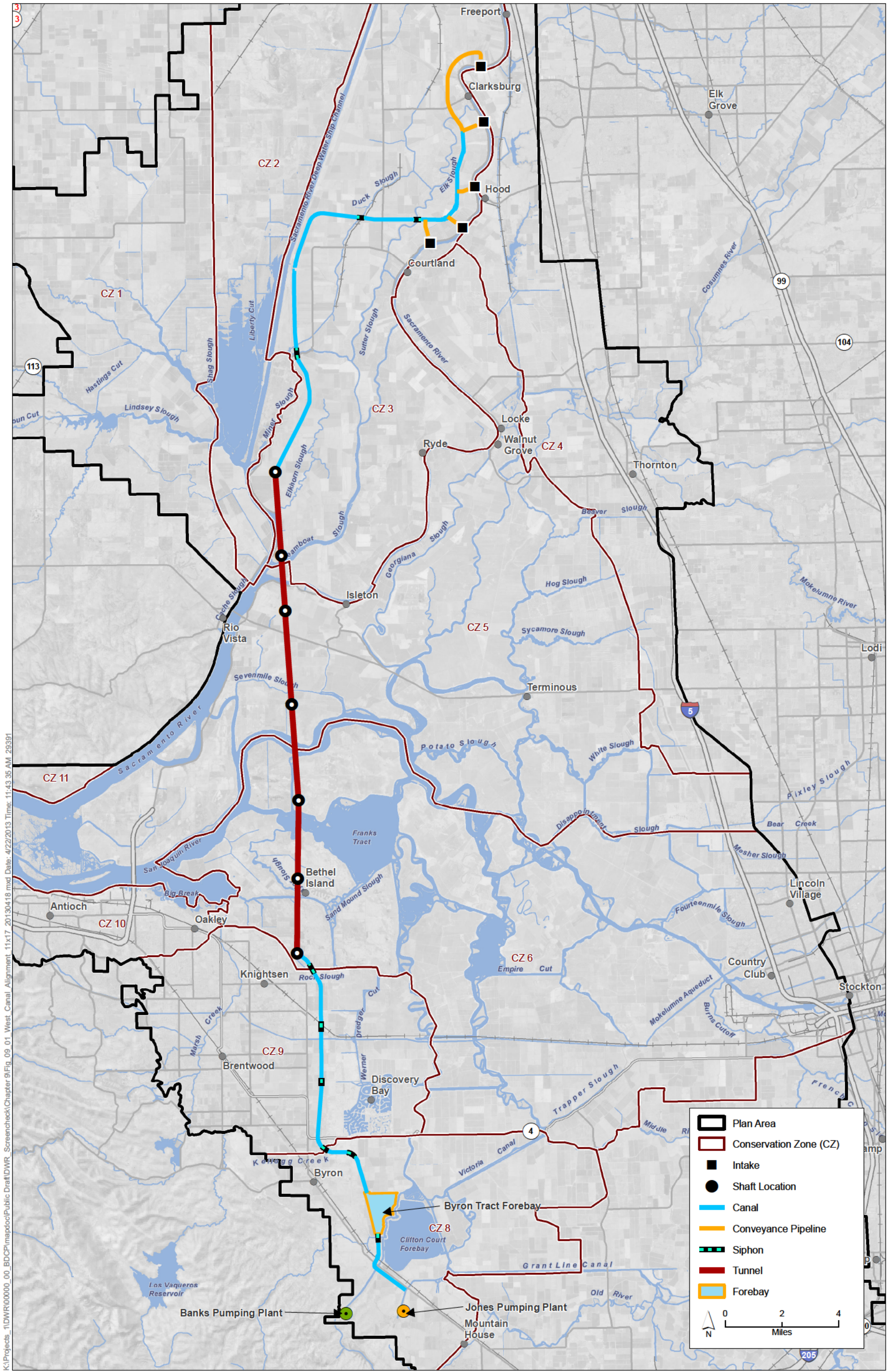
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38 9.7.2 Personal Communications

- 39 Neudeck, Randall. Metropolitan Water District.



K:\Projects_1\DW\000000_00_BDCP\mapdoc\Public Draft\DW_Screencheck\Chapter 9\Fig_09_01_West Canal Alignment_11x17_20130418.mxd Date: 4/22/2013 Time: 11:43:35 AM 29391

GIS Data Source: Plan Area, ICF 2012; Conservation Zones, SAIC 2012; Constructability (Rev 10b), DWR 2012.

Figure 9-1
West Canal Alignment

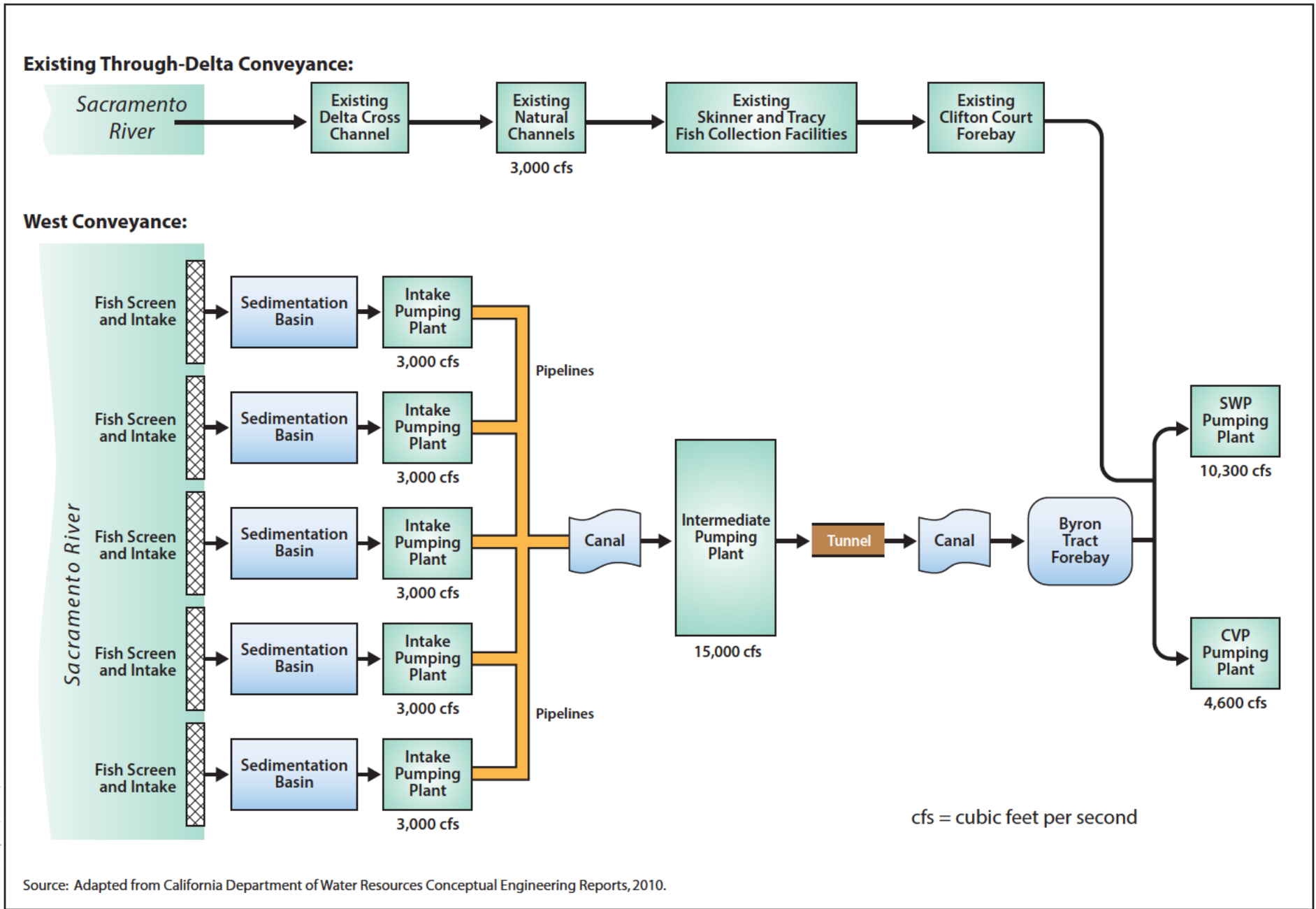


Figure 9-2
Take Alternative A Conveyance Schematic

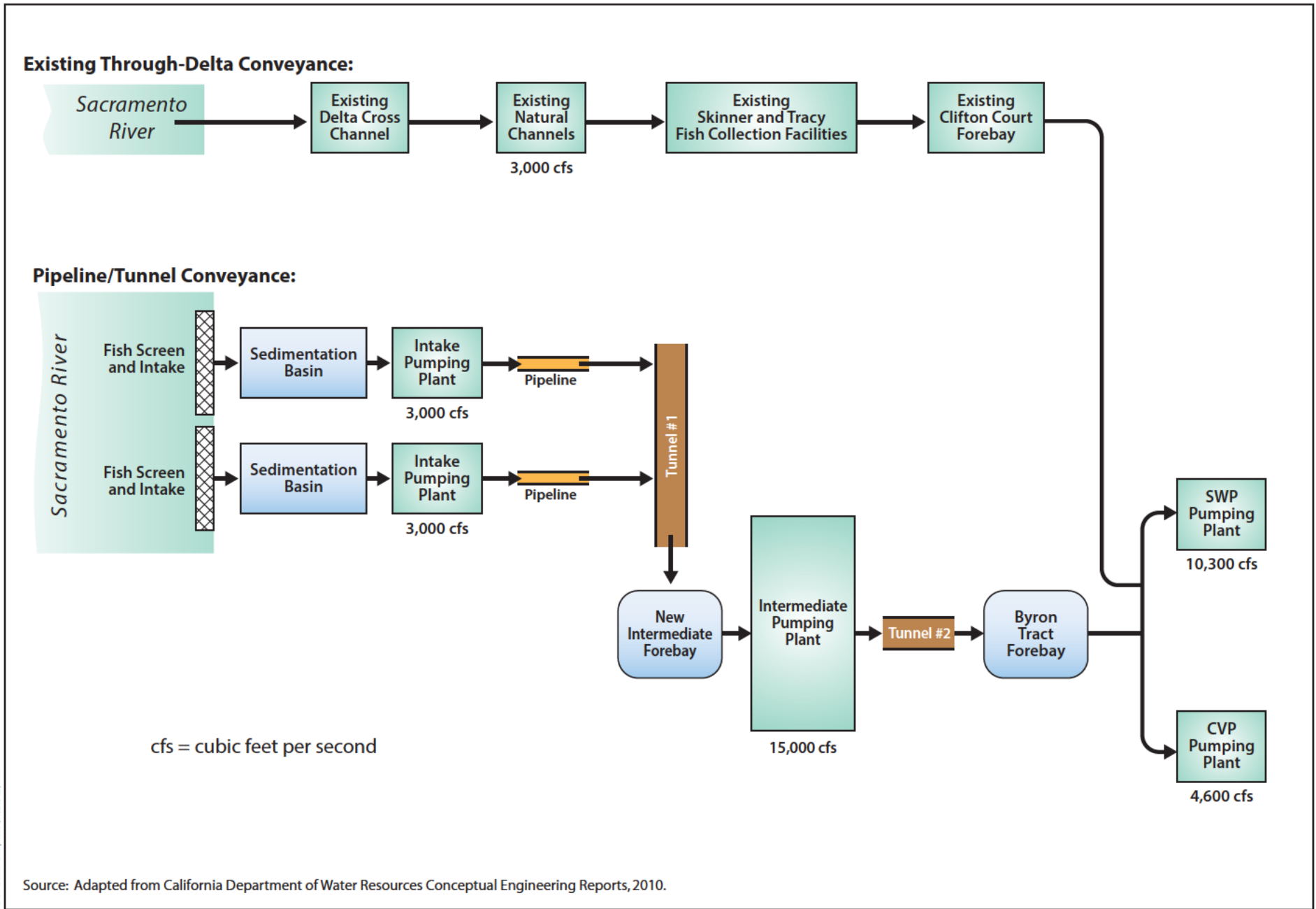


Figure 9-3
Take Alternative B Conveyance Schematic

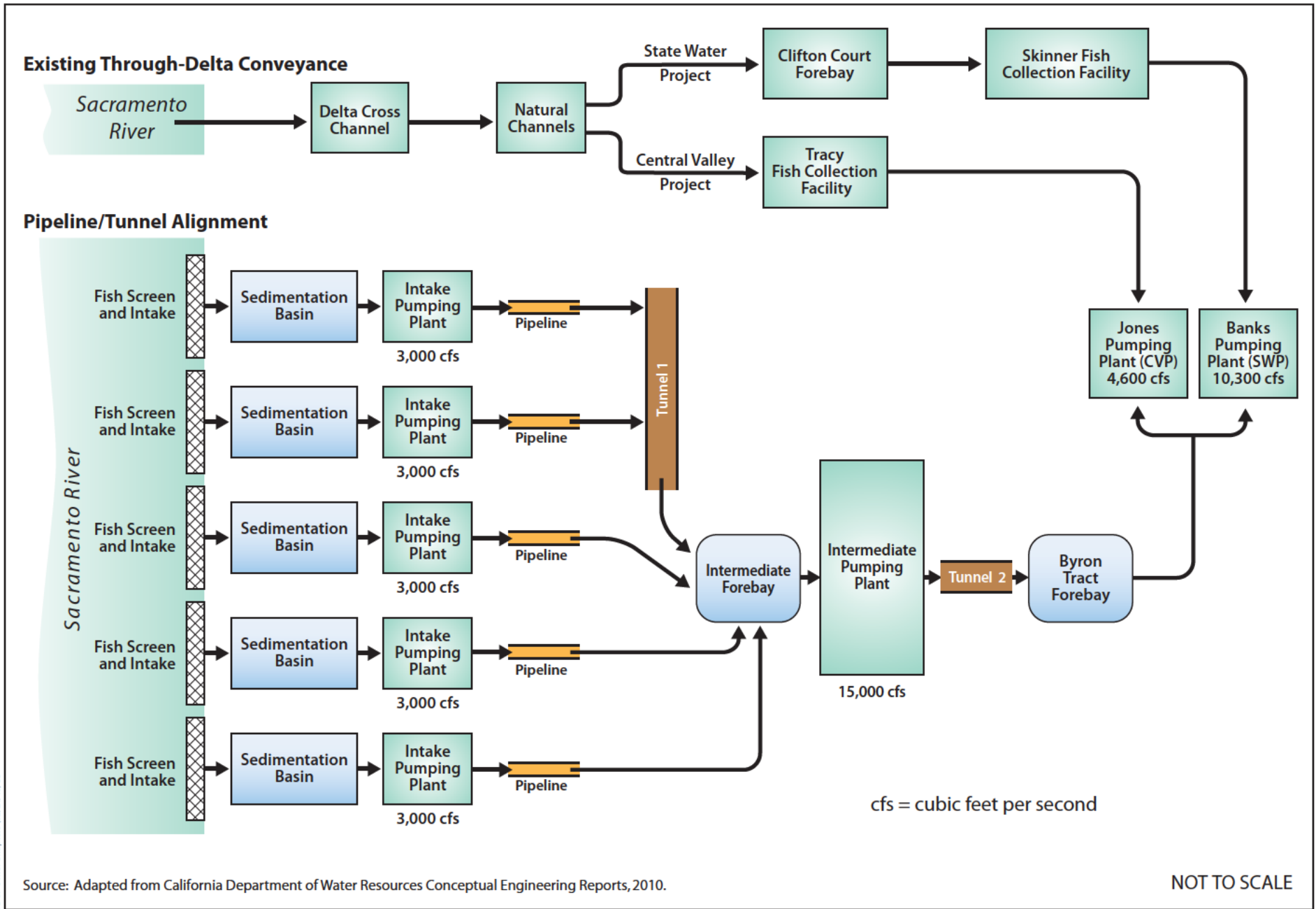


Figure 9-4
Take Alternative C Conveyance Schematic

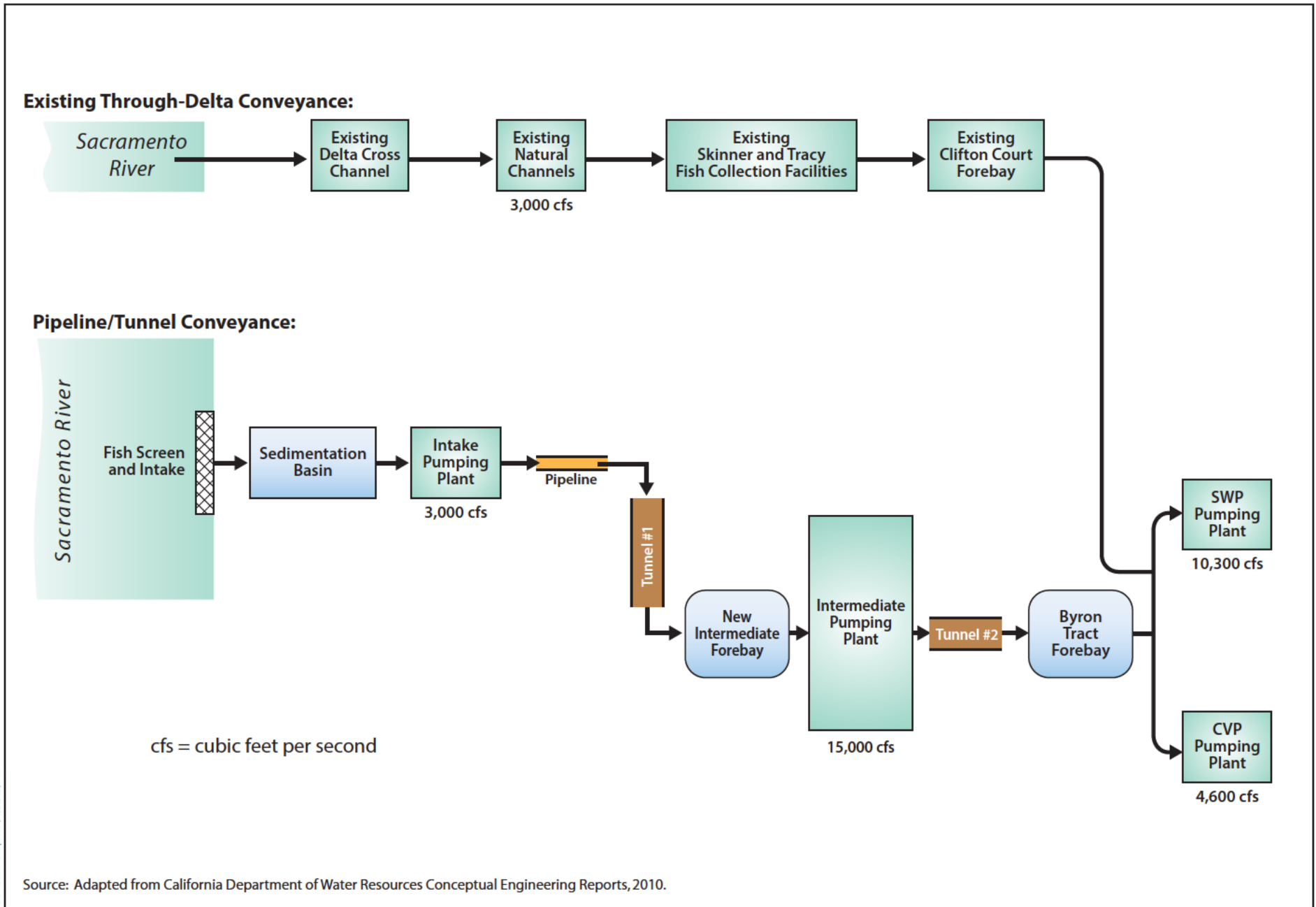
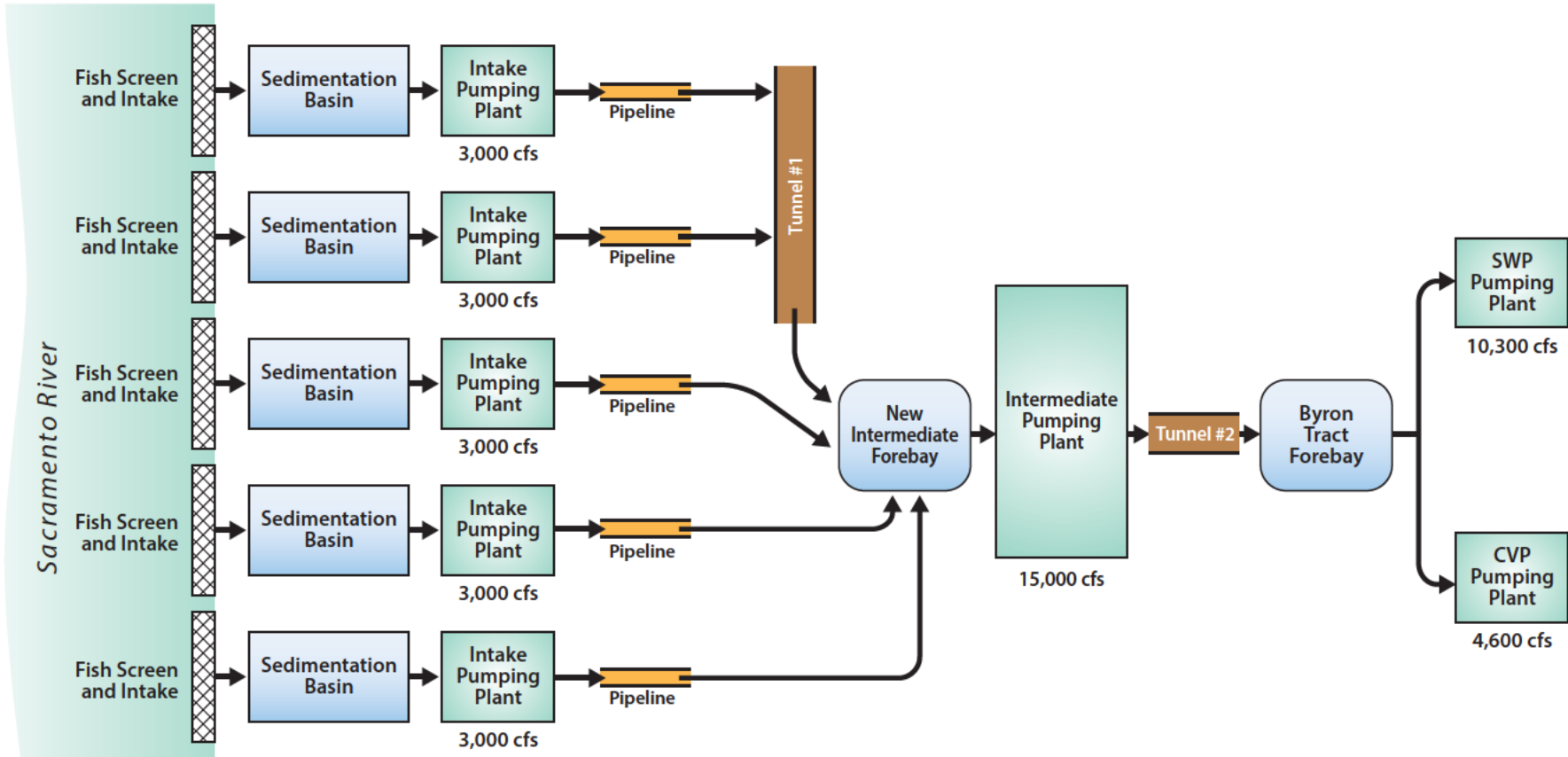


Figure 9-5
Take Alternative D Conveyance Schematic

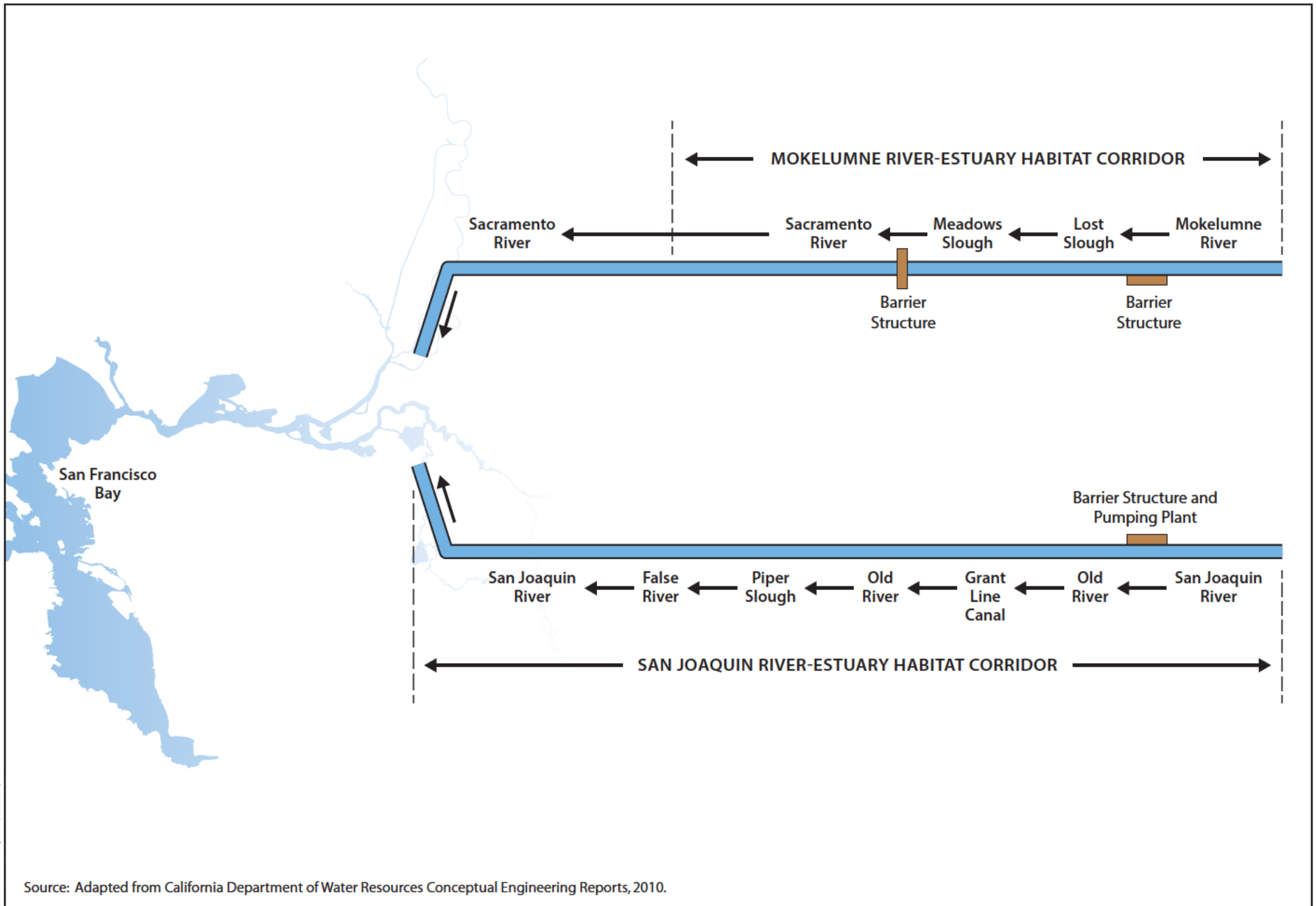
Pipeline/Tunnel Conveyance:



cfs = cubic feet per second

Source: Adapted from California Department of Water Resources Conceptual Engineering Reports, 2010.

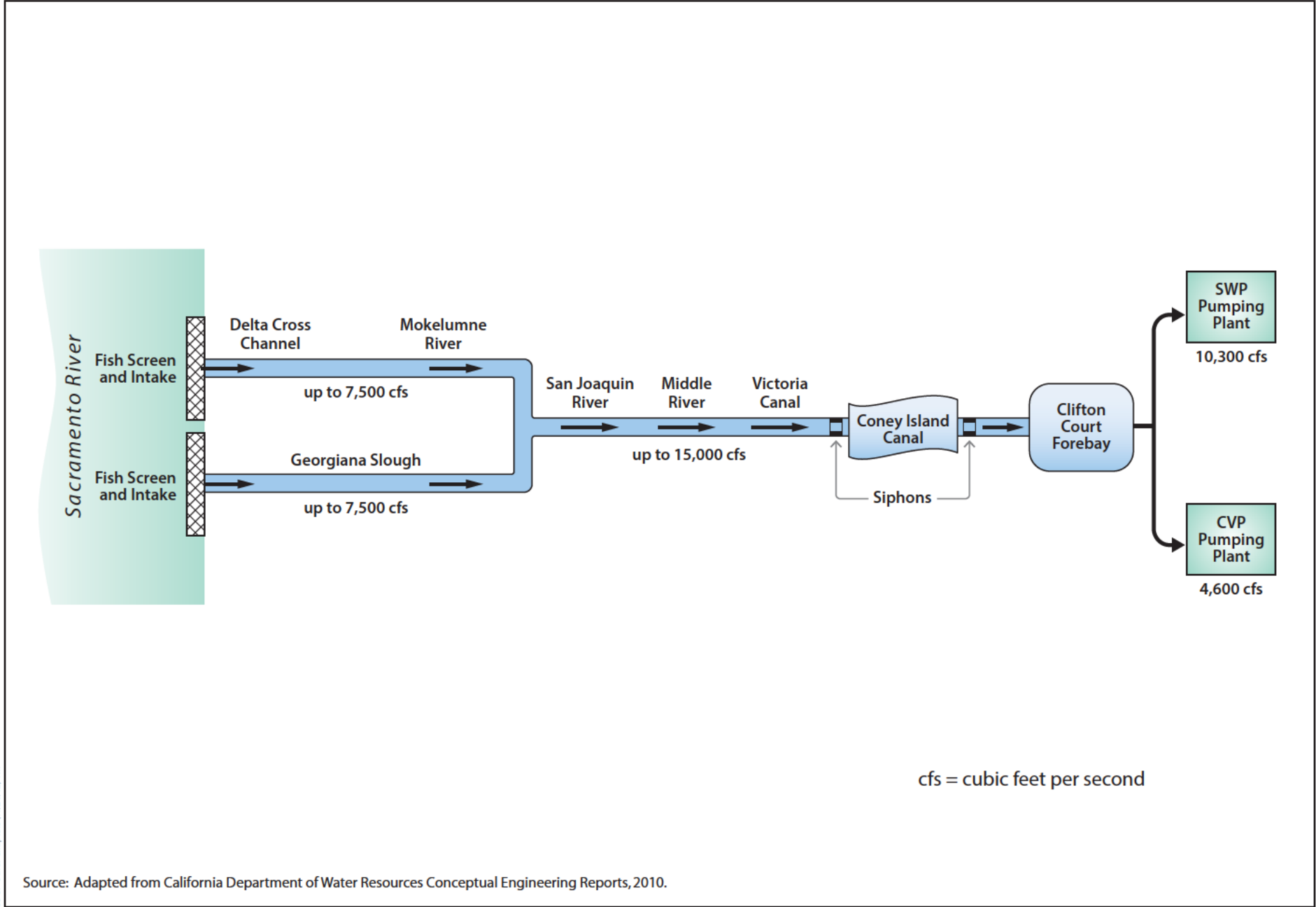
**Figure 9-6
Take Alternative E Conveyance Schematic**



BDP Other Chapters (11/26/12).TM

Source: Adapted from California Department of Water Resources Conceptual Engineering Reports, 2010.

Figure 9-8
Take Alternative F Fish Movement Corridor Schematic



BDP Other Chapters (11/26/12).TM

Figure 9-9
Take Alternative F Water Supply Corridor Schematic