Appendix 1.A

# USFWS Official Species List

# United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish And Wildlife
650 Capitol Mall
Suite 8-300
Sacramento, CA 95814
Phone: (916) 930-5603 Fax: (916) 930-5654


In Reply Refer To: December 22, 2023
Project Code: 2024-0029957
Project Name: Delta Conveyance Project

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through IPaC by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)

(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at: https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf

**Migratory Birds**: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts, see Migratory Bird Permit | What We Do | U.S. Fish & Wildlife Service (fws.gov).

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures, see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/partner/council-conservation-migratory-birds.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

**Note:** IPaC has provided all available attachments because this project is in multiple field office jurisdictions.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Bald & Golden Eagles
- Migratory Birds
- Wetlands

# OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

**San Francisco Bay-Delta Fish And Wildlife**
650 Capitol Mall
Suite 8-300
Sacramento, CA 95814
(916) 930-5603

This project's location is within the jurisdiction of multiple offices. However, only one species list document will be provided for all offices. The species and critical habitats in this document reflect the aggregation of those that fall in each of the affiliated office's jurisdiction. Other offices affiliated with the project:

**Sacramento Fish And Wildlife Office**
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
(916) 414-6600

# PROJECT SUMMARY

Project Code: 2024-0029957
Project Name: Delta Conveyance Project
Project Type: Water Supply Facility - New Constr
Project Description: DWR's fundamental purpose in proposing to develop new diversion and conveyance facilities in the Sacramento–San Joaquin Delta (Delta) is to restore and protect the reliability of SWP water deliveries south of the Delta, consistent with the California Water Resilience Portfolio. The proposed action would involve the construction and operation of new SWP water conveyance facilities in the Delta that would be operated to meet the objectives stated above. The proposed action also includes maintenance of new diversion and conveyance facilities. The proposed action would include a new Bethany Reservoir Pumping Plant and Surge Basin to the south of Clifton Court Forebay, and the new Bethany Reservoir Aqueduct that would convey flows to a new Bethany Reservoir Discharge Structure on the shore of Bethany Reservoir.

Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@38.11418185,-121.3780255391896,14z

Counties: California

# ENDANGERED SPECIES ACT SPECIES

There is a total of 22 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

## MAMMALS

| NAME | STATUS |
|---|---|
| Riparian Brush Rabbit *Sylvilagus bachmani riparius*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/6189 | Endangered |
| San Joaquin Kit Fox *Vulpes macrotis mutica*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/2873 | Endangered |

## BIRDS

| NAME | STATUS |
|---|---|
| California Condor *Gymnogyps californianus*<br>Population: U.S.A. only, except where listed as an experimental population<br>There is **final** critical habitat for this species. Your location does not overlap the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/8193 | Endangered |
| Yellow-billed Cuckoo *Coccyzus americanus*<br>Population: Western U.S. DPS<br>There is **final** critical habitat for this species. Your location does not overlap the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/3911 | Threatened |

## REPTILES

| NAME | STATUS |
|---|---|
| Alameda Whipsnake (=striped Racer) *Masticophis lateralis euryxanthus*<br>There is **final** critical habitat for this species. Your location does not overlap the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/5524 | Threatened |
| Giant Garter Snake *Thamnophis gigas*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/4482 | Threatened |
| Northwestern Pond Turtle *Actinemys marmorata*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/1111 | Proposed Threatened |

## AMPHIBIANS

| NAME | STATUS |
|---|---|
| California Red-legged Frog *Rana draytonii*<br>There is **final** critical habitat for this species. Your location overlaps the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/2891 | Threatened |
| California Tiger Salamander *Ambystoma californiense*<br>Population: U.S.A. (Central CA DPS)<br>There is **final** critical habitat for this species. Your location does not overlap the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/2076 | Threatened |

## FISHES

| NAME | STATUS |
|---|---|
| Delta Smelt *Hypomesus transpacificus*<br>There is **final** critical habitat for this species. Your location overlaps the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/321 | Threatened |
| Longfin Smelt *Spirinchus thaleichthys*<br>Population: San Francisco Bay-Delta DPS<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/9011 | Proposed Endangered |
| Longfin Smelt *Spirinchus thaleichthys*<br>Population: San Francisco Bay-Delta DPS<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/9011 | Proposed Endangered |

## INSECTS

| NAME | STATUS |
|---|---|
| Monarch Butterfly *Danaus plexippus*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/9743 | Candidate |
| Valley Elderberry Longhorn Beetle *Desmocerus californicus dimorphus*<br>There is **final** critical habitat for this species. Your location does not overlap the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/7850 | Threatened |

## CRUSTACEANS

| NAME | STATUS |
|---|---|
| Conservancy Fairy Shrimp *Branchinecta conservatio*<br>There is **final** critical habitat for this species. Your location does not overlap the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/8246 | Endangered |
| Longhorn Fairy Shrimp *Branchinecta longiantenna*<br>There is **final** critical habitat for this species. Your location does not overlap the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/4294 | Endangered |
| Vernal Pool Fairy Shrimp *Branchinecta lynchi*<br>There is **final** critical habitat for this species. Your location overlaps the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/498 | Threatened |
| Vernal Pool Tadpole Shrimp *Lepidurus packardi*<br>There is **final** critical habitat for this species. Your location does not overlap the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/2246 | Endangered |

## FLOWERING PLANTS

| NAME | STATUS |
|---|---|
| Contra Costa Goldfields *Lasthenia conjugens*<br>There is **final** critical habitat for this species. Your location overlaps the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/7058 | Endangered |
| Fleshy Owl's-clover *Castilleja campestris ssp. succulenta*<br>There is **final** critical habitat for this species. Your location does not overlap the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/8095 | Threatened |
| Large-flowered Fiddleneck *Amsinckia grandiflora*<br>There is **final** critical habitat for this species. Your location does not overlap the critical habitat.<br>Species profile: https://ecos.fws.gov/ecp/species/5558 | Endangered |
| Palmate-bracted Bird's Beak *Cordylanthus palmatus*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/1616 | Endangered |

### CRITICAL HABITATS

There are 4 critical habitats wholly or partially within your project area under this office's jurisdiction.

| NAME | STATUS |
|---|---|
| California Red-legged Frog *Rana draytonii*<br>https://ecos.fws.gov/ecp/species/2891#crithab | Final |
| Contra Costa Goldfields *Lasthenia conjugens*<br>https://ecos.fws.gov/ecp/species/7058#crithab | Final |
| Delta Smelt *Hypomesus transpacificus*<br>https://ecos.fws.gov/ecp/species/321#crithab | Final |
| Vernal Pool Fairy Shrimp *Branchinecta lynchi*<br>https://ecos.fws.gov/ecp/species/498#crithab | Final |

# USFWS NATIONAL WILDLIFE REFUGE LANDS AND FISH HATCHERIES

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

The following FWS National Wildlife Refuge Lands and Fish Hatcheries lie fully or partially within your project area:

| FACILITY NAME | ACRES |
|---|---|
| STONE LAKES NATIONAL WILDLIFE REFUGE<br>https://www.fws.gov/our-facilities?$keywords="%5C%22STONE+LAKES+NATIONAL+WILDLIFE+REFUGE%5C%22" | 6,404.823 |

# BALD & GOLDEN EAGLES

Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act[1] and the Migratory Bird Treaty Act[2].

Any person or organization who plans or conducts activities that may result in impacts to bald or golden eagles, or their habitats[3], should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

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1. The Bald and Golden Eagle Protection Act of 1940.
2. The Migratory Birds Treaty Act of 1918.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

**There are bald and/or golden eagles in your project area.**

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

| NAME | BREEDING SEASON |
|---|---|
| Bald Eagle *Haliaeetus leucocephalus*<br>This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.<br>https://ecos.fws.gov/ecp/species/1626 | Breeds Jan 1 to Aug 31 |
| Golden Eagle *Aquila chrysaetos*<br>This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.<br>https://ecos.fws.gov/ecp/species/1680 | Breeds Jan 1 to Aug 31 |

## PROBABILITY OF PRESENCE SUMMARY

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

**Probability of Presence** (■)

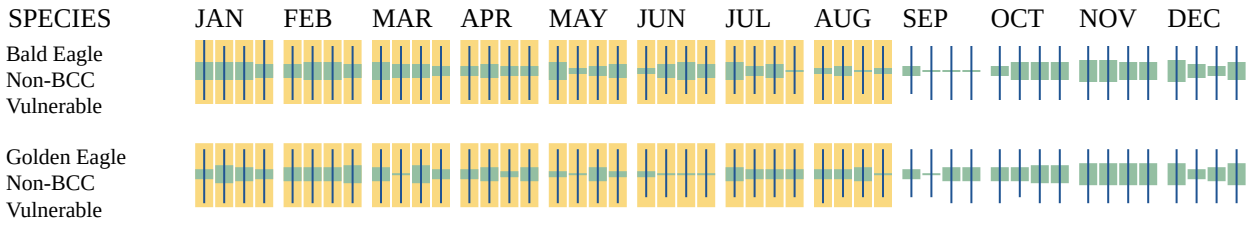
Green bars; the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during that week of the year.

**Breeding Season** (■)
Yellow bars; liberal estimate of the timeframe inside which the bird breeds across its entire range.

**Survey Effort** (|)
Vertical black lines; the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

**No Data** (–)
A week is marked as having no data if there were no survey events for that week.

■ probability of presence ■ breeding season | survey effort – no data




Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

# MIGRATORY BIRDS

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats[3] should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

| NAME | BREEDING SEASON |
|---|---|
| Allen's Hummingbird *Selasphorus sasin*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/9637 | Breeds Feb 1 to Jul 15 |

| NAME | BREEDING SEASON |
|---|---|
| Bald Eagle *Haliaeetus leucocephalus*<br>This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.<br>https://ecos.fws.gov/ecp/species/1626 | Breeds Jan 1 to Aug 31 |
| Belding's Savannah Sparrow *Passerculus sandwichensis beldingi*<br>This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA<br>https://ecos.fws.gov/ecp/species/8 | Breeds Apr 1 to Aug 15 |
| Black Swift *Cypseloides niger*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/8878 | Breeds Jun 15 to Sep 10 |
| Black Tern *Chlidonias niger*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/3093 | Breeds May 15 to Aug 20 |
| Bullock's Oriole *Icterus bullockii*<br>This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA<br>https://ecos.fws.gov/ecp/species/9458 | Breeds Mar 21 to Jul 25 |
| California Gull *Larus californicus*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/10955 | Breeds Mar 1 to Jul 31 |
| California Thrasher *Toxostoma redivivum*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/9436 | Breeds Jan 1 to Jul 31 |
| Clark's Grebe *Aechmophorus clarkii*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/10575 | Breeds Jun 1 to Aug 31 |
| Common Yellowthroat *Geothlypis trichas sinuosa*<br>This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA<br>https://ecos.fws.gov/ecp/species/2084 | Breeds May 20 to Jul 31 |
| Golden Eagle *Aquila chrysaetos*<br>This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.<br>https://ecos.fws.gov/ecp/species/1680 | Breeds Jan 1 to Aug 31 |

| NAME | BREEDING SEASON |
|---|---|
| Lawrence's Goldfinch *Carduelis lawrencei*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/9464 | Breeds Mar 20 to Sep 20 |
| Long-eared Owl *asio otus*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/3631 | Breeds Mar 1 to Jul 15 |
| Marbled Godwit *Limosa fedoa*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/9481 | Breeds elsewhere |
| Nuttall's Woodpecker *Picoides nuttallii*<br>This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA<br>https://ecos.fws.gov/ecp/species/9410 | Breeds Apr 1 to Jul 20 |
| Oak Titmouse *Baeolophus inornatus*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/9656 | Breeds Mar 15 to Jul 15 |
| Olive-sided Flycatcher *Contopus cooperi*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/3914 | Breeds May 20 to Aug 31 |
| Short-billed Dowitcher *Limnodromus griseus*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/9480 | Breeds elsewhere |
| Tricolored Blackbird *Agelaius tricolor*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/3910 | Breeds Mar 15 to Aug 10 |
| Western Grebe *aechmophorus occidentalis*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/6743 | Breeds Jun 1 to Aug 31 |
| Willet *Tringa semipalmata*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/10669 | Breeds elsewhere |

| NAME | BREEDING SEASON |
|---|---|
| Wrentit *Chamaea fasciata*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/10668 | Breeds Mar 15 to Aug 10 |
| Yellow-billed Magpie *Pica nuttalli*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/9726 | Breeds Apr 1 to Jul 31 |

## PROBABILITY OF PRESENCE SUMMARY

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

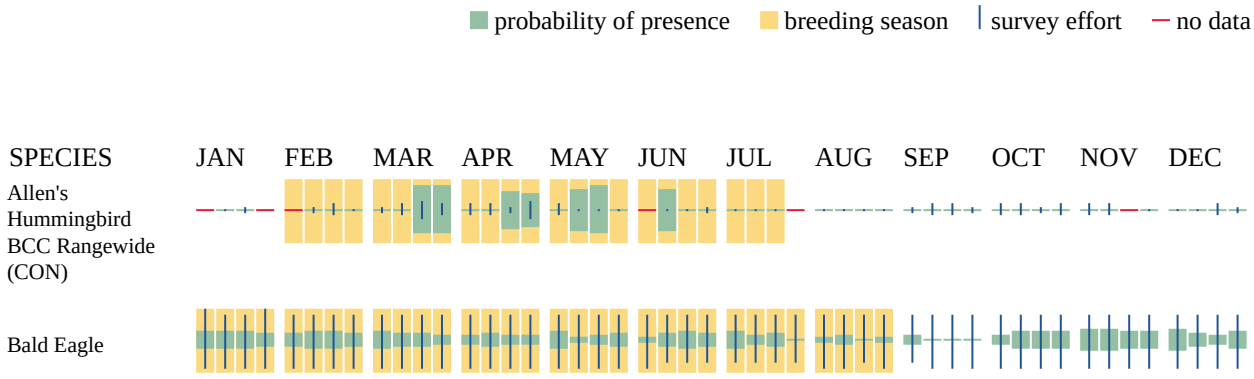
**Probability of Presence** (■)

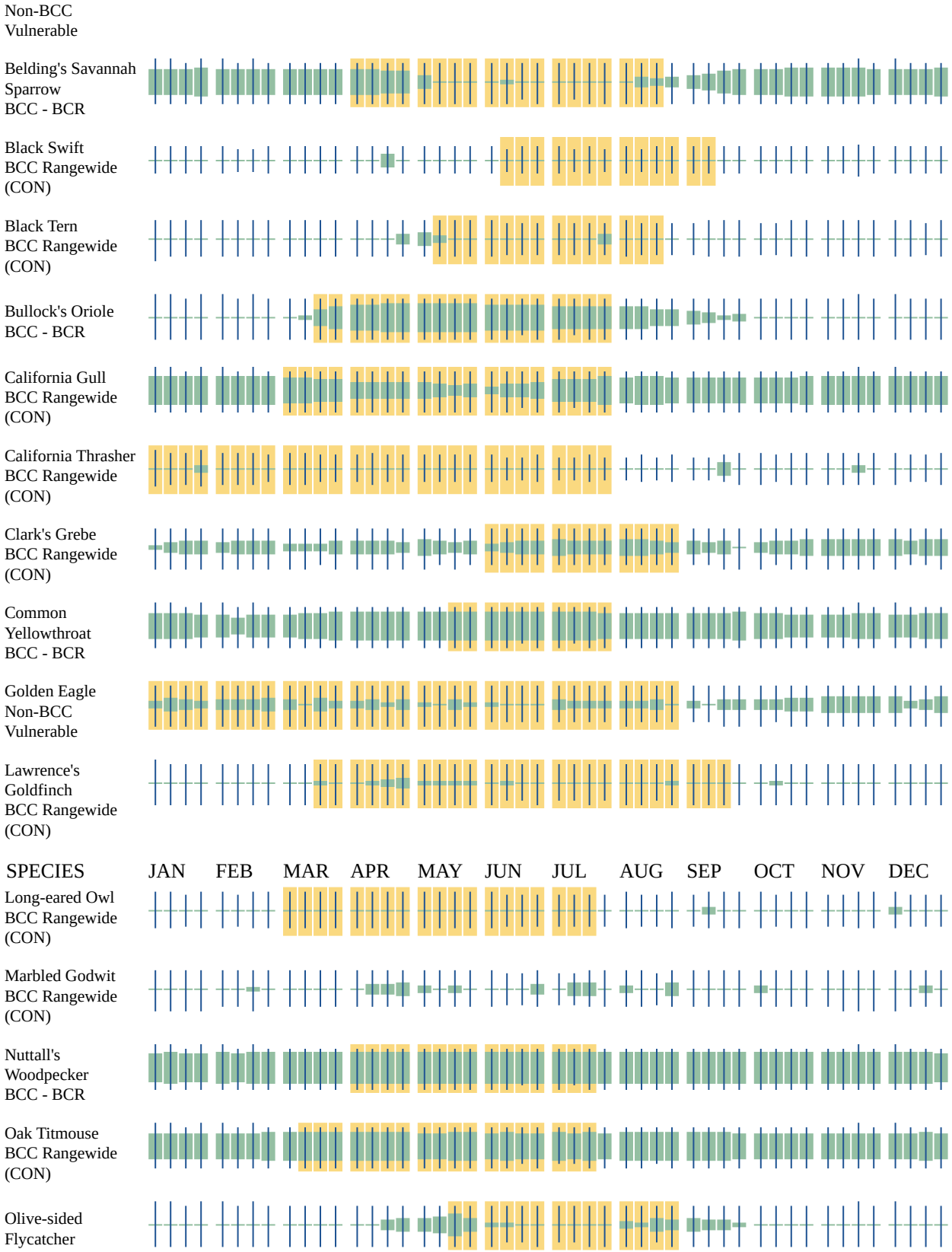
Green bars; the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during that week of the year.

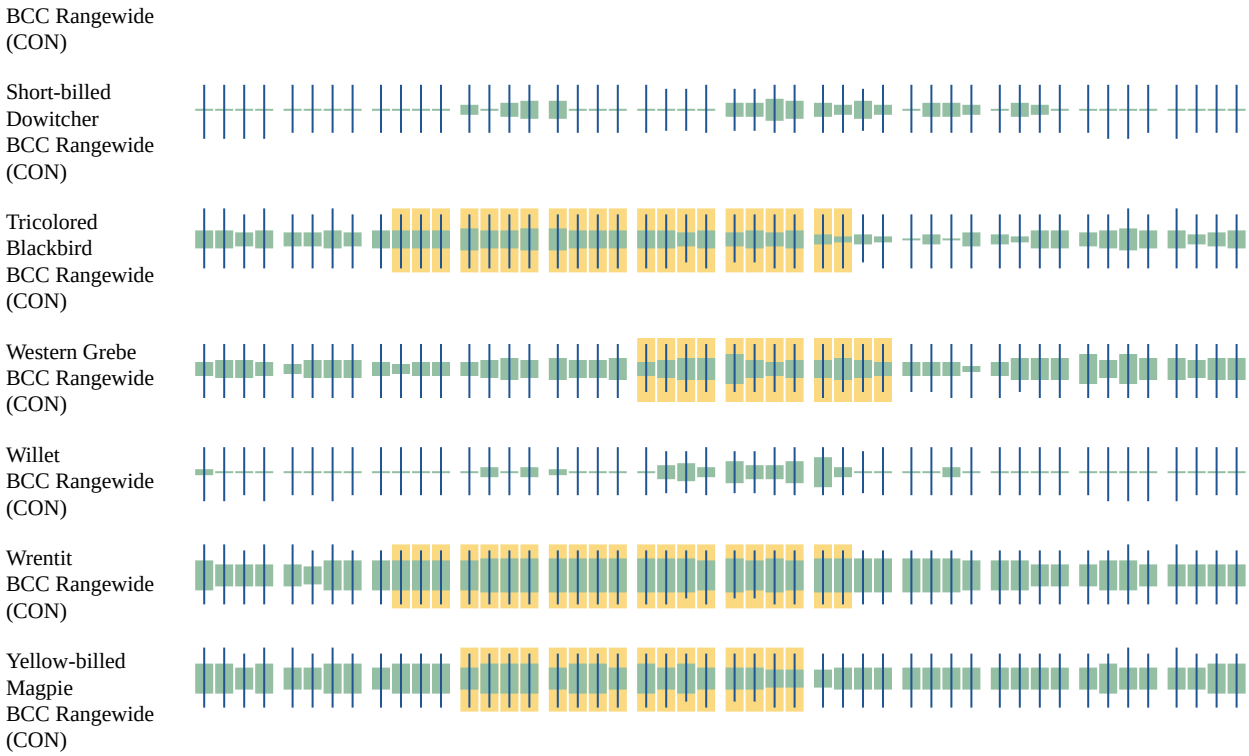
**Breeding Season** (■)
Yellow bars; liberal estimate of the timeframe inside which the bird breeds across its entire range.

**Survey Effort** (|)
Vertical black lines; the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

**No Data** (–)
A week is marked as having no data if there were no survey events for that week.




Non-BCC Vulnerable
Belding's Savannah Sparrow BCC - BCR
Black Swift BCC Rangewide (CON)
Black Tern BCC Rangewide (CON)
Bullock's Oriole BCC - BCR
California Gull BCC Rangewide (CON)
California Thrasher BCC Rangewide (CON)
Clark's Grebe BCC Rangewide (CON)
Common Yellowthroat BCC - BCR
Golden Eagle Non-BCC Vulnerable
Lawrence's Goldfinch BCC Rangewide (CON)
SPECIES
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long-eared Owl BCC Rangewide (CON)
Marbled Godwit BCC Rangewide (CON)
Nuttall's Woodpecker BCC - BCR
Oak Titmouse BCC Rangewide (CON)
Olive-sided Flycatcher




Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

# WETLANDS

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

FRESHWATER FORESTED/SHRUB WETLAND

- PFO1A
- PSS1Ax
- PSS/EM1R
- PSSR
- PSSC
- PFO1C
- PFOA
- PSS1F
- PSSA
- PFO/EM1R
- PSST
- PSS1A
- PSS1C
- PSS1Cx
- PSS1Ah
- PFOS
- PSS1Fh
- PFO1Fh
- PFOR
- PFO1R
- PSSCh
- PSSCx
- PSS1Ch
- PFOC
- PSS1R

FRESHWATER POND

- PUBHh
- PUBF
- PUSCh
- PABF
- PUSKx
- PUBHx
- PABHx
- PUBFx
- PUBKx

- PABFx
- PUBFh
- PAB4Fh
- PAB4F
- PUBK
- PABHh
- PUBH
- PUSC
- PABV
- PUSA

FRESHWATER EMERGENT WETLAND

- PEM1Ai
- PEM1Ax
- PEM1Ah
- PEM1T
- PEM1Cx
- PEM1F
- PEM1C
- PEM1Jh
- PEM1Fx
- PEM1/USA
- PEM1Fh
- PEM1Ch
- PEM1R
- PEM1Kx
- PEM1K
- PEM1A

OTHER

- Pf

RIVERINE

- R1UBV
- R2UBHx
- R4SBA
- R1UBVx
- R4SBC
- R2ABHx

- R5UBFx
- R4SBCx
- R2UBHr
- R5UBF
- R1ABV
- R2ABH
- R2UBH

LAKE

- L1UBHh
- L1UBHx
- L1UBH

## IPAC USER CONTACT INFORMATION

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## LEAD AGENCY CONTACT INFORMATION

Lead Agency: California Department of Water Resources

Appendix 3A

# General Avoidance and Minimization Measures

## 3A.1 Introduction

Avoidance and minimization measures (AMMs) are those actions that are incorporated into the engineering or design of the Delta Conveyance Project (proposed action) and are intended to avoid, reduce, or minimize adverse effects that apply to one or more species. The AMMs address construction and construction-related maintenance activities, thus they should be considered project-level actions. There are exceptions to this focus on construction, including AMM-23: *Develop and Implement a Mercury Management and Monitoring Plan*, which is associated with the Compensatory Mitigation Plan (CMP). The avoidance and minimization features are included in the Mitigation Monitoring and Reporting Plan to enhance implementation tracking, identify the responsible party, and clarify implementation timing. Best management practices (BMPs) are standard construction practices or design elements that are incorporated into the proposed action's design to generally address the construction-related environmental concerns that typically occur for most construction actions. AMMs discussed in this appendix do not include the engineering or design features described in Chapter 3, *Description of the Proposed Action*, Section 3.2, *Conveyance Facility Construction*, that may indirectly address environmental effects.[1]

### 3A.1.1 AMM-1: Conduct Environmental Resources Worker Awareness Training

The California Department of Water Resources (DWR) will provide training to field management and construction personnel on the importance of protecting sensitive natural resources (e.g., special-status fish species, wildlife species, plant species, and designated critical and/or suitable habitats for these species) prior to any ground-disturbing activity. Preconstruction training will be conducted so that construction personnel are aware of their responsibilities and the importance of compliance. All trainees will be required to sign a sheet indicating their attendance and completion of environmental training. The signature pages will be provided to California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NMFS), if requested.

Construction personnel will be educated on the types of sensitive resources in the action area and the measures required to avoid and minimize impacts on these resources. Materials covered in the training program will include environmental rules and regulations for the specific site requirements for limiting activities to approved work areas, timing restrictions, and avoidance of sensitive resource areas.

[1] The conveyance features have been designed to reduce numerous impacts, as described in the Efforts to Minimize Delta Community Effects Technical Memorandum in Attachment H of *Volume 1: Delta Conveyance Final Draft Engineering Project Report—Central and Eastern Options* and in the Efforts to Minimize Delta Community Effects Supplement—Bethany Reservoir Alternative Technical Memorandum in *Volume 1: Delta Conveyance Final Draft Engineering Project Report—Bethany Reservoir Alternative* (Delta Conveyance Design and Construction Authority 2022a, 2022b).

In general, trainings will include the following components.

1. The need and legal requirements for resource avoidance and protection.
2. Important timing windows for special-status species (i.e., timing of special-status fish migration, spawning, and rearing; wildlife mating, nesting, and fledging; amphibian breeding and dispersal; and plant flowering periods).
3. Identification of listed fish, wildlife, and plant species potentially affected at the worksite, which will depend upon the work to be performed and location of the work.
4. Relevant measures from environmental documents and regulatory permits to be implemented during construction for the protection of covered fish, wildlife, and plant species, depending upon work to be performed and location of the work (i.e., in-water, upland, wetland).
5. Brief discussions of special-status species and natural communities of concern.
6. Boundaries of the work area.
7. Exclusion and construction fencing methods.
8. Roles and responsibilities, including an explanation regarding the authority of biological monitors to stop work as required by permits and/or project approvals.
9. What to do when special-status fish, wildlife, or plants are encountered (including dead, injured, stressed, or entrapped individuals) in work areas.
10. Staking methods to protect resources.
11. Avoidance and minimization commitments.
12. Emergency procedures.
13. Consequences of violations of the laws and regulations protecting resources.

A fact sheet or other supporting materials containing this information will be prepared and distributed to construction supervisors and managers, along with a list of contacts (names, numbers, and affiliations) prior to initiating construction activities. DWR will appoint a representative to be the primary point of contact for any employee or contractor who might inadvertently take[2] a special-status species, or a representative will be identified during the employee education program and the representative's name and telephone number provided to the fish and wildlife agencies.

If new construction personnel are added, the contractor will require that the personnel receive the mandatory training and sign a sheet indicating their attendance and completion of the environmental training before starting work. The training sheets for new construction personnel will be provided to CDFW, USFWS, and NMFS, if requested.

[2] Under Section 9 of the Endangered Species Act, the term *take* means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in any such conduct. Take includes the modification of a listed species' designated critical habitat. Additionally, "harm" per Section 9 of the Endangered Species Act may include significant habitat modification or degradation that actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR § 17.3). Under the California Endangered Species Act, *take* refers to mortality or injury of any fish, wildlife, or plant species that has been listed as endangered or threatened or designated as a candidate for listing, but not the modification of habitat for a listed species.

### 3A.1.2 AMM-2: Develop and Implement Hazardous Materials Management Plans

DWR will require that each project contractor responsible for construction of a project facility or project develop and implement a hazardous materials management plan (HMMP) before beginning construction. Multiple HMMPs will be prepared for the overall project construction activities, each considering site-specific conditions such as hazardous materials present on site and known historic site contamination. A database on known historic instances of contamination and results of any field inspections regarding the presence of hazardous chemicals will be maintained. The HMMPs will provide detailed information on the types of hazardous materials used or stored at all sites associated with the water conveyance facilities (e.g., intake pumping plants, maintenance facilities); phone numbers of applicable city, county, state, and federal emergency response agencies; primary, secondary, and final cleanup procedures; emergency-response procedures in case of a spill; and other applicable information. The HMMPs will include appropriate practices to reduce the likelihood of a spill of toxic chemicals and other hazardous materials during construction and facilities operation and maintenance. A specific protocol for the proper handling and disposal of hazardous materials will be established before construction activities begin, will be implemented during project construction, and will be enforced by DWR.

The HMMP will include, but not be limited to, the following measures or practices.

1. Fuel, oil, and other petroleum products will be stored only at designated sites.
2. Hazardous materials containment containers will be clearly labeled with the identity of the hazardous materials contained therein, handling and safety instructions, and emergency contact information.
3. Storage, use, or transfer of hazardous materials in or near wet or dry streams will be consistent with the Fish and Game Code (Section 5650) and/or with the permission of CDFW.
4. Material Safety Data Sheets will be made readily available to the contractor's employees and other personnel at the work site.
5. The accumulation and temporary storage of hazardous wastes will not exceed 90 days.
6. Soils contaminated by spills or cleaning wastes will be contained and removed to an approved disposal site by an appropriately-certified hazardous waste disposal contractor.
7. Hazardous waste generated at work sites, such as contaminated soil, will be segregated from other construction spoils and properly handled, hauled, and disposed of at an approved disposal facility by a licensed hazardous waste hauler in accordance with applicable law and regulations. The contractor will obtain permits required for such disposal.
8. Emergency spill containment and cleanup kits will be located at the work site. The contents of the kit will be appropriate to the type and quantities of chemical or goods stored at the work site.
9. Handling and disposal of roadway materials will follow existing standards and specifications.
10. When refueling vehicles at construction sites, refueling will only occur when employees are present; refueling will be conducted only with approved pumps, hoses, and nozzles; all disconnected hoses will be placed in containers to collect residual fuel from the hoses; and

vehicle engines will be shut down during refueling. In addition, when refueling is completed, the service truck will leave the project site.

### 3A.1.3 AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans

DWR will require that each project contractor responsible for construction of a project facility or project develop and implement a spill prevention, control, and countermeasure plan (SPCCP) for each project site (typically required to meet state and federal water quality requirements). Multiple SPCCPs will be prepared for project construction activities, each taking into account site-specific conditions. The SPCCPs will be developed in accordance with the regulatory requirements of Title 40 of the Code of Federal Regulations (CFR), Part 112, or the Spill Prevention, Control, and Countermeasure Rule under the Oil Pollution Act of 1990, which includes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters of the United States and adjoining shorelines. The rule requires the preparation, amendment and implementation of site-specific SPCCPs to prevent and respond to oil discharges that could affect navigable waters. The SPCCPs will be developed and implemented to minimize effects from spills of oil or oil-containing products[3] during project construction and operation. Each SPCC plan will address actions used to prevent spills in addition to specifying actions that will be taken should any spills occur, including emergency notification procedures.

The SPCCPs will include the following measures and practices.

1. Discharge prevention measures will include procedures for routine handling of products (e.g., loading, unloading, and facility transfers) (40 CFR § 112.7(a)(3)(i)).
2. Discharge or drainage controls will be implemented such as secondary containment around containers and other structures, equipment, and procedures for the control of a discharge (40 CFR § 112.7(a)(3)(ii)).
3. Countermeasures will be implemented for discharge discovery, response, and cleanup (both the facility's capability and those that might be required of a contractor) (40 CFR § 112.7(a)(3)(iii)).
4. Methods of disposal of recovered materials will comply with applicable legal requirements (40 CFR §112.7(a)(3)(iv)).
5. Personnel will be trained in emergency response and spill containment techniques, and will also be made aware of the pollution control laws, rules, and regulations applicable to their work.
6. Petroleum products will be stored in non-leaking containers at impervious storage sites from which an accidental spill cannot escape.
7. Absorbent pads, pillows, socks, booms, and other spill containment materials will be stored and maintained at the hazardous materials storage sites for use in the event of an accidental spill.
8. Contaminated absorbent pads, pillows, socks, booms, and other spill containment materials will be placed in non-leaking sealed containers until transport to an appropriate disposal facility.

[3] "Oil" includes a variety of petroleum and non-petroleum based substances including gasoline, diesel fuel, motor oil, hydraulic fluid, aviation fuel, oil-based paint, oil-based paint thinner, roofing tar, and petroleum-based solvents.

9. When transferring oil or other hazardous materials from trucks to storage containers, absorbent pads, pillows, socks, booms or other spill containment material will be placed under the transfer area.
10. Refueling of construction equipment will occur only in designated areas that will be a minimum of 150 feet from surface waters and other sensitive habitats, such as wetlands.
11. Equipment used in direct contact with water will be inspected daily for oil, grease, and other petroleum products. All equipment must be cleaned of external petroleum products prior to beginning work where contact with water may occur to prevent the release of such products to surface waters.
12. Oil-absorbent booms will be used when equipment is used in or immediately adjacent to waters.
13. All reserve fuel supplies will be stored only within the confines of a designated staging area, to be located a minimum of 150 feet from surface waters and other sensitive habitats, such as wetlands.
14. Fuel transfers will take place a minimum of 150 feet from surface waters and other sensitive habitats, such as wetlands, and absorbent pads will be placed under the fuel transfer operation.
15. Staging areas will be designed to contain contaminants such as oil, grease, fuel, and other petroleum products so that should an accidental spill occur, they do not drain toward receiving waters or storm drain inlets.
16. All stationary equipment will be staged in appropriate staging areas and positioned over drip pans.
17. In the event of an accidental spill, personnel will identify and secure the source of the discharge and contain the discharge with sorbents, sandbags, or other material from spill kits and will contact appropriate regulatory authorities (e.g., National Response Center will be contacted if the spill threatens navigable waters of the United States or adjoining shorelines, as well as other appropriate response personnel).
18. When refueling vehicles at construction sites, refueling will only occur when employees are present; refueling will be conducted only with approved pumps, hoses, and nozzles; all disconnected hoses will be placed in containers to collect residual fuel from the hoses; and vehicle engines will be shut down during refueling. In addition, when refueling is completed, the service truck will leave the project site.

Methods of cleanup may include the following:

19. Physical methods for the cleanup of dry chemicals include the use of brooms, shovels, sweepers, or plows.
20. Mechanical methods include, but may not be limited to, the use of vacuum cleaning systems and pumps.
21. Chemical methods include the use of appropriate chemical agents such as sorbents, gels, and foams.

### 3A.1.4 AMM-4a: Develop and Implement Erosion and Sediment Control Plans

DWR will require all contractors prepare and implement erosion and sediment control plans[4] to control short-term and long-term erosion and sedimentation effects and to restore soils and vegetation in areas damaged by construction activities. Multiple erosion and sediment control plans will be prepared for project-related construction activities, each taking into account site-specific conditions such as proximity to surface water, erosion potential, drainage, etc. The plans will include all the necessary CGP requirements regarding erosion control and will specify BMPs for erosion and sediment control that are to be implemented during construction activities. These BMPs will be incorporated into the SWPPPs (see AMM-4b: *Develop and Implement Stormwater Pollution Prevention Plans*). In addition, to reduce aesthetic impacts, the tops and bottoms of spoils disposal areas will be rounded, and slope faces will be contoured, to create more natural-looking landforms; these will be planted with diverse appropriate native and indigenous vegetation that will also help control erosion.

Erosion control measures will include the following.

1. Install physical erosion control stabilization features (hydroseeding with native seed mix, mulch, silt fencing, fiber rolls, sandbags, and erosion control blankets) to capture sediment and control both wind and water erosion. Erosion control may not use netting made with plastic monofilament or similar materials or netting with cross joints that are bound or stitched (such as straw wattles, fiber rolls, or erosion control blankets), which could trap wildlife including snakes or birds. All fiber rolls, straw wattles, and hay bales used within and adjacent to the project site shall be free of nonnative plant materials. Fiber rolls or erosion-control mesh shall be made of loose-weave mesh that is not fused at the intersections of the weave, such as jute or coconut (coir) fiber, or other products without welded weaves.
2. Keep emergency erosion-control supplies on-site at all times during construction, and have the contractor(s) use these emergency stockpiles as needed. DWR and/or the contractors will require that supplies used from the emergency stockpiles are replaced within 48 hours. DWR will also require that materials used in construction of erosion control methods will be removed from the work site and properly disposed when no longer needed.
3. Design grading to be compatible with adjacent areas and minimize potential for disturbance of adjacent terrain and natural land features and minimize erosion in disturbed areas to the extent practicable.
4. Divert runoff away from steep, denuded slopes, or other critical areas with barriers, berms, ditches, or other facilities.
5. To the extent possible, retain native trees and vegetation to help stabilize hillsides, retain moisture, and reduce erosion.
6. Limit construction, clearing of native vegetation, and disturbance of soils to areas of proven stability.

[4] An erosion and sediment control plan is typically required for ground-disturbing projects as part of the National Pollutant Discharge Elimination System (NPDES)/SWPPP permitting process (U.S. Environmental Protection Agency 2007), depending on the size of the disturbed area. The Phase II EPA rules would cover project activities with 1 or more acres of ground disturbance.

7. To the extent possible, sequence clearing of native vegetation and disturbance of soils to minimize overall time of soil disturbance.
8. Implement construction management and scheduling measures to avoid exposure and mitigate erosion from rainfall events, runoff, or flooding at construction sites, to the extent feasible.
9. Conduct frequent site inspections (before, during, and after significant storm events) to confirm that control measures are intact and working properly and to correct problems as needed.
10. Install runoff and drainage control features (e.g., berms and swales, slope drains) as necessary to avoid and minimize erosion.
11. Install wind erosion control features (e.g., application of hydraulic mulch or bonded fiber matrix).
12. Watertight forms and other containment structures will be used to prevent spills or discharge of raw concrete, wash water, and other contaminants from entering surface waters and other sensitive habitats during overwater activities (e.g., casting of barge decks)

Sediment control measures will include:

13. Use sediment ponds, silt traps, wattles, berms, barriers, physical treatment facilities, or similar measures to slow water velocity and retain sediment transported by on-site run on or runoff.
14. Collect and direct surface run on and runoff at non-erosive velocities to on-site treatment facilities for storage and reuse as needed with controlled flows and velocities to drainage courses.
15. When ground-disturbing activities are required adjacent surface water, wetlands, or aquatic habitat, use sediment and turbidity barriers, treatment facilities, soil stabilization, and revegetation of disturbed surfaces.
16. Prevent mud from being tracked onto public roadways by installing gravel on primary construction ingress/egress points, rumble plates, and/or truck tire washing.
17. Deposit or store excavated materials away from drainage courses and apply soil stabilization materials if left in place for more than 5 days or storm events are forecast within 48 hours.

After construction is complete, site-specific restoration efforts will include grading, post construction BMPs for erosion control, and revegetation. Self-sustaining, local native plants that require little or no maintenance and do not create an extreme fire hazard will be used. All disturbed areas will be graded, recontoured to pre-project contours, as feasible, and seeded with a native seed mix. Consideration will also be given to additional replacement of or upgrades to drainage facilities to avoid and minimize erosion. Paved areas damaged by construction activities will be repaved to avoid erosion due to pavement damage. Once post construction BMPs are constructed and revegetation is appropriately established, a Notice of Termination will be filed with the State Water Board. DWR will apply for a long-term SWPPP permit with the Central Valley Water Board for operations of the intake, tunnel shaft, and Bethany Complex sites that will include long-term erosion control plans.

### 3A.1.5 AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans

Project activities that disturb 1 or more acres of land have the potential to alter stormwater runoff. This includes project activities that require excavation, grading, or stockpiling material at project sites, which could result in temporary and/or permanent changes to drainage patterns, paths, and facilities that would, in turn, cause changes in drainage flow rates, directions, and velocities of runoff, or constituents of runoff. Construction sites for the intakes, tunnel shafts, concrete batch plants, and Bethany Complex would include facilities to capture and divert all runoff, dewatering, and decant flows (from soil material storage areas) to on-site treatment facilities for direct on-site reuse or on-site storage. If these flows exceed the on-site reuse demand or storage capacities, the treated water would be discharged into adjacent water bodies. Construction sites for access roads and installation activities for electrical and SCADA connections would include methods described in this section to protect water quality of adjacent waterbodies.[5]

DWR will require that the construction contractors implement measures, as described below, as part of the construction activities and in advance of any necessary permit(s). In accordance with this AMM, DWR will require the preparation and implementation of SWPPPs to control short-term and long-term effects associated with construction-generated stormwater runoff. The SWPPPs will include all the necessary state requirements regarding construction-generated stormwater collection, detention, treatment, and discharge that will be in place throughout the construction period.

For the proposed action, a series of separate but related SWPPPs will be prepared by a Qualified SWPPP Developer (QSD) and will be implemented under the supervision of a Qualified SWPPP Practitioner (for each construction site and/or each construction contract). As part of the procedure to gain coverage under the CGP, the QSD will determine the "Risk Level" (Levels 1, 2, or 3, or Types 1, 2, or 3 for linear underground/overhead projects) of the construction activities covered by a given SWPPP, which involves an evaluation of the site's "Sediment Risk" and "Receiving Water Risk." The risk level of the site will be determined based on the probability of a significant risk of causing or contributing to an exceedance of a water quality standard based on the construction activities to be performed, the existing water quality, and soil and sediment conditions, without additional requirements (pursuant to Order No. 2009-0009-DWQ as amended by Order Nos. 2010-0014-DWQ and 2012-2006-DWQ).

The risk is calculated separately for sediment and receiving water, with two risk categories for receiving water (low and high) and three risk categories for sediment risk (low, medium, and high). The overall project risk levels (1, 2, or 3) are then determined through a matrix, where Risk Level 1 applies to projects with low receiving water and sediment risks, Risk Level 3 for projects with high receiving water and sediment risks, and Risk Level 2 for all other combinations of sediment and receiving water risks. These project risk levels determine the level of protection (i.e., the BMPs to be used) and monitoring that is required for the proposed action. If the site is Risk Level 2 or 3, water sampling for pH and turbidity will be required and the SWPPP will specify sampling locations and

[5] These activities are regulated under the Construction General Permit for Construction and Land Disturbance Activities (Construction General Permit [CGP]) (Order 2010-0014-DWQ or any more recent version) issued from the State Water Resources Control Board (State Water Board). The CGP requires the development and implementation of a stormwater pollution prevention plan for NPDES permit coverage for stormwater discharges.

schedule, sample collection and analysis procedures, and recordkeeping and reporting protocols. Other typical requirements for such situations are provided below under Risk Levels 2 and 3.

Table 3A-1 shows how varying sediment risk and receiving water risk combine to result in a given Risk Level for a given construction site.

**Table 3A-1. Combined Risk Level Matrix**

| | | **Sediment Risk** | | |
|---|---|---|---|---|
| | | **Low** | **Medium** | **High** |
| Receiving Water Risk | Low | Level 1 | Level 2 | |
| | High | Level 2 | | Level 3 |

Changes in runoff characteristics associated with construction activities have the potential to be detrimental to special-status fish and wildlife species as well as aquatic habitat and natural communities associated with receiving waters, through changes in ambient water temperature, sediment, and pollutants resulting from stormwater runoff. The objectives of the SWPPPs will be to (1) identify pollutant sources associated with construction activities and operations that may affect the quality of stormwater and (2) identify, construct, and implement stormwater pollution prevention measures to reduce pollutants in stormwater discharges during and after construction. The SWPPP will be kept on-site during construction activity and operations and will be made available upon request.

The SWPPP will describe site topographic, soil, and hydrologic characteristics; construction activities and schedule; construction materials to be used, including sources of imported fill material, and other potential sources of pollutants at the construction site; potential non-stormwater discharges (e.g., trench dewatering); erosion and sediment control measures; "housekeeping" BMPs to be implemented; a BMP implementation schedule; a site and BMP inspection schedule; and ongoing personnel training requirements. The SWPPP will also include a hazardous materials management plan. These provisions are intended to prevent water quality degradation related to pollutant discharge to receiving waters and to prevent or constrain changes to the pH of receiving waters. Performance standards are expected to be specified in the CGP and will be met by implementing stormwater pollution prevention BMPs that are tailored to specific site conditions, including the Risk Level of individual construction sites. These measures mirror the requirements to gain and maintain coverage under the anticipated CGP. DWR will consult with the appropriate Regional Water Quality Control Board (RWQCB) or State Water Board to determine the appropriate aggregation of specific construction activities, or groups of activities, to be authorized under the CGP.

Multiple SWPPPs will be prepared for project-related construction activities, with a given SWPPP prepared to cover a particular water conveyance component, groups of components (e.g., intakes), and site-specific conditions (e.g., proximity to surface water, drainage). The risk level will be identified for each action covered by a specific SWPPP.

These SWPPPs will generally follow the U.S. Environmental Protection Agency (EPA) (2007) guidelines for such plans and would typically identify the following list of BMPs. These BMPs are requirements common to all Risk Level sites; however, some detail is provided in "Inspection and Monitoring" on various Risk Level requirements.

1. Erosion Control Measures.
    a. Implement effective wind erosion BMPs, such as watering, application of soil binders/tackifiers, and covering stockpiles.
    b. Provide effective soil cover for inactive areas and all finished slopes and utility backfill areas, such as seeding with a native seed mix, application of hydraulic mulch and bonded fiber matrices, and installation of erosion control blankets and rock slope protection.
2. Sediment Control Measures.
    a. Prevent transport of sediment at the construction site perimeter, toe of erodible slopes, soil stockpiles, and into storm drains.
    b. Capture sediment via sedimentation and stormwater detention facilities.
    c. Reduce runoff velocity on exposed slopes.
    d. Reduce off-site sediment tracking.
3. Management Measures for Construction Materials.
    a. Cover and berm inactive stockpiled construction materials.
    b. Store chemicals in watertight containers.
    c. Minimize exposure of construction materials to stormwater.
    d. Designate refueling and equipment inspection/maintenance locations.
    e. Control of drift and runoff from areas treated with herbicides, pesticides, and other chemicals that may be harmful to aquatic habitats.
4. Waste Management Measures.
    a. Prevent off-site disposal or runoff of any rinse or wash waters.
    b. Implement concrete and truck washout facilities and appropriately sized storage, treatment, and disposal practices.
    c. Require the containment of sanitation facilities (e.g., portable toilets).
    d. Clean or replace sanitation facilities (as necessary) and inspect regularly for leaks/spills.
    e. Cover waste disposal containers during rain events and at end of every day.
    f. Protect stockpiled waste material from wind and rain.
5. Construction Site Dewatering and Pipeline Testing Measures.
    a. Reclaim site dewatering discharges to the extent practicable, or use for other construction purposes (e.g., land application for dust control).
    b. Implement appropriate treatment and disposal of construction site dewatering from excavations to prevent discharges to surface waters, unless permitted by regulatory agencies to discharge to surface waters.
6. Accidental Spill Prevention and Response Measures.
    a. Maintain equipment and materials necessary for cleanup of accidental spills on-site.
    b. Clean up accidental spills and leaks immediately and dispose of properly.

c. Require that there are trained spill response personnel available.

7. Non-stormwater Management Measures.
   a. Control all non-stormwater discharges during construction.
   b. Wash vehicles in such a manner as to prevent non-stormwater discharges to surface waters.
   c. Clean streets in such a manner as to prevent non-stormwater discharges from reaching surface water.
   d. Discontinue the application of any erodible landscape material during rain, or within 2 days before a forecasted rain event.
8. Inspection and Monitoring Common to All Risk Levels.
   a. Require that all inspection, maintenance, repair, and sampling activities at the construction site will be performed or supervised by a QSP representing the discharger.
   b. Develop and implement a written site-specific Construction Site Monitoring Program (CSMP).
9. Inspection, Monitoring, and Maintenance Activities Based on the Risk Level of the Construction Site (as defined in the State Water Board CGP).
   a. Risk Level 1 Sites:
      1) Perform weekly inspections of BMPs, and at least once each 24-hour period during extended storm events.
      2) At least 2 business days (48 hours) prior to each anticipated qualifying rain event (a rain event producing 0.5 inch or more of precipitation), visually inspect: (a) stormwater drainage areas to identify any spills, leaks, or uncontrolled pollutant sources; (b) all BMPs to identify whether they have been properly implemented in accordance with the SWPPP; and (c) stormwater storage and containment areas to detect leaks and require maintenance of adequate freeboard.
      3) Visually observe stormwater discharges at all discharge locations within two business days (48 hours) after each qualifying rain event and identify additional BMPs as necessary, and revise the SWPPP accordingly.
      4) Conduct minimum quarterly visual inspections of each drainage area for the presence of (or indications of prior) unauthorized and authorized non-stormwater discharges and their sources.
      5) Collect one or more samples of construction site effluent during any breach, malfunction, leakage, or spill observed within the construction site during a visual inspection that could result in the discharge of pollutants to surface waters whether visually detectable or not.
   b. Risk Level 2 Sites:
      1) Perform all of the same visual inspection, monitoring, and maintenance measure specified for Risk Level 1 sites.

2) Perform sampling and analysis of stormwater discharges to characterize discharges associated with construction activity from the entire disturbed area at all discharge points where stormwater is discharged offsite.

3) At a minimum, collect and analyze a minimum of three samples per day for pH and turbidity during qualifying rain events. The CGP also requires the discharger to revise the SWPPP and to immediately modify existing BMPs and/or implement new BMPs such that subsequent discharges are below the relevant Numeric Action Levels (NALs) specified by the CGP. It may be a violation of the CGP if the discharger fails to take corrective action to reduce the discharge below these NALs specified by the CGP.

4) When an active treatment system is deployed on the site or a portion of the site, collect active treatment system effluent samples and measurements from the discharge pipe or another location representative of the nature of the discharge.

5) In the event that any effluent sample exceeds an applicable NAL, Risk Level 2 dischargers will submit all storm event sampling results to the State Water Board no later than 10 days after the conclusion of the storm event. The Regional Boards have the authority to require the submittal of an NAL Exceedance Report, which includes a description of the current BMPs associated with the effluent sample that exceeded the NAL and the proposed corrective actions taken.

c. Risk Level 3 Sites:

1) Perform all of the same visual inspection, monitoring, and maintenance measure specified for Risk Level 1 and Risk Level 2 sites.

2) In the event that a numeric effluent limitation (NEL) of the CGP (i.e., pH and turbidity) is exceeded and has a direct discharge into receiving waters, the discharger will subsequently sample receiving waters for all parameter(s) monitored in the discharge. An exceedance of an NEL is considered a violation of the CGP, and the discharger must electronically submit all storm event sampling results to the State and Regional Water Boards via Stormwater Multiple Application and Report Tracking System (SMARTS) no later than 5 days after the conclusion of the storm event.[6]

3) If disturbing 30 acres or more of the landscape and discharging directly into receiving waters, conduct a benthic macroinvertebrate bioassessment of receiving waters prior to and after commencement of construction activities to determine if significant degradation to the receiving water's biota has occurred. However, if commencement of construction is outside of an index period (i.e., the period of time during which bioassessment samples must be collected to produce results suitable for assessing the biological integrity of streams and rivers) for the site location, the discharger will participate in the State of California's Surface Water Ambient Monitoring Program.

The SWPPP will also specify the forms and records that must be uploaded to the State Water Board online SMARTS, such as quarterly non-stormwater inspection and annual compliance reports.

[6] The State Water Board has suspended the applicability of NELs for pH and turbidity at Risk Level 3/LUP Type 3 construction sites. In addition, because receiving water monitoring is required only if the NELs are triggered, all receiving water monitoring requirements are also suspended. The Level 3/Type 3 NEL requirements are presented here assuming that such NELs will be reinstated when project construction commences.

If the QSP determines the site is Risk Level 2 or 3, water sampling for pH and turbidity will be required and the SWPPP will specify sampling locations and schedule, sample collection and analysis procedures, and recordkeeping and reporting protocols. In accordance with the CGP numeric action level requirements, the contractor's QSD will revise the SWPPP and modify existing BMPs or implement new BMPs when effluent monitoring indicates that daily average runoff pH is outside the range of 6.5 to 8.5 and that the daily average turbidity is greater than 250 nephelometric turbidity units (NTUs). Such BMPs may include construction of sediment traps and sediment basins, use of Baker or other type tanks, installation of rock slope protection, covering of active stockpiles in event of rain, constructing desilting basins, and use of ATS. The ability of other areas to withstand excessive erosion and sedimentation may be increased by applying additional mulching, bonded fiber matrices, and erosion control blankets; reseeding with a native seed mix; and installation of additional fiber rolls, silt fences, and gravel bag berms. The QSD may also specify changes in the manner and frequency of BMP inspection and maintenance activities. The determination of which BMP should be applied in a given situation is very site-specific. QSDs typically refer to the California Stormwater Quality Association's *Stormwater Best Management Practice Handbook Portal: Construction* or the similar Caltrans manual for selecting BMPs for particular site conditions.

Additionally, if a given construction component is Risk Level 3, for that component DWR will report to the State Water Board when effluent monitoring indicates that daily average runoff pH is outside the range of 6.0 to 9.0 or the daily average turbidity is greater than 500 NTUs. In the event that the turbidity NEL is exceeded, DWR may also be required to sample and report to the State Water Board pH, turbidity, and suspended sediment concentration of receiving waters for the duration of construction.

The contractor will also conduct sampling of runoff effluent when a leak, spill, or other discharge of non-visible pollutants is detected.

The CGP has specific monitoring and action level requirements for the Risk Levels, which are summarized in Table 3A-2.

**Table 3A-2. SWPPP Monitoring and Action Requirements**

| | Risk Level/Type | | |
|---|---|---|---|
| **SWPPP Requirements** | **1** | **2** | **3** |
| Minimum Stormwater and Non-Stormwater BMPs | ✓ | ✓ | ✓ |
| Numeric Action Levels (NALs), NAL for pH: 6.5–8.5 pH units, NAL for turbidity: 250 NTU | | ✓ | ✓ |
| Numeric Effluent Limitations (NELs), NEL for pH: 6–9 pH units, NEL for turbidity: 500 NTU | | | ✓ |
| Visual Monitoring (weekly; before, during, after rain events; non-stormwater) | ✓ | ✓ | ✓ |
| Runoff Monitoring | | ✓ | ✓ |
| Receiving Water Monitoring | | | ✓ |

Note: The State Water Board has suspended the applicability of NELs for pH and turbidity at Risk Level 3/LUP Type 3 construction sites. In addition, because receiving water monitoring is required only if the NELs are triggered, all receiving water monitoring requirements are also suspended. The Level 3/Type 3 NEL requirements are presented here assuming that such NELs will be reinstated when project construction commences.

BMP = best management practice; pH = potential hydrogen; NAL = Numeric Action Level; NEL = numeric effluent limitation; NTU = nephelometric turbidity unit.

The QSD preparing a SWPPP may include BMPs such as preservation of existing vegetation, perimeter control, seeding, mulching, fiber roll and silt fence barriers, erosion control blankets, protection of stockpiles, watering to control dust entrainment, rock slope protection, tracking control, equipment refueling and maintenance, concrete and solid waste management, and other measures to comply with the pH and turbidity level requirements defined by the CGP. Partly because the potential adverse effect on receiving waters depends on location of a work area relative to a waterway, the BMPs will be site-specific. For example, BMPs applied to level island-interior sites will be different than BMPs applied to water-side levee conditions. The QSP will be responsible for day-to-day implementation of the SWPPP, including BMP inspections, maintenance, water quality sampling, and reporting to the State Water Board. If the water quality sampling results indicate an exceedance of NALs and NELs for pH and turbidity, as described above, the QSD will modify the type and/or location of the BMPs by amending the SWPPP in order to reduce pH, turbidity, and other contaminants to acceptable levels, consistent with CGP NALs and NELs and with the water quality objectives and beneficial uses set forth in the *Water Quality Control Plan (Basin Plan) for the Sacramento River Basin and the San Joaquin River Basin* (Central Valley Regional Water Quality Control Board 2018).

DWR will apply for a long-term SWPPP permit with the Central Valley Water Board for operations of the intake, tunnel shaft, and Bethany Complex sites that will include long-term BMPs.

### 3A.1.6 AMM-5: Develop and Implement a Fire Prevention and Control Plan

DWR will develop and implement a fire prevention and control plan in consultation with the appropriate fire suppression agencies to verify that the necessary fire prevention and response methods are included in the plan. The plan will include fire prevention and suppression measures as appropriate for different activities and will consider the policies and standards in the affected jurisdictions.

At a minimum, the following components, as applicable, will be included in the plan. If a component is not applicable to a specific activity, DWR or its contractor will explain in the plan why that component or a portion thereof is not included in the plan.

1. If a fire should start, the appropriate fire protection agencies will be contacted immediately.
2. Procedures and policies for controlling any fires that are on the work site, and other related fire prevention and control procedures developed in consultation with and fire protection agencies.
3. Procedures for regular maintenance of safeguards installed on heat-producing equipment to prevent the accidental ignition of combustible materials.
4. A list of all major potential fire hazards, proper handling and storage procedures for hazardous materials, potential ignition sources and their control, and the type of fire protection equipment necessary to control each potential major hazard.
5. Smoking will be allowed only in areas designated for smoking, and these areas will be cleared of vegetation, or in enclosed vehicles. Cigarette butts are to be disposed of in car ashtrays or other approved disposal containers and dumped daily in a proper receptacle off the work site.
6. The contractor will be responsible for maintaining appropriate fire suppression equipment at the work site including a water truck or fire truck with a water tank with a capacity of at least

3,000 gallons. Fire extinguishers, shovels, and other firefighting equipment will be available at work sites and on appropriate construction equipment. The contractor will be required to require that each construction vehicle on the work site will be equipped with a minimum 20-pound (or two 10-pound) fire extinguisher(s).

7. At the work site, a sealed fire toolbox will be located at a point accessible in the event of fire. This fire toolbox will contain: one back-pack pump-type extinguisher filled with water, two axes, two McLeod fire tools, and shovels so that employees at the work site can be equipped to fight fire.
8. Gasoline-powered construction equipment with catalytic converters will be equipped with shielding or other acceptable fire prevention features. Internal combustion engines will be equipped with spark arrestors.
9. Welding sites will include fire prevention provisions.
10. The contractor will maintain contact with local firefighting agencies throughout the fire season for updates on fire conditions, and such fire conditions will be communicated daily to the on-site employees of the contractor and subcontractors daily.

In addition to the plan, fire protection will conform to the State Fire Marshal requirements and will be in full compliance with Cal/OSHA standards for fire safety and prevention. Public road modifications will be designed per the county or state standards, which includes adequate widths for first responders. The construction-only access roads would be designed with widths for large construction trucks, which would also be adequate for first responders and fire suppression equipment. Any fire hydrants will be located as deemed acceptable by the State Fire Marshal and will meet state government standards. Fire protection using water will be provided by a potable water system either from the nearest municipal clean water conveyance system or from a self-contained filtration and treatment system that takes water from an adjacent waterway or a site well or tank.

## 3A.1.7 AMM-6: Conduct Cultural Resources Awareness Training

Prior to the start of ground disturbance, a qualified archaeologist will conduct a mandatory cultural resources awareness training for all personnel involved in ground-disturbing work about cultural resources sensitivity in the construction footprint and cultural resources that could be encountered during work. Cultural resources awareness training will also be conducted for all operations and maintenance staff. Participants will be required to sign a form stating that they have received and understand the training. DWR will maintain the record of training and make it available to interested parties, including but not limited to State Historic Preservation Officer, the Advisory Council on Historic Preservation, local historical societies, and other interested parties such as local preservation and community organizations with a demonstrated interest in the resource, upon request. The foreman will require that the new personnel brought onto the construction staff receive the mandatory training before starting work.

In general, trainings will include the following components:

1. The need and legal requirements for resource avoidance and protection.
2. Types of materials that could indicate the presence of an archaeological resource.

3. Brief discussion of the cultural context for the area.
4. Roles and responsibilities, including an explanation regarding the authority of archaeological monitors to stop work if needed.
5. What to do when archaeological resources or human remains are encountered in work areas.
6. Avoidance and minimization commitments.
7. Consequences of violations of the laws and regulations protecting resources.

## 3A.1.8 AMM-7: Off-Road Heavy-Duty Engines

### 3A.1.8.1 Zero-Emission Equipment

DWR will reinforce state priorities for zero-emission equipment (including generators) during construction and operation of the project. Zero-emission equipment (e.g., electric, hydrogen fuel cell) does not produce any emissions during operation from the tailpipe. Requirements for use of these technologies will follow the phased approach that focuses on implementation feasibility that is described here.

1. At the start of each construction contract, prohibit use of fossil fuel–powered axial fans, gantry cranes, light plants, and forklifts. All construction contractors must use zero-emission versions of these equipment types.
2. By 2030, require 10% zero-emission off-road equipment in all construction contracts, where feasible (i.e., equipment is commercially available, is cost-effective, and has earned a track record of reliability in real-world construction conditions).
3. By 2035, require 100% zero-emission off-road equipment in all construction contracts, where feasible (i.e., equipment is commercially available, is cost-effective, and has earned a track record of reliability in real-world construction conditions).
4. At the start of and during project operation, require 100% zero-emission off-road equipment, where feasible (i.e., equipment is commercially available, is cost-effective, and has earned a track-record of reliability in real-world construction conditions).

DWR will support attainment of the performance standards by prioritizing contractors that operate zero-emission and electric off-road equipment and by offering contract incentives for compliance.

### 3A.1.8.2 Diesel Equipment

DWR will require all off-road diesel engines greater than or equal to 25 horsepower to use EPA-certified Tier 4 Final engines. This mandate does not preclude use of engines that meet certification standards more stringent than Tier 4 Final, if commercially available at the time of construction. A copy of each unit's certified tier specification, emissions rating, and any required California Air Resources Board (CARB) permit or air pollution control district operating permit will be made available to DWR at the time of mobilization of each piece of equipment. Each project contractor responsible for construction of a project facility will keep a written record (supported by equipment-hour meters where available) of equipment usage during project construction and maintenance for each piece of equipment. Each contractor will also provide DWR with monthly and annual reports of equipment operating hours documenting compliance.

All off-road diesel equipment with engines less than 25 horsepower (i.e., non–Tier 4) will be required to use renewable diesel fuel that meets the most recent ASTM D975 specification for ultra-low sulfur diesel and has a carbon intensity no greater than 50% of diesel with the lowest carbon intensity among petroleum fuels sold in California. Each project contractor responsible for construction of a project facility will provide DWR with monthly and annual reports of renewable diesel purchase records and equipment and vehicle fuel consumption. Pursuant to the In-Use Off-Road Diesel-Fueled Fleets Regulation (In-Use Regulation), contractors will also be required to submit to CARB an affirmation that the fleet complied with the renewable diesel mandate in each year that annual reporting is required under the In-Use Regulation.

All off-road diesel equipment will be required to minimize idling time either by shutting off when not in use or reducing idling time to 5 minutes (13 Cal. Code Regs. § 2449(d)(2)). Each project contractor responsible for construction of a project facility must provide clear signage that posts this requirement for workers at the entrances to the site.

## 3A.1.9 AMM-8: On-Road Haul Trucks

### 3A.1.9.1 Zero-Emission Vehicles

DWR will reinforce state priorities for zero-emission vehicles (ZEVs) during construction and operation of the project. A ZEV (e.g., electric, hydrogen fuel cell) does not produce any emissions during operation from the tailpipe. Requirements for use of these technologies will follow the phased approach that focuses on implementation feasibility that is described here.

1. At the start of each construction contract, require 100% light-duty ZEVs for on-site contractor travel, where feasible (i.e., vehicle is commercially available, is cost-effective, and has earned a track-record of reliability in real-world construction conditions). On-site light-duty vehicles are defined to include automobiles and pickup trucks that will exclusively operate within the construction right-of-way for at least 6 months.
2. By 2030, require 50% medium- and heavy-duty on-site ZEVs in all construction contracts, where feasible (i.e., vehicle is commercially available, is cost-effective, and has earned a track-record of reliability in real-world construction conditions). On-site vehicles are defined to include utility trucks, service trucks, water trucks, and dump trucks that will exclusively operate within the construction right-of-way for at least 6 months.
3. By 2035, require 75% medium- and heavy-duty on-site ZEVs in all construction contracts. On-site vehicles are defined to include utility trucks, service trucks, water trucks, and dump trucks that will exclusively operate within the construction right-of-way for at least 6 months.
4. By 2035, require 50% ZEVs for all off-site short-haul and drayage (i.e., within 10 miles of a project site), where feasible (i.e., vehicle is commercially available, is cost-effective, and has earned a track-record of reliability in real-world construction conditions).
5. At the start of and during project operation, require 100% ZEVs for all vehicle types, where feasible.

DWR will support attainment of the performance standards by prioritizing contractors that operate ZEVs and electric on-road vehicles and by offering contract incentives for compliance.

#### 3A.1.9.2 Diesel Vehicles

DWR will require all contractors to use diesel trucks that have model year engines manufactured or retrofitted ideally within the past 5 years from when the vehicles are brought to the individual construction or maintenance sites, but no more than 8 years from overall project groundbreaking. Each contractor will provide DWR with monthly and annual reports documenting compliance. All on-road diesel vehicles will be required to comply with California idling regulations (13 Cal. Code Regs. §§ 2485 and 2480).

### 3A.1.10 AMM-9: On-Site Locomotives

DWR will require all locomotives operating within Twin Cities Complex, and/or Lower Roberts Island to utilize EPA certified Tier 4 or more advanced engines. A copy of each unit's certified tier specification and any required CARB or air pollution control district operating permit will be made available to DWR at the time of mobilization of each locomotive. Each contractor will keep a written record (supported by engine-hour meters where available) of locomotive usage during project construction. Each contractor will provide DWR with monthly and annual reports of locomotive operating hours documenting compliance.

### 3A.1.11 AMM-10: Marine Vessels

DWR will require all marine vessels to operate engines no older than model year 2010 (manufactured or retrofitted) during geotechnical investigations. All marine vessels working on intake construction will be required to operate engines no older than model year 2020 (manufactured or retrofitted). A copy of each vessel's engine specifications will be made available to DWR at the time of mobilization of each vessel. Each contractor will keep a written record (supported by engine-hour meters where available) of engine usage during project construction. Each contractor will provide DWR with monthly and annual reports of engine operating hours documenting compliance.

### 3A.1.12 AMM-11: Fugitive Dust Control

DWR will require that all contractors employ the following measures to minimize and control fugitive dust emissions.

1. Water exposed soil during active construction with adequate frequency for continued moist soil and to prevent visible dust from leaving work areas. Frequency of watering will be increased during especially dry or windy periods or in areas with high construction activity. Active work areas include (but are not limited to), graded areas, excavation areas, and demolition sites.
2. Gravel and cover all on-site vehicle travel routes with chip-seal, or apply dust suppressants (e.g., Soil-Sement, PennzSuppress) on all ungraveled travel routes. On-site vehicle travel routes include (but are not limited to), staging areas, access roads, and haul areas.
3. Apply and maintain an organic biopolymer tackifier on all stockpiles during active use.
4. Cover or maintain at least 2 feet of freeboard space on haul trucks and rail cars transporting soil, sand, or other loose material on the site. Haul trucks and rail cars transporting soil, sand, or other loose material that will be traveling along freeways, major roadways, or railways will be covered.

5. If practicable, install wind breaks (e.g., plant trees, solid fencing) on the average dominant windward side(s) of construction areas. For purposes of implementation, chain-link fencing with added landscape mesh fabric adequately qualifies as solid fencing.
6. Enclose all mechanical dryers and conveyors.
7. Plant vegetative ground cover (native grass/plant seed) in disturbed areas (including stockpiles) as soon as reasonable after construction is completed. Water appropriately until vegetation is established.
8. Promptly finish and/or protect and maintain all disturbed areas in a manner to control fugitive dust. Mulch, dust palliative, soil binders, or other reasonable measures will be used in all inactive areas.
9. Establish and enforce a 15-miles-per-hour speed limit for vehicles driving on unpaved portions of project construction sites.
10. Use wet power vacuum street sweepers to remove any visible trackout mud or dirt onto adjacent public roads at least once a day. Use of dry power sweeping is prohibited.
11. Install rattle plates, stabilized construction entrances/exits at construction exits, where feasible. Install tire wheel wash facilities at construction sites with entrances and exits, where feasible.
12. Post a publicly visible sign with the telephone number and person to contact at the lead agency regarding dust complaints. This person will respond and take corrective action within 48 hours. The phone number of the air quality management district will also be visible to confirm compliance.

## 3A.1.13 AMM-12: On-Site Concrete Batching Plants

DWR will require that the following measures be implemented to control fugitive dust emissions during concrete batching activities.

1. Apply best available control technology (BACT) (e.g., water and/or chemical suppressants) to reduce fugitive dust emissions from active storage piles and during aggregate and sand delivery, storage, and transfer.
2. Apply BACT (e.g., water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central dust collection systems) to reduce fugitive dust emissions during cement delivery and hopper and central mix loading.

Prior to beginning operations, batch plant managers must provide to DWR documentation that each batch plant meets this standard during operation.

## 3A.1.14 AMM-13: DWR Best Management Practices to Reduce GHG Emissions

DWR will require all construction contractors to implement the following applicable greenhouse gas (GHG) BMPs, which are outlined in DWR's *Climate Action Plan Phase I: Greenhouse Gas Emissions Reduction Plan Update 2020* (California Department of Water Resources 2020).

### 3A.1.14.1 Preconstruction and Final Design BMPs

Preconstruction and final design BMPs are designed to ensure that individual projects are evaluated and their unique characteristics taken into consideration when determining if specific equipment, procedures, or material requirements are feasible and efficacious for reducing GHG emissions from the proposed action.

1. **BMP 1.** Evaluate project characteristics, including location, project work flow, site conditions, and equipment performance requirements, to determine whether the specifications for the use of equipment with repowered engines, electric drive trains, or other high-efficiency technologies are appropriate and feasible for the proposed action or specific elements of the proposed action.
2. **BMP 2**. Evaluate the feasibility and efficacy of performing on-site material hauling with trucks equipped with on-road engines.
3. **BMP 3.** Confirm that all feasible avenues have been explored for providing an electrical service drop to the construction site for temporary construction power. When generators must be used, use alternative fuels, such as propane, or solar power, to power generators to the maximum extent feasible.
4. **BMP 4**. Evaluate the performance requirements for concrete used on the proposed action and specify concrete mix designs that minimize GHG emissions from cement production and curing while preserving all required performance characteristics.
5. **BMP 5**. Limit deliveries of materials and equipment to the site to off peak traffic congestion hours.

### 3A.1.14.2 Construction BMPs

Construction BMPs apply to all construction and maintenance projects that DWR completes or for which DWR issues contracts. All projects are expected to implement all Construction BMPs unless a variance is granted by the Division of Engineering Chief, Division of Operation and Maintenance Chief, or Division of Flood Management Chief, as applicable, and the variance is approved by the DWR CEQA Climate Change Committee. Variances will be granted when specific project conditions or characteristics make the BMP infeasible and where omitting the BMP will not be detrimental to the proposed action's consistency with the *Climate Action Plan Phase I: Greenhouse Gas Emissions Reduction Plan Update 2020* (California Department of Water Resources 2020).

6. **BMP 7.** Minimize idling time by requiring that equipment be shut down after five minutes when not in use (as required by the State airborne toxics control measure [13 Cal. Code of Regs. § 2485]). Provide clear signage that posts this requirement for workers at the entrances to the site and provide a plan for the enforcement of this requirement.
7. **BMP 8.** Maintain all construction equipment in proper working condition and perform all preventative maintenance. Required maintenance includes compliance with all manufacturer's recommendations, proper upkeep and replacement of filters and mufflers, and maintenance of all engine and emissions systems in proper operating condition. Maintenance schedules will be detailed in an Air Quality Control Plan prior to commencement of construction.
8. **BMP 9.** Implement tire inflation program on jobsite to confirm that equipment tires are correctly inflated. Check tire inflation when equipment arrives on site and every two weeks for equipment that remains on site. Check vehicles used for hauling materials off site weekly for

correct tire inflation. Procedures for the tire inflation program will be documented in an Air Quality Management Plan prior to commencement of construction.

9. **BMP 10.** Develop a project specific ride share program to encourage carpools, shuttle vans, transit passes and/or secure bicycle parking for construction worker commutes.
10. **BMP 11.** Reduce electricity use in temporary construction offices by using high efficiency lighting and requiring that heating and cooling units be Energy Star compliant. Require that all contractors develop and implement procedures for turning off computers, lights, air conditioners, heaters, and other equipment each day at close of business.
11. **BMP 12.** For deliveries to project sites where the haul distance exceeds 100 miles and a heavy-duty class 7 or class 8 semi-truck or 53-foot or longer box type trailer is used for hauling, a SmartWay[7] certified truck will be used.
12. **BMP 13.** Minimize the amount of cement in concrete by specifying higher levels of cementitious material alternatives, larger aggregate, longer final set times, or lower maximum strength where appropriate.
13. **BMP 14.** Develop a project specific construction debris recycling and diversion program to achieve a documented 50% diversion of construction waste.
14. **BMP 15.** Evaluate the feasibility of restricting all material hauling on public roadways to off-peak traffic congestion hours. During construction scheduling and execution minimize, to the extent possible, uses of public roadways that are not designated as construction haul routes during peak commuting hours.

## 3A.1.15 AMM-14: Construction Best Management Practices for Biological Resources

DWR will require all construction and restoration activities in and adjacent to suitable habitat for special-status species and sensitive natural communities implement BMPs and have construction monitored by qualified biologists (experience with the resources and environmental compliance training and monitoring). Depending on the resource of concern and construction timing, construction activities and areas will be monitored for compliance with water quality regulations (SWPPP monitor, see AMM-4b: *Develop and Implement Stormwater Pollution Prevention Plans*).

Before initiating construction, DWR or its contractor, with DWR approval, will prepare a site or activity-specific environmental compliance monitoring plan to monitor, enforce and document measures to protect special-status fish, wildlife, plant species, and their habitats, designated critical habitat, and sensitive natural communities. The plan will include the following elements.

1. Reference to or inclusion of the SWPPP prepared under the CGP, where one is needed. (See AMM-4b: *Develop and Implement Stormwater Pollution and Prevention Plans.*)

[7] The EPA has developed the SmartWay truck and trailer certification program to set voluntary standards for trucks and trailers that exhibit the highest fuel efficiency and emissions reductions. These tractors and trailers are outfitted at point of sale or retrofitted with equipment that significantly reduces fuel use and emissions including idle reduction technologies, improved aerodynamics, automatic tire inflation systems, advanced lubricants, advanced powertrain technologies, and low rolling resistance tires. EPA Smartway (https://www.epa.gov/smartway).

2. Summaries or copies of planning and preconstruction surveys (if applicable) for natural communities and special-status species.
3. Description of mitigation measures to be implemented, including a description of site or activity-specific BMPs or additional measures not otherwise included in the proposed action.
4. Descriptions of monitoring parameters (e.g., turbidity), including the specific activities to be monitored (e.g., dredging, grading activities) and monitoring frequency and duration as well as parameters and reporting criteria (e.g., turbidity is not to exceed 10 NTUs above background. Exceedances will be reported and the contractor must identify and correct the cause.).
5. Description of roles and responsibilities of the monitors and protocols for notifying CDFW, NMFS, and USFWS, if needed.
6. A daily monitoring log prepared by the monitor, which documents the day's construction activities, notes any problems identified and solutions implemented to rectify those problems, and document notifications of the construction superintendent and/or the fish and wildlife agencies regarding any exceedances of specific parameters (i.e., turbidity) or observations of special-status species. The monitoring log will also document construction start/end times, weather and general site conditions, and any other relevant information.

The following measures will be implemented prior to and during construction activities and field investigations for the protection of special-status fish, wildlife and plant species and their habitats, designated critical habitats, and sensitive natural communities. Additional measures may be developed for site-specific conditions or specific biological resources during the review and preconstruction planning of individual work areas.

7. All in-water construction All in-water construction activities where special-status species are known or have a potential to occur will be conducted during the allowable in-water work windows established by the USFWS, NMFS, and CDFW for the protection of special-status fish or wildlife species. With regard to impact pile driving, work windows for the north Delta intakes may be lengthened subject to NMFS, CDFW, and USFWS approval based on success of bubble curtain or other noise attenuation methods and real-time monitoring for fish presence. In-water activities associated with mobilization and demobilization (e.g., initial movement of materials to construction sites) are not subject to the work windows. In-water impact pile installation may occur outside of the work windows if performed within a cofferdam, or behind the sheet pile training walls, and with in-channel acoustic monitoring to verify that generated sound thresholds do not exceed the 150-dB behavioral criterion as described in *Delta Conveyance Project Final Environmental Impact Report* (Final EIR) Chapter 12, *Fish and Aquatic Resources*, Impact AQUA-1: *Effects of Construction of Water Conveyance Facilities on Fish and Aquatic Species* at 10 meters from the cofferdam or sheet pile training walls. Apart from impact pile driving, any other in-water work may occur within a cofferdam, or behind the sheet pile training walls, regardless of the timing of in-water work windows. Any extension/reduction of in-water work windows would focus on half-month increments.
    a. Geotechnical exploration: August 1 to October 31.
    b. North Delta intakes: June 1 to October 31, except that in-water impact pile driving is unlimited during the period June 15 to September 15, and in-water impact pile driving is subject to the conditions noted above for the periods from June 1 to June 15 and September 15 to October 31.

c. Modified bridges: June 1 to October 31, except that in-water impact pile driving is unlimited during the period June 15 to September 15.

d. California Aqueduct (between Skinner Fish Facility, Banks Pumping Plant, and Bethany Reservoir) and Delta-Mendota Canal (between Tracy Fish Collection Facility and Jones Pumping Plant): January 1 through December 31.

e. Work in the Delta except for the north Delta intakes, modified bridges, and California Aqueduct and Delta-Mendota Canal: August 1 to October 31.

8. Qualified biologists will monitor construction activities in areas identified during the planning stages and species/habitat surveys as having special-status fish, wildlife, and plant species or their habitats, designated critical habitat, and sensitive natural communities. The intent of the biological monitoring is to confirm that specific measures that have been integrated into the proposed action's design and permit requirements are being implemented correctly during construction and are working appropriately and as intended for the protection of special-status species, natural communities, and the environment in general.

9. Biological monitors will be professional biologists selected for their knowledge of the special-status species and natural communities that may be affected by construction activities. The qualifications of the biologist(s) will be presented to the fish and wildlife agencies for review and written approval, consistent with permits and authorizations. If a special-status species is observed in an active work area, the biological monitors will immediately provide the construction manager and contractor with its location and recommendations to address the species' presence and steps necessary to ensure the protection of the species consistent with permits and authorizations.

10. During construction, the non-disturbance buffers described under the special-status species' mitigation measures in Chapter 3, Section 3.6.2, Species-Specific Avoidance and Minimization Measures, will be established and maintained as necessary. A qualified biologist will monitor the site consistent with the requirements described for special-status species to enforce buffers and non-disturbance of sensitive resources.

11. Active construction and staging areas will be delineated with high-visibility temporary fencing at least 4 feet in height, flagging, or other barrier to prevent encroachment of construction personnel and equipment outside the defined project footprint. The location of fencing will be included in construction plans and/or EC sheets. Such fencing will be inspected and maintained daily by the construction foreman until completion of the proposed action. Status of the fencing will also be verified and documented by the biological monitor. The fencing or flagging will be removed from areas after all construction activities have ceased and equipment is removed. No project-related construction activities will occur outside the delineated project construction areas.

12. Project-related vehicles will observe a maximum speed limit of 15 miles per hour on unpaved non-public construction access roads and in construction sites where it is safe to do so. Paved, non-public construction access roads will observe a maximum speed limit of 30 miles per hour. Speeds limits will be posted in both directions and will be enforced. Signage would be provided for extra caution to be used on cool days when giant garter snake may be basking on roads and on rainy nights when California tiger salamander and California red-legged frog are most likely to be moving between breeding and upland habitats. Vehicles will observe a nighttime speed

limit of 10 miles per hour in construction sites within the Bethany Complex to avoid potential vehicle strikes of California red-legged frog, California tiger salamander, and San Joaquin kit fox.

13. All ingress/egress at the proposed action construction site will be restricted to those routes identified in the proposed action plans and description. Cross-country access routes will be clearly marked in the field with appropriate flagging and signs.
14. All vehicle parking will be restricted to established areas, existing roads, or other suitable areas.
15. To avoid attracting predators, all food-related trash items such as wrappers, cans, bottles, and food scraps will be disposed of in enclosed containers and trash will be removed and disposed of at an appropriate facility at least once a week from the construction or project site. All contracts with contractors will include language reminding them of the obligations to abide by all laws related to litter. These obligations will be applicable both within work areas and while traveling along public roads within the action area. Vehicles carrying trash will be required to have loads covered and secured to prevent trash and debris from falling onto roads and adjacent properties.
16. To avoid injury or death to wildlife, no firearms will be allowed on the proposed action site except for those carried by authorized security personnel or local, state, or federal law enforcement officials.
17. To prevent harassment, injury, or mortality of sensitive wildlife by dogs or cats, no pets will be permitted in the active construction area.
18. To prevent inadvertent entrapment of special-status wildlife during construction in areas that may be occupied by wildlife at risk for entrapment, all excavated, steep-walled holes or trenches more than 6 inches deep, with the exception of shaft excavation, will be covered at the close of each working day with plywood or similar material, or will be provided with one or more escape ramps constructed of earthfill or wooden planks at no more than a 30° angle. Shaft excavation sites are exempt from this measure because it would not be feasible to place a ramp into a vertical shaft. Rather than a vertical ramp inside the shaft, suitable barriers, approved by a qualified biologist prior to construction at the shaft site (e.g. chain link fence for large wildlife such as foxes and appropriate exclusion barriers for amphibians and reptiles), will be placed around the shaft opening to prohibit entry of wildlife into the shaft. Before such holes or trenches are filled, they will be thoroughly inspected for trapped animals.
19. If a special-status species is encountered during construction work, including dewatering, generally construction activities should be diverted away from the animal or, depending upon the conditions and specification in the relevant environmental documents and permits, work will cease until it moves out of the work area on its own or is relocated by a qualified biologist, following the species-specific mitigation measures appearing in the environmental documents and relevant permits. The monitor's authority to stop work will depend on the species encountered and the specific requirement of the relevant environmental documents and permits.
20. Capture and relocation of trapped or injured special-status wildlife can only be performed by personnel with appropriate USFWS and CDFW handling approvals. Any sightings and any incidental take will be reported to CDFW and USFWS via email within 1 working day of the discovery. A follow-up report will be sent to these agencies, including dates, locations, habitat description, and any corrective measures taken to protect special-status species encountered. For each special-status species encountered, the biologist will submit a completed CNDDB field

survey form (or equivalent) to CDFW no more than 90 days after completing the last field visit to the proposed action site.

21. Plastic monofilament netting or similar material will not be used for erosion control, because smaller wildlife may become entangled or trapped in it. Acceptable substitutes include coconut coir matting, burlap-wrapped straw wattles, or tackified hydroseeding compounds. This limitation will be communicated to the contractor through specifications or special provisions included in the construction bid solicitation package.
22. Wildlife, including special-status wildlife and their predators, can be attracted to den-like structures such as debris piles or pipes and may enter stored pipes and become trapped or injured. All pipes and culverts stored in the open will have their ends capped. Debris piles should be kept to a minimum and removed regularly. All construction, construction equipment, or construction debris left overnight in areas that may be occupied by wildlife that could occupy such structures will be inspected by the biological monitor prior to being used for construction. Such inspections will occur at the beginning of each day's activities, for those materials to be used or moved that day.
23. CDFW, NMFS and/or USFWS will be notified within 1 working day of the discovery of, injury to, or mortality of a special-status species that results from project-related construction activities or is observed at the proposed action site. Notification will include the date, time, and location of the incident or of the discovery of an individual special-status species that is dead or injured. For a special-status species that is injured or killed, general information on the type or extent of injury or likely cause of death will be included. The location of the incident will be recorded using a GPS and the coordinates will be made available upon requests by CDFW, NMFS and/or USFWS. The biologist is encouraged to include any other pertinent information in the notification. All observations of special-status species will be reported to the California Natural Diversity Database.
24. Rodenticides and herbicides will be used in accordance with the manufacturer-recommended uses and applications and in such a manner as to prevent primary or secondary poisoning of special-status fish, wildlife, and plant species and depletion of prey populations upon which they depend. Broadcast baiting will be avoided on all project-related and mitigation lands. Rodenticides will not be used on compensatory mitigation lands. All uses of such compounds will observe label and other restrictions mandated by EPA, the California Department of Pesticide Regulation, and other appropriate state and federal regulations, as well as additional project-related restrictions imposed by USFWS, NMFS and/or CDFW. If rodent control must be conducted in San Joaquin kit fox habitat, zinc phosphide should be used because of its proven lower risk to kit fox. Use of pesticides may be limited in other species-specific instances as well. In addition, the method of rodent control will comply with those discussed in the 4(d) rule published in the final listing rule for California tiger salamander (69 Federal Register [FR] 47211–47248).
25. The most recent available standard methods for species capture and handling, as well as species specific authorizations, will be used to capture and handle special-status fish or wildlife species. A professional biologist, with appropriate USFWS and CDFW handling approvals, will be responsible for and direct any efforts to capture and handle special-status species. Any person who captures and handles special-status species will ensure their hands are free of soaps, oils, creams, lotions, insect repellents, solvents or other potentially harmful chemicals and if not single use, nitrile or other hypo-allergenic gloves (non-latex) will be used for handling special-

status fish or wildlife. To avoid transferring diseases or pathogens between aquatic habitats during the course of surveys or the capture and handling of special-status fish or wildlife species, all species captured and handled will be released in a safe, aquatic environment as close to the point of capture as possible. When capturing and handing special-status amphibians, the biologists will follow the Declining Amphibian Population Task Force's Fieldwork Code of Practice (U.S. Fish and Wildlife Service 2019) or the most current applicable guidance. While in captivity, individual amphibians will be kept in a cool, moist, aerated environment such as a dark (e.g., green or brown) bucket containing a damp sponge. Containers used for holding or transporting these species will be sanitized and will not contain any standing water, unless transporting larvae or fish species.

26. The qualified biologist(s) will maintain monitoring records that include (1) the beginning and ending time of each day's monitoring effort; (2) a statement identifying the species encountered, including the time and location of the observation; (3) the time the specimen was identified and by whom and its condition; (4) the capture and release locations of each individual; (5) photographs and measurements of each individual; and (6) a description of any actions taken. The biologist(s) will maintain complete records in their possession while conducting monitoring activities and will immediately provide records to USFWS, CDFW, and NMFS upon request. If requested, all monitoring records will be provided to agencies according to the reporting requirements of the relevant permits.
27. Permanent and temporary construction disturbances and other types of ongoing project-related disturbance activities in suitable habitat for special-status species will be minimized by adhering to the following activities. Project designs will limit or cluster permanent project features to the smallest area possible while still permitting achievement of project goals. To minimize temporary disturbances, all project-related vehicle traffic and material storage will be restricted to established and/or designated ingress/egress points, construction areas, and other designated staging/storage areas. These areas will also be included in preconstruction and clearance surveys and, to the extent possible, will be established in locations disturbed by previous activities to prevent further effects.
28. Geotechnical investigations taking place on land over tunnel sections where there will be no surface disturbance during construction will avoid citing test trenches, CPTs, and borings in aquatic features, to the extent possible. This measure would not apply to the West Tracy Fault studies because these investigations need to take place along the fault alignment to gather the necessary information to support future designs.
29. Temporarily affected areas will be restored within 1 year to their pre-project conditions, including grade and hydrology. Areas to be restored to grassland will be reseeded with non-invasive native mix of grasses and flowering forbs. Revegetation will take place during the appropriate time of year for the species being planted. A vegetation restoration plan will be prepared to facilitate revegetation of the temporary disturbance footprints on-site for each of the covered species habitats; in addition, this plan shall ensure that the vegetation restoration plan is successfully implemented to restore covered species habitat. Where there are temporary impacts to potentially suitable, but unoccupied Mason's lilaeopsis (*Lilaeopsis masonii*) habitat, the vegetation restoration plan will require post-disturbance grading to elevations and hydrology suitable for Mason's lilaeopsis.

30. All equipment used for construction and habitat creation, enhancement, and management will be cleaned and inspected by a qualified biologist for terrestrial invasive plant or animal species prior to entering work areas and before moving between work areas.
31. Equipment to be used in aquatic habitats will be thoroughly cleaned and inspected for aquatic invasive plant propagules and animal species before entering aquatic habitats.

DWR will also develop an invasive plant species management and control plan prior to construction. The plan will ensure that invasive plant species and populations are kept below preconstruction abundance and distribution levels and will be developed in consultation with CDFW and local experts (e.g., California Invasive Plant Council). The invasive plant species management plan will include the following elements.

32. Documentation of preconstruction conditions.
33. Annual monitoring to document percent cover of native and nonnative invasive plant species.
34. Preparation of an annual report that includes the type, location, and quantity of the invasive plant species; the percent cover of invasive plant species for (i) the year prior to preconstruction, (ii) the current monitoring year, and (iii) any prior monitoring years; and a description of any management problems and remedial actions taken. Annual reports will be provided to CDFW on request.
35. Guidance provided by the California Invasive Plant Council (2012) for weed mapping field protocols and treatment plans, with particular attention given to species rated as high-level invasives with a negative ecological impact in California (California Invasive Plant Council 2006).

    Invasive plant species management and control techniques employed where necessary. For terrestrial species, these techniques include hand or mechanical removal, chemical treatment, and targeted livestock grazing for terrestrial species management; for aquatic species, these techniques include hand or mechanical removal and chemical treatment. Only chemicals approved for use for such purposes in California may be employed in any control action.

## 3A.1.16 AMM-15: Sediment Monitoring, Modeling, and Reintroduction Adaptive Management

It is estimated that the proposed action would entrain 4%–6% of the sediment load entering the Delta from the Sacramento River, which could have limited negative effects on turbidity and therefore on delta smelt habitat. A multi-step process to assess and minimize potential negative effects will be implemented where necessary. The process will include multi-year monitoring and estimation of sediment entrainment during initial operations following north Delta diversion construction; monitoring and modeling of potential effects relative to performance criteria based on the sediment entrainment estimates; and development and implementation of a sediment reintroduction plan should performance criteria have been exceeded. The process will be implemented by DWR and the permitting fish agencies (NMFS, USFWS, and CDFW) will have approval authority for products developed during the process (e.g., monitoring plans and annual reports).

The monitoring program will be the first step in the adaptive management process and will involve monitoring and estimating sediment entrainment during the first several years of operations

following north Delta diversion construction. Monitoring duration will be subject to input from agency review and independent peer review but is anticipated to be at least 5 years to account for hydrological variability. Methods for estimating sediment entrainment will be determined during the planning phase and may include measurement of suspended sediment concentration and flow in the Sacramento River upstream and downstream of the north Delta diversion, as well as in the water diverted by each intake. Annual monitoring plans and results reporting will receive initial and periodic independent peer reviews facilitated by the Delta Science Program, and will be subject to approval by NMFS, USFWS, and CDFW.

The second step of the process will involve monitoring and modeling of potential effects relative to performance criteria. The specifics of the performance criteria will be developed with the input of the permitting fish agencies and independent peer review. The performance criteria are expected to include assessments of habitat indicators such as the percentage of time that turbidity at monitoring stations exceeds an established threshold (e.g., 12 nephelometric turbidity units; Sommer and Mejia 2013). To account for the likely variability in sediment delivery caused by operations (i.e., sediment entrainment) and other factors (e.g., contribution of sediment from other tributaries), sediment modeling (e.g., using methods from Bever et al. 2018) will be used to approximate the incremental effects of operations given the estimates of sediment entrainment made during the first step of the process. Assessments of achievement of performance criteria will receive independent scientific peer review and will be subject to approval by NMFS, USFWS, and CDFW.

If the monitoring and modeling estimates of the second step indicate exceedance of performance criteria attributable to operations, the third step of the proposed process will be initiated. This step will involve development and implementation of a sediment reintroduction plan within 5 years of the end of step two. This plan will aim to reintroduce sediment to allow performance criteria to be met. Sources of sediment to be reintroduced may include proposed facilities (e.g., the north Delta diversion sediment lagoons), existing facilities (e.g., Clifton Court Forebay), or locations unrelated to the proposed action, and will account for factors such as sediment composition to meet performance criteria (e.g., fine particles for turbidity) and reintroduction location. Subject to approval by NMFS, USFWS, and CDFW, alternative means of achieving performance criteria may also be considered (e.g., restoration of turbid tidal habitat in the vicinity of areas that do not appear to be achieving performance standards). Modeling (e.g., using methods such as those of Bever and MacWilliams 2018, Bever et al. 2018) may be used to optimize sediment reintroduction locations relative to performance criteria to be achieved. The sediment reintroduction plan will be prepared to meet required permitting standards from the Central Valley RWQCB and USACE. The sediment reintroduction approach will be consistent with objectives for turbidity in the Central Valley Water Board's Water Quality Control Plan for the Sacramento River and San Joaquin River Basins, and, if necessary, will obtain coverage under an individual National Pollutant Discharge Elimination System (NPDES) permit. The permitting fish agencies and independent peer review facilitated by the Delta Science Program will review and provide input on the proposed sediment reintroduction plan and annual reports of its implementation and monitoring to assess achievement of performance standards. The sediment reintroduction plan and reports of its implementation and effectiveness will be subject to approval by NMFS, USFWS, and CDFW.

## 3A.1.17 AMM-16: Provide Notification of Construction and Maintenance Activities in Waterways

DWR will notify agencies, including the U.S. Army Corps of Engineers, the Department of Boating and Waterways, and the U.S. Coast Guard, before in-water construction or maintenance activities begin and will notify appropriate fish and wildlife agency representatives and others when these activities could affect water quality or aquatic species. The notification procedures will follow stipulations included in applicable permit documents for the construction. In general, the notification information will include site location(s), schedules, and work activities. Information on detours would include site-specific details regarding any temporary partial channel closures, including contacting other agencies and organizations, such as the U.S. Coast Guard, boating organizations, marina operators, city or county parks departments, and the California Department of Pesticide Regulation, where applicable. Before maintenance activities begin in waterways, DWR will require the posting of information regarding the maintenance of any in-water project facilities (e.g., intakes for the water conveyance facility) at nearby affected Delta marinas and public launch ramps. This information will include maintenance site location(s), maintenance schedules, speed limits, and identification of no-wake zone and/or detours, where applicable. Information on detours would include site-specific details regarding any temporary partial channel closures, including contacting the U.S. Coast Guard, boating organizations, marina operators, city or county parks departments, and California Department of Parks and Recreation, where applicable.

## 3A.1.18 AMM-17: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities

DWR will implement the following process and measures to avoid and minimize potential impacts on terrestrial biological resources when surface maintenance activities occur at DWR project facilities. Consistent with current DWR environmental clearance review procedures, qualified biologists will implement the following measures to avoid and minimize impacts on sensitive species, sensitive natural communities, and sensitive vegetation alliances during project maintenance activities. Additional measures may be developed for site-specific conditions or specific biological resources and implemented, as necessary. If additional permits and approvals are determined to be necessary through a subsequent consultation process, then the conditions of those permits and approvals will supersede the measures listed below.

1. Prior to the start of maintenance activities, a qualified team of biologists will conduct an environmental review of the potential for maintenance to affect sensitive resources. Using occurrence databases, aerial imagery, and prior knowledge of maintenance areas, a qualified team of biologists will evaluate the potential for suitable habitat for special-status species, sensitive natural communities, and/or cultural resources to occur in the maintenance footprint. A site visit may be conducted to verify whether sensitive resources have the potential to be present within the maintenance area. Based on the results of the desktop review and/or site visit, the following avoidance measures may be required, as appropriate for the timing, location, and nature of the maintenance activity.
2. Depending on the timing (see Chapter 4, *Action Area and Environmental Baseline*, for species-specific timing and suitable habitat definitions), location, and nature of the maintenance activity, a preconstruction survey may be required as determined by a qualified team of biologists to determine potential presence of suitable habitat for sensitive species prior to the start of

maintenance activities. Surveys will be conducted by a qualified biologist with experience identifying the resources in question using standard survey protocols and during appropriate timeframes specific to each sensitive resource. Surveys and monitoring will be conducted from locations where access allows.

3. Appropriate non-disturbance buffers will be applied around sensitive biological resources and habitat as determined by a qualified team of biologists during the environmental clearance review or preconstruction surveys. Non-disturbance buffers will be established by a qualified biologist and will take into consideration the nature of the maintenance activity, the sensitivity of the species, site-specific conditions, and applicable state and federal recommendations. See Chapter 3 for appropriate species-specific buffers. Maintenance activities will avoid impacts on rodent burrows, wetlands, or other areas that may provide potential habitat to avoid impacts on sensitive biological resources except when work in these habitats is required to ensure safety and integrity of facilities. Areas to be avoided will be flagged. Debris or cut vegetation will not be left where it may enter aquatic habitat. Non-disturbance buffers may be removed after a qualified biologist determines the sensitive resource is no longer present or at risk of impacts due to maintenance activities.
4. Appropriate work windows and weather restrictions will be applied to avoid impacts on sensitive biological resources identified during the environmental clearance review or preconstruction survey.
5. A Worker Awareness Training will be required if sensitive natural resources are present. DWR will provide training to maintenance personnel on the importance of protecting sensitive natural resources (e.g., special-status fish species, wildlife species, plant species, and designated critical and/or suitable habitats for these species). Pre-construction training will be conducted so that maintenance personnel are aware of their responsibilities and the importance of compliance. Construction personnel will be educated on the types of sensitive resources in the action area and the measures required to avoid and minimize impacts on these resources. Materials covered in the training program will include environmental rules and regulations for the specific site requirements for limiting activities to approved work areas, timing restrictions, and avoidance of sensitive resource areas (i.e., timing of special-status fish migration, spawning, and rearing; wildlife mating, nesting, and fledging; amphibian breeding and dispersal; and plant flowering periods). A record of personnel that completed the environmental training will be kept. Operations and maintenance personnel may also be required to complete the existing DWR environmental trainings at regular intervals such as the Employee Environmental Responsibility training.
6. Qualified biologists will monitor maintenance activities in areas identified during the environmental clearance review and preconstruction surveys as having special-status fish, wildlife, and plant species and their habitats, designated critical habitat, and sensitive natural communities.
7. Any wildlife that is encountered within the maintenance area will be avoided and allowed to move out of harm's way of its own accord.
8. Vegetation removal will be kept to the minimum necessary to accomplish maintenance need.
9. Spill prevention measures described under AMM-3: *Develop and Implement Spill Prevention, Control, and Countermeasure Plans* will be implemented to prevent and respond to petroleum product discharges into wetlands or waters of the United States and state.

10. Maintenance vehicles will observe a maximum speed limit of 15 miles per hour on un-paved non-public access roads where it is safe to do so, and 30 miles per hour on paved non-public access roads.
11. All ingress/egress at the proposed action site will be restricted to those routes identified in the proposed action plans and description. Cross-country access routes will be clearly marked in the field with appropriate flagging and signs.
12. All vehicle parking will be restricted to established areas, existing roads, or other suitable areas.
13. To prevent harassment, injury, or mortality of sensitive wildlife, no pets will be permitted in the maintenance area.
14. Plastic monofilament netting or similar material will not be used for erosion control, because smaller wildlife may become entangled or trapped in it. Acceptable substitutes include burlap-wrapped straw wattles, coconut coir matting or tackified hydroseeding compounds.
15. Rodenticides, pesticides, and herbicides will be used in accordance with the manufacturer recommended uses and applications and in such a manner as to prevent primary or secondary poisoning of special-status fish, wildlife, and plant species and depletion of prey populations upon which they depend. Broadcast baiting will be avoided on all project-related and mitigation lands. Rodenticides will not be used on compensatory mitigation lands. All uses of such compounds will observe label and other restrictions mandated by EPA, the California Department of Pesticide Regulation, and other appropriate state and federal regulations, as well as additional project-related restrictions imposed by USFWS, NMFS, and/or CDFW. If rodent control must be conducted in San Joaquin kit fox habitat, zinc phosphide should be used because of its proven lower risk to kit fox. Use of pesticides may be limited in other resource-specific instances as well. In addition, the method of rodent control will comply with those discussed in the 4(d) rule published in the final listing rule for California tiger salamander (69 FR 47211–47248).

## 3A.1.19 AMM-18: Avoid and Minimize Operational Traffic Impacts on Wildlife

DWR will implement the following measures to avoid and minimize wildlife-vehicle collisions on DWR facility access roads.

1. Vehicles will observe a maximum speed limit of 15 miles per hours on unpaved non-public DWR access roads where it is safe to do so. Vehicles will observe a maximum speed limit of 30 miles per hour on paved, non-public DWR access roads.
   Speed limits will be posted directions.
2. To the extent practicable, traffic control structures, such as speed bumps, will be utilized to reduce speeds.
3. Wildlife crossing signs will be posted in both directions on new or widened access roads that overlap with California red-legged frog and California tiger salamander aquatic and upland habitat, to the extent practicable.

## 3A.1.20 AMM-19: Minimize Fugitive Light from Portable Sources Used for Construction

1. DWR will minimize fugitive light, or light trespass, from portable lighting sources used during construction by adhering to the following practices, at a minimum.
    a. Portable lights will be operated at the lowest feasible wattage and height.
    b. All lights will be screened and directed down toward work activities and away from the night sky and nearby residents to the maximum extent safely possible.
    c. The number of nighttime lights used will be minimized to the greatest extent feasible.

Implementation of this measure will reduce—to the extent as governed by site-specific safety and fisheries protection requirements—the overall amount of new daytime and nighttime light and glare introduced to the proposed action vicinity during construction.

## 3A.1.21 AMM-20: Install Visual Barriers along Access Routes, Where Necessary, to Prevent Light Spill from Truck Headlights toward Residences

1. DWR will evaluate construction routes and identify portions of access routes where the use of visual barriers would minimize the introduction of new light and glare from construction truck headlights and the impact on nearby residents. Access routes could include SR 160, Hood-Franklin Road, West Walnut Grove Road, Mountain House Road, Byron Highway, and various levee roads.
    a. DWR will install a visual barrier along portions of access routes where screening would prevent excessive light spill toward residents from truck headlights being used during nighttime construction activities. DWR will also coordinate with local recreational interested parties to protect sensitive nighttime recreational resources, such as nighttime fishing spots, from construction truck headlight light spill. These visual barriers will meet the following performance criteria.
        1) The visual barrier will be a minimum of 5 feet high and will provide a continuous surface impenetrable by light. This height may be obtained by installing a temporary structure, such as fencing (e.g., chain link with privacy slats) or a semi-permanent structure, such as a concrete barrier (e.g., a roadway median barrier or architectural concrete wall system) retrofitted with an approved visual screen, if necessary, to meet the required height.
        2) The visual barriers will be of a material or have a color treatment appropriate for the location and traffic safety requirements. The use of glossy materials will be avoided.

## 3A.1.22 AMM-21: Develop and Implement a Noise Control Plan

DWR and project contractors will develop and implement a noise control plan consisting of pre-construction actions, sound-level monitoring, best noise control practices, and noise barriers

constructed in locations where sound levels from construction are anticipated to exceed daytime or nighttime noise level criteria. The frequency and duration of construction noise are also considered as factors in the implementation of these measures.

**Pre-construction Actions**

Future investigations test pile sound-level monitoring. Prior to construction, as a part of field investigations, pile testing would be done in the vicinity of one of the future intake locations where ground conditions are similar to intake areas (see Chapter 24, *Noise and Vibration,* of the Final EIR, Impact NOI-1: *Generate a Substantial Temporary or Permanent Increase in Ambient Noise Levels in the Vicinity of the Project in Excess of Standards Established in the Local General Plan or Noise Ordinance, or Applicable Standards of Other Agencies*[California Department of Water Resources 2023]). During pile testing, sound-level monitoring would be conducted to measure source sound levels from in-water pile driving. Noise modeling will be updated based on result of test pile sound-level monitoring.[8] Updated sound-level modeling will be used to determine where impacts would occur to receptors due to pile driving, to update the construction noise analysis for all facilities, based on daytime and nighttime noise level criteria described in Chapter 24 of the Final EIR (California Department of Water Resources 2023).

**Sound Insulation Program**

DWR will coordinate a program to offer sound insulation to property owners of residences and businesses where sound levels during construction of project facilities are predicted to exceed daytime or nighttime noise level criteria for a specified duration, notwithstanding other noise mitigation measures described below. The program would consist of, but would not be limited to, installation of dual pane windows, new or improved exterior doors, and new HVAC systems for qualifying homes.[9] Updated modeling will identify locations of sensitive receptors that would qualify for sound insulation.[10] The following two categories of residences would be eligible.

1. Residences where construction would exceed the daytime criterion of 60 dBA 1-hour $L_{eq}$ for more than 12 months.
2. Residences where night work would exceed the nighttime criterion of 50 dBA 1-hour $L_{eq}$ for more than 21 days.

Replacement or acoustical treatment of windows and doors can result in a noise reduction of 5 dB or more in interior rooms, depending on condition of existing construction. New HVAC systems would provide regulated internal temperatures of residential buildings, allowing for inhabitants to close their windows. To reduce the level of impact due to construction noise, this measure would require voluntary participation of all property owners and occupants of residences affected by project-related construction noise. The sound insulation program would continue to be available for property owners to opt in after facility construction begins.

[8] Sound level modeling in the Final EIR (California Department of Water Resources 2023) is developed for environmental review, to determine whether noise impacts would occur. Modeled source levels used in the Final EIR noise analysis are conservative. Source levels measured during test-pile installation would be representative of construction, and inclusion of measured data would improve the accuracy of the model.

[9] Furnace/heat pump systems are included so that residents can close their windows, reducing interior noise. Homes already with newer systems (installed within the last 8 years) would not qualify for replacement.

[10] The program would be done in coordination with Mitigation Measure AQ-6: *Avoid Residential Exposure to Localized Diesel Particulate Matter* presented in the Final EIR (California Department of Water Resources 2023).

### Sound-Level Monitoring

To address additional noise concerns during construction, SLMs will be installed at locations outside construction work areas to collect sound-level data continuously during long-term buildout of facilities (Intakes A, B and C, Twin Cities, and Bethany). SLMs will be located as near as possible to a location equidistant from the construction boundary to the nearest sensitive receptor, at a location where property access for this purpose is allowed. Sound-level data collected at each site will be used to verify compliance with daytime and nighttime noise limits. All SLMs will be programmed to run continuously and have the capability to access data remotely, so that data reviews and compliance reporting can be done on a weekly basis.

A daytime exceedance would occur if on-site equipment or truck noise during daytime hours (7:00 a.m. to 10:00 p.m.) is measured to exceed a daily average of 60 dBA 1-hour $L_{eq}$ for a period of more than 3 days in any 14-day period, or a daily average of 70 dBA 1-hour $L_{eq}$ for a period of more than 1 day in any 14-day period. A nighttime exceedance would occur if on-site equipment or truck noise during nighttime hours (10:00 p.m. to 7:00 a.m.) is measured to exceed a daily average of 50 dBA 1-hour $L_{eq}$ for a period of more than 3 days in any 14-day period.

In the event of an exceedance, DWR will contact affected residents to offer short-term relocation (or long-term, if preferred) assistance and/or measures stated above for the duration of the time construction is expected to exceed the specified levels.

To reduce the significance of Impact NOI-1 (California Department of Water Resources 2023) due to construction noise, this measure would require voluntary participation of all property owners of residences affected by project-related construction noise.

### Best Noise Control Practices

1. Construction hours**.** Construction activities will be restricted to certain hours of the day.
    a. Pile driving will be limited to the hours between 7:00 a.m. and 7:00 p.m.
    b. Construction will not occur during nighttime hours (10:00 p.m. to 7:00 a.m.), except for concrete pours, which, when they occur, will be done on a 24-hour basis as required at each new facility.[11]
    c. Off-site haul truck trips on local roads will be limited to the hours between 7:00 a.m. and 7:00 p.m., except for 24-hour concrete deliveries during continuous pours.
    d. Where workplace safety standards allow, dedicated backup monitors will be used instead of backup beepers on heavy equipment between 10:00 p.m. and 7:00 a.m.
2. Noise shrouds for pile drivers. Shrouds will be used to reduce noise from pile driving. A shroud or noise blanket of sufficient mass installed on pile-driver scaffolding is effective as a noise-reduction method for noise from impact hammers or vibratory pile drivers. A noise blanket has been shown to reduce pile hammer noise by 8 to 23 dBA (Teachout and Cushman 2005:8; Washington State Department of Transportation 2018:7–13).
3. Implementation of Quiet Zones around work areas. Construction work areas will include signage indicating areas that will be operated as "Quiet Zones." These signs will be located within areas

[11] The total durations of continuous pours would range from 1 week to 4 months and are specified for each facility. Pours at a given facility would not be consecutive over the total duration specified for nighttime pours.

where residences are more likely to be affected by noise from heavy equipment or trucks. Quiet Zones will limit truck idling time and require shut down of equipment (no idling). The zone will end at a distance approximately 700 feet from the nearest residence.[12]

4. Installation of enclosures around noise-generating equipment. If there are one or more dominant sources of noise in fixed locations where enclosures make a noticeable difference in overall ambient levels, then the use of this measure will be appropriate. This measure will substantially reduce levels from a single piece of equipment in a fixed location, such as a generator or ventilation fan. The achievable amount of noise reduction relative to a receptor will vary depending on the enclosure type and the location of equipment. For a given piece of equipment, sound reductions from an enclosure or silencer will typically be in the range of 8 to 25 dBA.

**Installation of Temporary Sound Barriers at Work Areas**

In the event of an exceedance during sound-level monitoring as defined above, a temporary sound barrier will be used to reduce noise from work areas where it is determined that use of barriers would be effective to reduce noise levels at sensitive receptor locations. A barrier of sufficient dimensions can effectively reduce noise from heavy equipment activity occurring at a construction site to levels below daytime and nighttime noise level criteria at sensitive receptors.

## 3A.1.23 AMM-22: Electrical Power Line Support Placement

1. DWR will contract with electric utilities to provide primary power to designated locations for project construction and operation. DWR will coordinate with electric utilities to design and construct power transmission and distribution lines and the locations of necessary appurtenances such as supports and substations to avoid sensitive terrestrial habitat by 150 feet and aquatic habitats by 250 feet and to minimize take and encumbrance of agricultural lands. Non-disturbance buffers will be determined by a qualified biologist in coordination with the electric utility provider and the size of the buffer will depend on the rarity and sensitivity of the resource as identified by the qualified biologist. In cases where sensitive habitat cannot be feasibly avoided, disturbance will be minimized to the greatest degree feasible, and disturbed areas will be returned as near as reasonably and practically feasible to preconstruction conditions by reestablishing surface conditions through carefully grading, reconstructing features such as irrigation and drainage facilities, and replanting vegetation and crops and/or compensating farmers for crops losses. This will be accomplished through an agreement with the utility providers. Implementation of this measure relies, in part, on coordination and cooperation with all appropriate utility providers and local agencies to integrate with other construction projects and minimize disturbances.
2. DWR will coordinate with electric utilities to design tower and pole placement and location of substations to avoid existing structures (such as ag irrigation infrastructure) by 50 feet. In cases where existing structures and improvements cannot be feasibly avoided, and clearances less than 50 feet are allowable (under Cal/OSHA Title 8 regulations and/or any requirements of the utility provider), DWR will relocate structures and improvements or compensate the owner for the loss, and will return temporarily disturbed areas to preconstruction conditions (as

[12] This is the distance where heavy equipment noise is expected to be 60 dBA 1-hour $L_{eq}$ or lower, according to modeling.

described in Mitigation Measure AG-1: *Preserve Agricultural Land* and Mitigation Measure AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties,* presented in Chapter 15, *Agricultural Resources*, of the Final EIR [California Department of Water Resources 2023]). Where poles or towers are to be constructed in agricultural areas, DWR will require incorporation of the following BMPs where feasible.

a. Select means and methods of construction to minimize crop damage.

b. Use single-pole structures instead of H-frame or other multiple-pole structures to reduce the potential for interference with farm machinery, reduce land impacts, and minimize weed encroachment issues.

c. Locate lines adjacent to roads and existing property lines to reduce property take and encumbrance.

d. Use transmission structures with longer spans to clear longer sections of fields or sensitive areas where feasible. Longer spans may not be feasible in areas where aerial spraying and seeding is common. In areas where aerial spraying and seeding are common, install highly visible markers on the shield wires above the conductors.

e. Minimize the use of guy wires, and keep guy wires out of crop and hay lands. Place highly visible shield guards on guy wires in farm vehicle and equipment traffic areas.

f. Locate new transmission lines along existing transmission line corridors.

g. Locate new powerlines on existing poles on same vertical plane as the existing wires.

3. As part of and prior to approval of construction, DWR will work with electric utilities to ensure incorporation of bird and raptor-safe design in accordance with the applicable recommendations presented by the Avian Power Line Interaction Committee (APLIC) in *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* (Avian Power Line Interaction Committee 2006) and *Reducing Avian Collisions with Power Lines: State of the Art in 2012* (Avian Power Line Interaction Committee 2012), or with more current guidance if it becomes available. Applicable APLIC recommendations include, but are not limited to:

   a. Ensuring sufficient spacing of phase conductors to prevent bird electrocution.

   b. Minimizing the use of guywires. Where the use of guywires is unavoidable, demarcating guywires using the best available methods to minimize avian collisions (e.g., line markers).

   c. Reusing or co-locating new transmission facilities and other ancillary facilities with existing facilities and disturbed areas to minimize habitat impacts and avoid potential collisions.

   d. Configuring lines to reduce vertical spread of lines and/or decreasing the span length if such options are feasible.

   e. Marking lines to increase the visibility of lines and reduce the potential for collision.

4. DWR will work with electric utilities to mark all aboveground project lines and towers with bird flight diverters that are visible under all conditions (e.g., glow-in-the-dark markers, near-UV line markers). Bird flight diverters will be installed with the following conditions:

   a. If a new project line will be placed on poles or towers with existing lines that have bird diverters installed, bird diverters will not be required on the new project lines if the new project lines can be placed within the same vertical prism as the existing lines.

b. If a new project line will be placed on poles or towers with existing lines but cannot be placed within the same vertical prism as the existing lines (e.g., a new project SCADA line that will be placed on a transmission tower with existing transmission lines), bird diverters will be required on both the new and existing lines.

5. DWR will work with electric utilities to:

a. Select the most effective and appropriate bird flight diverter for minimizing collisions based on APLIC recommendations (Avian Power Line Interaction Committee 2006, 2012), or more current guidance if available.

b. Install bird flight diverters in a configuration, frequency, and spacing consistent with APLIC recommendations (Avian Power Line Interaction Committee 2006, 2012), or more current guidance if available.

c. Periodically inspect and replace bird flight diverters as needed until or unless the project or existing line is removed.

## 3A.1.24 AMM-23: Develop and Implement a Mercury Management and Monitoring Plan

DWR will minimize methylmercury generation and mobilization into the food chain resulting from resulting from the CMP (Appendix 3B, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*) by developing a Mercury Management and Monitoring Plan (MMMP) to guide tidal habitat siting, design, monitoring, and adaptive management. The MMMP will require evaluation of site-specific conditions to assess whether the creation and existence of new tidal habitats would make the current Delta mercury impairment discernibly worse and include siting, design, monitoring, and adaptive management elements to minimize conditions within new tidal habitats that may be conducive to the creation or increased availability of methylmercury while still achieving most or all of the desired CMP benefits.

The MMMP objective will be to control levels of bioavailable methylmercury within the CMP tidal habitats such that aquatic organisms in waters within the CMP tidal habitats and immediately adjacent waterways that directly exchange water with the tidal habitats will not have measurably higher body burdens compared to those in comparable reference locations in the Delta, and thus CMP implementation will not make the current Delta mercury impairment discernably worse. The MMMP will serve as the framework for site-specific mercury management plans to be prepared for each proposed new tidal habitat site that address the MMMP elements (defined below) based on site-specific conditions.

DWR will retain a qualified water quality specialist, wildlife biologist, or fisheries biologist with expertise in methylmercury management to develop the MMMP.

**Mercury Management and Monitoring Plan Elements**

The MMMP will address the following elements to minimize and control measured mercury methylation and methylmercury bioavailability within CMP tidal habitats.

1. **Predesign field studies**—The MMMP will define the predesign field studies to be conducted at potential tidal habitat sites to characterize mercury sources and concentrations of mercury,

methylmercury, organic carbon, iron, and sulfate in surface water and sediment to inform tidal habitat design and post-restoration monitoring.

2. **Siting, design, source control, and management measures**—The MMMP will define tidal habitat siting, design, source control, and management measures to minimize mercury bioaccumulation into the foodweb so that mean tissue mercury concentrations in fish collected within and immediately adjacent to the CMP tidal habitats are not significantly greater than mercury tissue concentrations for the same species in similar habitats tidal habitat elsewhere in the Delta. Siting, design, source control, and management measures that will be considered and evaluated in the MMMP will include, but not be limited to, the following.

    a. Avoid siting tidal habitats in areas that currently have high soil or sediment mercury levels and minimize exposure of mercury-containing soils.

    b. Design for favorable water and sediment exchange with adjacent Delta waters to manage elemental mercury input and export of methylmercury over time (Davis et al. 2012:20).

    c. Minimize microbial methylation of mercury associated with anoxic or near-anoxic conditions by managing the amount of organic material at a restoration site and dissolved oxygen levels. This can be affected by managing vegetation to reduce this organic carbon source, which fuels mercury methylation by bacteria (California Department of Water Resources et al. 2020:7-1; Alpers et al. 2014:285).

    d. Manage vegetation to reduce organic carbon, which fuels mercury methylation by bacteria, by mechanical removal (California Department of Water Resources et al. 2020:7-1; Alpers et al. 2014:285; Windham-Myers et al. 2009:10).

    e. Minimize seasonal wetting/drying cycles that encourage mercury methylation (California Department of Public Health 2013:12).

    f. Minimize drainage through soils where mercury methylation is greatest (Bergamaschi et al. 2011:1369)

    g. Enhance photo-demethylation that converts methylmercury into a biologically unavailable, inorganic form of mercury (California Department of Public Health 2013:2).

    h. Control sediment mobilization into the tidal habitat and Delta waterways if particulates or sediment is determined to be a key source of mercury (California Department of Water Resources et al. 2020:7-1).

    i. Remediate tidal habitat soils with iron to reduce methylation in sulfide rich soils (McCord and Heim 2015:732).

    j. Current and ongoing research programs are providing information regarding mercury cycling in tidal wetlands. These include data from the Yolo Wildlife Area Tidal Wetland in the Yolo Bypass, Blacklock Tidal Wetland in Suisun Marsh, North Lindsey Slough Tidal Wetland in the Cache Slough Complex, and the Westervelt Cosumnes River Tidal Wetland east of the confluence of the Cosumnes and Mokelumne Rivers (California Department of Water Resources 2020:7). Several other tidal wetland restoration projects are being planned that will contribute to the available data informing management actions to minimize methylmercury generation and bioaccumulation in tidal wetlands. The CMP ecosystem restoration objectives will be considered throughout the development of the MMMP.

3. **Monitoring**—The MMMP will describe strategies to monitor and collect data to determine how well the design, source control, and management measures are affecting methylmercury concentrations in fish tissue at the new tidal habitats relative to comparable reference locations.
4. **Adaptive management**—The MMMP will describe actions to be taken to further reduce methylmercury concentrations in sediment, the water column, and fish tissues should they be shown to exceed performance standards. Adaptive management strategies will be fully developed as part of the MMMP and will inform future tidal habitat siting and initial and future management actions.

**Site-Specific Mercury Management Plans**

5. The MMMP will be implemented by DWR through development and implementation of site-specific mercury management plans for each CMP tidal habitat site. The potential effectiveness and need for design elements described in the MMMP will be considered when developing the site-specific mercury management plans. Appropriate design elements will be integrated into project-specific designs or an explanation of why a particular element is not applicable to the site will be provided. Where site-specific siting, design, source control, and management measures could limit the ecosystem benefits of CMP tidal habitat, such as by limiting the amount of carbon supplied to the Delta as a whole or by requiring flows inconsistent with the habitat type, discussions among involved resource agencies will be held to resolve such technical issues. The site-specific mercury management plans will also include the following components.
    a. A review of predicted changes in hydrology at the new tidal habitat site, expected changes in conditions affecting mercury methylation, expected changes in bioavailable methylmercury concentrations, and possible changes in bioaccumulation by fish.
    b. A determination of whether preconstruction sampling for baseline characterization of mercury and methylmercury concentrations in water, sediment, and/or biota is warranted. If this work was recently completed for a comparable reference location, then repeating the preconstruction sampling may not be needed. Decisions will be made on a site-specific basis.
    c. A description of characterization sampling and post-restoration monitoring at each tidal habitat project site that includes a Quality Assurance/Project Plan specifying sampling procedures, analytical methods, data review requirements, data analysis approaches (e.g., statistical tools), and data management and reporting procedures.

**Site-Specific Monitoring and Adaptive Management**

6. DWR will conduct monitoring at the new tidal habitat sites in accordance with the site-specific mercury management plans. Adaptive management will be implemented if monitoring results indicate that tissues of fish collected from within and immediately adjacent waterways that directly exchange water with the tidal habitat have statistically significant and higher average mercury concentrations than tissues of the same species of fish collected from appropriate reference habitats elsewhere in the Delta. Conversely, if the mean mercury concentrations in fish tissues collected within the CMP tidal habitat and immediately adjacent waterways that directly exchange water with the tidal habitat are not significantly greater than mercury concentrations in tissues of the same species collected from appropriate reference habitats in the Delta, then the new tidal habitat will be determined to not be making the current mercury impairment discernably worse. This statistical analysis serves as a performance standard for this mitigation measure and identifies when adaptive management actions will need to be

implemented. This performance standard will be defined as an action level for adaptive management in the site-specific mercury management plans.

7. Adaptive management actions will be developed in coordination with the State Water Board and Central Valley RWQCB and based on monitoring findings. Adaptive management actions for newly created tidal habitats could include modifications to the type and frequency of monitoring being conducted and modifications to various ongoing management actions that affect vegetation, water and sediment exchange, dissolved oxygen levels, water depths, and sediment chemistry. Adaptive management actions for future CMP tidal habitats will be based on information gained from newly created tidal habitats and could include modifying criteria for siting future tidal habitats or modifying design criteria that affect tidal and sediment exchange, depth, dissolved oxygen levels, vegetation management, and sediment chemistry.

***Oversight and Coordination***

8. DWR will identify a qualified specialist in methylmercury cycling and biological effects who will oversee all aspects of implementing this mitigation measure. The methylmercury specialist will review and approve all mercury and methylmercury-related conclusions and recommendations generated from the tidal habitat component of the CMP, including site-specific mercury management plans. The methylmercury specialist will develop a Quality Assurance/Project Plan to describe all sampling, analyses, and reporting as part of any site-specific mercury management plan. The specialist will also be responsible for integrating new, relevant information generated by research over the course of this program.
9. The Implementation Section of the Central Valley RWQCB WQCP states, in part, "In subareas needing reductions in methylmercury, proponents of new wetland and wetland restoration projects scheduled for construction after 20 October, 2011 shall (a) participate in methylmercury Control Studies, or shall implement site-specific study plans, that evaluate practices to minimize methylmercury discharges, and (b) implement methylmercury controls as feasible. New wetland projects may include pilot projects and associated monitoring to evaluate management practices that minimize methylmercury discharges" (Central Valley Regional Water Quality Control Board 2018:4-93). DWR has participated in these studies.
10. Methylmercury management approaches will be developed and implemented consistent with the Delta Methylmercury TMDL (Central Valley Regional Water Quality Control Board 2010a) and *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Methylmercury and Total Mercury in the Sacramento-San Joaquin Delta Estuary* (Central Valley Regional Water Quality Control Board 2010a, 2010b). These implementation provisions of the Central Valley RWQCB WQCP require developing measures to control methylmercury generation and loading into the Delta in accordance with TMDL goals. Phase I Methylmercury TMDL studies emphasize investigation and pilot projects to develop and evaluate management practices to control methylmercury. Phase II involves implementation of mercury control measures. Additional considerations on managing methylmercury discharges can be found in Attachment 3B.1, *Compensatory Mitigation Design Parameters*.

***Timing and Phasing***

11. DWR will develop the MMMP prior to siting any CMP tidal habitat. Site-specific mercury management plans will be developed by DWR as part of the design and implementation of individual CMP tidal habitat projects.

## 3A.1.25 AMM-24: Minimize Access Road Impacts on Listed Amphibian Connectivity

To minimize impacts on California red-legged frog and California tiger salamander connectivity resulting from the construction of access roads in service to the Bethany Complex facilities, DWR will design and construct new and improved access roads that overlap with modeled California red-legged frog or California tiger salamander habitat.

1. The following three water crossings (i.e., culverts or bridges)—a new section of Mountain House Road crossing over Mountain House Creek near the new Grant Line Road interchange, a widened section of Byron Highway crossing over an unnamed channel just south of the new Lindemann Road interchange, and a widened section of Mountain House Road crossing over unnamed channels between sections of the Delta Mendota Canal—would be designed and constructed to meet the following requirements.
    a. Completely span suitable California red-legged frog aquatic habitat.
    b. Maintain natural channel substrates, or similar materials.
    c. Size bridges to include upland habitat on at least one side of each channel that is above the bank full width to allow for terrestrial movement and refugia from bank full flows.
    d. Size culverts to a minimum 1.5 feet wide and 3 feet of clearance (Clevenger and Huijser 2011).
2. The following four new or improved road segments will be designed and constructed with the below-listed features: widened Mountain House Road; widened Byron Highway and the new Lindemann Road interchange; new Mountain House Road section at the Grant Line Road interchange; and the new section of road between Mountain House Road and the Bethany discharge structure.
    a. New and widened access road segments will avoid installing curbs, to the extent practicable. If curbs must be installed, curbs will be designed with sloping sides less than 30 degrees (Clevenger and Huijser 2011) to allow amphibian movement across the road.
    b. New and widened access road segments will avoid installing median barriers (i.e., k-rails), to the extent practicable. If median barriers cannot be avoided due to public safety concerns, barriers will be outfitted with small openings at ground level to allow amphibian passage.

## 3A.1.26 AMM-25: Develop and Implement a Fish Rescue and Salvage Plan

Fish rescue operations will occur at any in-water construction site where dewatering and resulting isolation of fish may occur. Fish rescue and salvage plans will be developed by DWR or its contractors and will include detailed procedures for fish rescue and salvage to minimize the number of individuals of listed fish species subject to stranding during placement and removal of cofferdams. The plans will identify the appropriate procedures for removing fish from construction zones and preventing fish from reentering construction zones prior to dewatering and other construction activities. A draft plan will be submitted to the fish and wildlife agencies for review and approval. An authorization letter from NMFS, USFWS, and CDFW will be required before in-water construction activities with the potential for stranding fish can proceed.

All fish rescue and salvage operations will be conducted under the guidance of a qualified fish biologist and in accordance with required permits. Each fish rescue plan will identify the appropriate procedures for excluding fish from the construction zones, and procedures for removing fish, should they become trapped. The primary procedure will be to herd fish out of the partially enclosed work area with seines (nets) and/or dip nets, followed by collection and removal of any remaining fish once the work area is fully enclosed; electrofishing techniques may also be authorized. The primary procedure will be to block off the construction area and use seines (nets) and/or dip nets to collect and remove fish, although electrofishing techniques may also be authorized under certain conditions. It is critical that fish rescue and salvage operations begin as soon as possible and be completed within 48 hours after isolation of a construction area to minimize potential predation and adverse water quality impacts (e.g., high water temperature, low dissolved oxygen) associated with confinement. In the case of cofferdam construction, the cofferdam will be installed to block off the construction area before fish removal activities occur, except for a small area left open to allow fish to be herded out of the area to be enclosed. For other in-water construction activities, block nets or other temporary exclusion methods (e.g., silt curtains) could be used to exclude fish or isolate the construction area prior to the fish removal process. The appropriate fish exclusion or collection method will be determined by a qualified fish biologist, in consultation with a designated fish and wildlife agency biologist, based on site-specific conditions and construction methods. Capture, release, and relocation measures will be consistent with the general guidelines and procedures set forth in Part IX of the most recent edition of the *California Salmonid Stream Habitat Restoration Manual* (California Department of Fish and Game 2010) to minimize impacts on listed species of fish and their habitat.

All fish rescue and salvage operations will be conducted under the guidance of a fish biologist meeting the qualification requirements described under Qualifications of Fish Rescue Personnel. The following description includes detailed fish collection, holding, handling, and release procedures of the plan. The following description includes detailed fish collection, holding, handling, and release procedures of the plan. Unless otherwise required by project permits, the construction contractor will provide the following.

1. A minimum 7-day notice to the appropriate fish and wildlife agencies, prior to an anticipated activity that could result in isolating fish, such as installation of a cofferdam.
2. Unrestricted access for the appropriate fish and wildlife agency personnel to the construction site for the duration of the fish rescue plan.
3. A work site that is accessible and safe for fish rescue workers.
4. Safety training for fish rescue workers before accessing the work site.
5. Cessation of construction activities in the vicinity (as agreed upon by the contractor, DWR, and the fisheries monitor) of the fish rescue from the time the fish rescue begins until completion.

### 3A.1.26.1 Qualifications of Fish Rescue Personnel

Personnel active in fish rescue efforts will include at least one person with a 4-year college degree in fisheries or biology, or a related degree. This person also must have at least 2 years of professional experience in fisheries field surveys and fish capture and handling procedures. The person will have completed an electrofishing training course such as Principles and Techniques of Electrofishing (USFWS, National Conservation Training Center), or similar course, if electrofishing is used. To avoid and minimize the risk of injury to fish, attempts to seine and/or net fish will always precede the use

of electrofishing equipment. Fish rescue personnel will also have experience identifying Delta fish species.

### 3A.1.26.2 Seining and Dipnetting

Fish rescue and salvage operations will begin prior to or immediately after completing the cofferdam. For example, it may be necessary to herd fish from the construction area before installing the last sections of the cofferdam. Fish exclusion and/or rescue activities may need to be conducted incrementally in coordination with cofferdam placement to minimize the number of fish subjected to prolonged confinement and stressful conditions associated with crowding, capture, and handling. If the enclosed area is wadable (less than ~3 feet deep), fish can be herded out of the cofferdam enclosure by dragging a seine (net) through the enclosure, starting from the enclosed end and continuing to the cofferdam opening. It may also be possible to herd fish in deeper water with nets using divers or rafts as necessary. Depending on conditions, this process may need to be conducted several times. After completing this fish herding process, the net or an exclusion screen will be positioned at the cofferdam opening to prevent fish from reentering the enclosure while the final section of the cofferdam is installed. The net or screen mesh will be no greater than 0.125 inch, with the bottom edge of the net (lead line) securely weighted down to prevent fish from entering the area by moving under the net. Screens will be checked periodically and cleaned of debris to permit free flow of water.

After installing the last sections of the cofferdam or training wall, remaining fish in the enclosed area will be removed using seines, dip nets, electrofishing techniques, or a combination of these depending on site conditions.

Following each sweep of a seine through the enclosure, the fish rescue team will do the following.

6. Carefully bring the ends of the net together and pull in the wings, ensuring the lead line is kept as close to the substrate as possible.
7. Slowly turn the seine bag inside out to reveal captured fish, ensuring fish remain in the water as long as possible before transfer to an aerated container.
8. Follow the procedures outlined in Section 3A.1.26.3, *Electrofishing*, and relocate fish to a predetermined release site.

Dipnetting is best suited for very small, shallow pools in which fish are concentrated and easily collected. Dip nets will be made of soft (nonabrasive) nylon material and small mesh size (0.125 inch) to collect small fish.

### 3A.1.26.3 Electrofishing

After conducting the herding and netting operations described above, electrofishing may be necessary to remove as many fish as possible from the enclosure. Electrofishing will be conducted in accordance with NMFS electrofishing guidelines (National Marine Fisheries Service 2000) and other appropriate fish and wildlife agency guidelines. Electrofishing will be conducted by one or two 3- to 4-person teams, with each team having an electrofishing unit operator and two or three netters. At least three passes will be made through the enclosed cofferdam areas to remove as many fish as possible. Fish initially will be placed in 5-gallon buckets filled with river water. Following completion of each pass, the electrofishing team will do the following.

9. Transfer fish into 5-gallon buckets filled with clean river water at ambient temperature.

10. Hold fish in 5-gallon buckets equipped with a lid and an aerator, and add fresh river water or small amounts of ice to the fish buckets if the water temperature in the buckets becomes more than 2°F warmer than ambient river waters.
11. Maintain a healthy environment for captured fish, including low densities in holding containers to avoid effects of overcrowding.
12. Use water-to-water transfers whenever possible.
13. Release fish at predetermined locations as specified in the fish rescue and salvage plans approved by NMFS, USFWS, and CDFW.
14. Segregate larger fish from smaller fish to minimize the risk of predation and physical damage to smaller fish from larger fish.
15. Limit holding time to about 10 minutes, if possible.
16. Avoid handling fish during processing unless absolutely necessary; use wet hands or dip nets if handling is needed.
17. Handle fish with hands that are free of potentially harmful products, including but not limited to sunscreen, lotion, and insect repellent.
18. Avoid anesthetizing or measuring fish.
19. Note the date, time, and location of collection; species; number of fish; approximate age (e.g., young-of-the-year, yearling, adult); fish condition (dead, visibly injured, healthy); and water temperature.
20. If positive identification of fish cannot be made without handling the fish, note this and release fish without handling.
21. In notes, indicate the level of accuracy of visual estimates to allow appropriate reporting to the appropriate fish and wildlife agencies (e.g., “Approx. 10–20 young-of-the-year steelhead”).
22. Release fish in appropriate habitat either upstream or downstream of the enclosure, noting release date, time, and location.
23. Stop efforts and immediately contact the appropriate fish and wildlife agencies if mortality or injury occurs during relocation of listed species.
24. Place dead fish of listed species in sealed plastic bags with labels indicating species, location, date, and time of collection, and store them on ice.
25. Freeze collected dead fish of listed species as soon as possible and provide the frozen specimens to the appropriate fish and wildlife agencies, as specified in the permits.
26. Release rescued fish at sites either upstream or downstream of the construction area that are similar in temperature to the area from which fish were rescued, contain ample habitat, and have a low likelihood of fish reentering the construction area or being impinged on exclusion nets/screens.

## 3A.1.27 AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan

DWR will implement an underwater sound control and abatement plan outlining specific measures such as changing the time of activities, best practices, and equipment that will be used to avoid and minimize the effects of underwater construction noise on fish, particularly the underwater noise effects associated with impact pile driving activities.

The underwater sound control and abatement plan will be provided to the appropriate fish and wildlife agencies for their review and approval prior to any in-water impact pile driving activities. The plan will evaluate the potential effects of underwater noise on fish using applicable and interim underwater noise thresholds established for disturbance and injury of fish (California Department of Transportation 2020:4-24–4-31). The thresholds include the following.

1. Injury threshold for fish of all sizes includes a peak sound pressure level (SPL) of 206 decibels (dB) relative to 1 micropascal.
2. Injury threshold for fish less than 2 grams is 183 dB relative to 1 micropascal cumulative sound exposure level ($SEL_{sumulative}$), and 187 dB relative to 1 micropascal $SEL_{sumulative}$ for fish greater than or equal to 2 grams.
3. Disturbance threshold for fish of all sizes is 150 dB root mean square relative to 1 micropascal.

The specific number of pilings that will be driven per day with an impact pile driver, and thus the number of pile strikes per day, will be defined as part of the design of project elements that require pilings.

The sound control and abatement plan will restrict in-water work (including during the pile installation pilot studies described in Chapter 3) to the in-water work windows specified in AMM-14: *Construction Best Management Practices for Biological Resources* (Section 3A.1.15) and approved by NMFS/USFWS/CDFW. There would be rest periods without pile driving at night.

The underwater noise generated by impact pile driving will be abated using the best available and practicable methods. Examples of such methods include the use of vibratory rather than impact pile driving equipment; use of an impact pile driver to proof piles initially placed with a vibratory pile driver; noise attenuation with pile caps (e.g., wood or micarta), bubble curtains, air-filled fabric barriers, or isolation piles; or installation of piling-specific cofferdams. Specific techniques to be used will be selected based on site-specific conditions.

In addition to primarily using vibratory pile driving methods and establishing protocols for attenuating underwater noise levels produced during in-water construction activities, DWR will develop and implement operational protocols for when impact pile driving is necessary. These operational protocols will be used to minimize the effects of impact pile driving on fish and may include the following.

4. Monitoring the in-water work area for fish that may be showing signs of distress or injury as a result of pile driving activities and stopping work when distressed or injured fish are observed, for example, if injured fish are seen floating near the surface.
5. Initiating impact pile driving with a “soft-start,” such that pile strikes are initiated at reduced impact and increase to full impact over several strikes to provide fish an opportunity to move out of the area.

6. Restricting impact pile driving activities to specific times of the day and for a specific duration to be determined through coordination with the fish and wildlife agencies.
7. If more than one pile driving rig is employed, ensuring pile driving activities are initiated in a way that provides an escape route and avoid "trapping" fish between pile drivers in waters exposed to underwater noise levels that could potentially cause injury.

Where impact pile driving is required, prior to starting pile driving and during the pile driving, DWR will monitor underwater sound levels and require compliance with underwater noise thresholds at a distance appropriate (per guidance of the monitor) for protection of the species (e.g., 183 dB $SEL_{cumulative}$ for fish less than 2 grams, 187 dB $SEL_{cumulative}$ for fish greater than 2 grams), based on the results from calculations to be provided in the underwater sound control and abatement plan. If such monitoring shows that noise could exceed applicable thresholds, physical or operational attenuation methods will be implemented to ensure compliance with these thresholds.

## 3A.1.28 AMM-27: Develop and Implement a Barge Operations Plan

DWR will require that any construction contractor proposing to use barges (to perform construction or to transport materials or equipment) develop a barge operations plan, to be approved by NMFS, USFWS, and CDFW. Each plan will be developed and submitted by the construction contractors per standard DWR contract specifications. Each barge operations plan will be part of a comprehensive traffic control plan coordinated with the U.S. Coast Guard for large channels. The comprehensive traffic control plan will address traffic routes and machines used to deliver materials to and from the barges. The barge operations plan will address the following topics.

1. Bottom scour from propeller wash.
2. Bank erosion or loss of submerged or emergent vegetation from propeller wash and/or excessive wake.
3. Accidental material spillage.
4. Sediment and benthic community disturbance from accidental or intentional barge grounding or deployment of barge spuds (extendable shafts for temporarily maintaining barge position) or anchors, including a timeline for addressing grounding to minimize risk from potential channel blockage.
5. Hazardous materials spills (e.g., fuel, oil, hydraulic fluids).

The barge operations plan will serve as a guide to barge operations and to a biological monitor who will evaluate barge operations daily during construction with respect to the stated performance measures outlined in this mitigation measure (see Section 3A.1.28.4, *Performance Measures*). This plan, when approved by the DWR and other resource agencies, will be read by barge operators and kept aboard all vessels operating at the construction sites.

### 3A.1.28.1 Sensitive Resources

The barge operations plan is intended to protect fish and aquatic resources in the vicinity of barge operations. The plan will be developed to avoid barge-related effects on listed species of fish; if avoidance is not possible, the plan will include provisions to minimize effects on fish and aquatic resources as described under Sections 3A.1.28.3, *Avoidance Measures,* 3A.1.28.3.1, *Environmental*

*Training,* and 3A.1.28.3.2, *Approach and Departure Protocol*. The sensitive resources potentially affected by barge maneuvering and anchoring in affected areas are listed below.

6. Sediments that could cause turbidity or changes in bathymetry if disturbed.
7. Bottom-dwelling (benthic) invertebrates that provide a prey base for fish.
8. Riparian vegetation that provides shade, cover, habitat structure, and organic nutrients to the aquatic environment.
9. Submerged aquatic vegetation that provides habitat structure and primary (plant) production.

## 3A.1.28.2 Responsibilities

Construction contractors operating barges in the process of constructing the water conveyance facilities will be responsible for the following.

10. Operate vessels safely to prevent significant impacts on aquatic resources of the Delta.
11. Read, understand, and follow the barge operations plan.
12. Report to the project biological monitor any vessel grounding or other deviations from the barge operations plan that could have resulted in the disturbance of bottom sediments, damage to riverbanks, or loss of submerged, emergent, or riparian vegetation.
13. Immediately report material fuel or oil spills to the CDFW Office of Spill Prevention and Response, the project biological monitor, and DWR.
14. Follow all other relevant plans, including the hazardous materials management plan, stormwater pollution prevention plan (SWPPP), and SPCCP.
15. Observe state laws regarding monitoring and control of invasive species when introducing new watercraft to the Delta.

The biological monitor will be responsible for the following.

16. Observe barge operation activities including loading and unloading.
17. Provide same-day reports to DWR on any observed problems with barge operations.
18. Provide annual reports to DWR, summarizing monitoring observations during each construction year, including an evaluation of the plan performance measures. The annual report will also include descriptions and representative photographs and/or videos of conditions of riverbanks and vegetation.
19. Visit each site requiring barges to determine the extent of emergent and riparian vegetation, bank conditions, and general site conditions during the growing season prior to initiation of construction, during construction, and then annually for up to 5 years after construction.
20. Monitor construction including observation of barge arrival, loading, and unloading; departure of barges at each active site and the condition of both riverbanks at each site; pile driving; and other in-water construction activity as directed by DWR.

## 3A.1.28.3 Avoidance Measures

The following avoidance measures will be implemented to ensure that the goal of avoiding impacts on aquatic resources from tugboat and barge operations will be achieved: training of tug boat

operators; limiting vessel speed to minimize the effects of wake impinging on unarmored or vegetated banks and the potential for vessel wake to strand small fish; limiting the direction and/or velocity of propeller wash to prevent bottom scour and loss of aquatic vegetation; and prevention of spillage of materials and fluids from vessels.

If deviations from the identified environmental training, approach and departure protocol, and performance measures are required to maintain the safety of vessels and crew, at the earliest practicable convenience, the biological monitor will be informed of the circumstances and any apparent impacts on water quality, habitats, fish, or wildlife. Any such impacts will be brought to the attention of the applicable fish and wildlife agency to ascertain and implement appropriate remedial measures.

#### 3A.1.28.3.1 Environmental Training

All pilots operating at placement of riprap at intakes construction and geotechnical exploration sites will be required to read and follow the barge operations plan and to keep a copy aboard and accessible. All pilots responsible for operating a vessel at the intake sites will read the barge operations plan and sign an affidavit as provided in the plan.

#### 3A.1.28.3.2 Approach and Departure Protocol

DWR will require that construction contractors develop and implement a protocol for site approach and departure to ensure the following.

21. Vessel operators will obey all federal and state navigation regulations that apply to the Delta.
22. All vessels will approach and depart from sites at dead slow in order to reduce vessel wake and propeller wash.
23. To minimize bottom disturbance, anchors and barge spuds will be used to secure vessels only when it is not possible to tie up.
24. Barge anchoring will be preplanned. Anchors will be lowered into place and not be allowed to drag across the channel bed.
25. Vessel operators will limit vessel speed as necessary to maintain wake heights of less than 2 feet at shore.
26. Vessel operators will avoid pushing stationary vessels up against fixed structures for extended periods, because this could result in excessive directed propeller wash impinging on a single location. Barges will be tied up whenever possible to avoid the necessity of maintaining stationary position by tugboat or by the use of barge spuds.
27. Barges will not be anchored where they will ground during low tides.
28. All vessels will obey U.S. Coast Guard regulations related to the prevention, notification, and cleanup of hazardous materials spills.
29. All vessels will keep an oil spill containment kit and spill prevention and response plan onboard.
30. In the event of a fuel spill, CDFW Office of Spills Prevention and Response will be contacted immediately at 800-852-7550 or 800-OILS-911 (800-645-7911) to report the spill.
31. When transporting loose materials (e.g., sand, aggregate), barges will use deck walls or other features to prevent loose materials from blowing or washing off the deck.

### 3A.1.28.4 Performance Measures

Performance will be assessed based on the results of the biological monitoring reports. The assessment will evaluate observations for the following indicators of impacts.

32. **Emergent vegetation loss.** The extent and dominant species of emergent vegetation will be determined and mapped by a global positioning system (GPS) unit at and cross-channel from each of the intake sites during the growing seasons prior to, during, and after construction. Extent will be mapped as linear coverage along the site and opposite banks. In the event that the linear extent of emergent vegetation is found to have decreased by 20% or more following construction (or as otherwise conditioned by applicable CDFW streambed alteration agreements), the position and nature of the change will be evaluated for the probability that the loss was due to barge grounding, propeller wash, or other effects related to barge operations. Adequate performance will be achieved if the linear extent of riparian and emergent vegetation following construction is at least 80% of the preconstruction extent (or as otherwise conditioned by applicable CDFW streambed alteration agreements), not including areas that will be lost to construction activities (e.g., footprint impacts) and that will be mitigated with measures described below (Appendix 3B, Attachment 3B.1, specifically CMP-23: *Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources* and CMP-24: *Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources* [Table 3B.1-1]). Compensatory mitigation to replace lost emergent vegetation at a ratio approved through coordination with the appropriate agencies will be undertaken should the performance standards be exceeded.

33. **Bank erosion and riparian vegetation loss.** The linear extent of bank erosion will be mapped by GPS at each of the intake sites prior to, during, and after construction. Photos and written descriptions will be recorded for each area of eroded bank to describe the extent of the erosion. In the event that the linear extent of eroded bank is found to have increased by 20% or more following construction as a result of barge operations (and not other construction impacts; see above in *Emergent Vegetation Loss*), the position and nature of the change will be evaluated by guidance from the fisheries monitor for the probability (low, moderate, or high) that the erosion was due to barge grounding, propeller wash, or other effects related to barge operations, and preconstruction and postconstruction photographs will be compared to determine if riparian vegetation was also lost as a result of the erosion.

34. **Cargo containment.** The biological monitor will note the use of deck walls or other appropriate containment during loading and unloading of materials from a barge at each site. Adequate performance will be achieved if appropriate measures are in use during each observed loading and unloading. In the unlikely event that an accidental spill occurs despite appropriate containment measures, the barge crew will describe the type, amount, and location of the spill to the biological monitor as soon as practicable and safe. The biological monitor will make observations at the site of the material spill and evaluate the potential impacts of the spill on biological resources. This will help the biological monitor evaluate whether mitigation is required and will be included in the annual monitoring report. Any such impacts will be brought to the attention of the applicable fish and wildlife agency to ascertain and implement appropriate remedial measures within 24 hours.

35. **Fuels spill prevention.** Vessels operating in accordance with the SPCCP and all applicable federal, state, and local safety and environmental laws and policies governing commercial vessel

and barge operations will be considered to be performing adequately with regard to fuel spill prevention.

36. **Barge grounding.** Barges are not to be grounded or anchored where falling tides are reasonably expected to cause grounding during a low tide. Barge grounding has the potential to disturb bottom sediments and benthic organisms, as well as creating a temporary obstacle to fish passage. Performance will be considered adequate if no cases of vessel grounding occur.

### 3A.1.28.5 Contingency Measures

In the event that the performance measures are not met, DWR will coordinate with NMFS, USFWS, CDFW, and Central Valley Regional Water Quality Control Board to determine appropriate rectification or compensation for impacts on aquatic resources.

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Appendix 3B

# Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources

## 3B.S.1 Compensatory Mitigation Plan Permitting Supplement

The Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources (CMP) describes the actions that would be implemented to offset the impacts associated with construction, operation, and maintenance of the Delta Conveyance Project (project). The siting, construction, operations, maintenance, and monitoring actions associated with the Initial Mitigation Sites, described in Section 3B.4.1, are evaluated at the project level for each relevant terrestrial species in Chapter 6, *Effects Analysis*. The tidal restoration and channel margin enhancement mitigation actions are described in Section 3B.4.3, *Tidal Habitat Mitigation Framework*, and are evaluated programmatically in Chapter 6 due to a lack of detail about the specific location where the action would occur. When the siting and construction detail becomes available for these programmatic mitigation actions, DWR would share those details with the Services along with an application to amend the biological opinion and authorize incidental take for the affected species. Actions associated with the creation of mitigation credits or site protection instruments are not expected to affect listed species. However, if there is a need for consultation, that will occur at the time of development. Non-bank sites, like tidal restoration and channel margin enhancement, are evaluated programmatically in Chapter 6.

The CMP is a technical appendix that is attached to multiple environmental compliance documents. The CMP was originally developed to support the *Delta Conveyance Project Draft Environmental Impact Report* (EIR) (California Department of Water Resources 2022) as Appendix 3F of that document, but has since been adapted to also support the Biological Assessment (BA), as Appendix 3B, (which is submitted as an application for incidental take under Section 7 of the Endangered Species Act). Although cross-references in this document have been updated to reference the BA chapters and sections where appropriate, because the CMP was originally drafted in support of the EIR this introductory or *supplemental* section was created to summarize key information for wildlife agency staff. California Department of Water Resources (DWR) published and certified the Final EIR in December 2023 (California Department of Water Resources 2023a).

## 3B.S.2 Impacts and Compensatory Mitigation Needs of the Proposed Action

Implementation of the project would affect special-status species regulated by the California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NMFS). The CMP details the types of mitigation projects that would be used to offset the impacts to species. To supplement the CMP in support of the BA, Table 3B.S-1 summarizes the total acreage of permanent habitat loss that would occur as a result of project

construction, operation, and maintenance and implementation of the proposed action (which is the preferred alternative, Alternative 5, in the Final EIR); the applied mitigation ratios; the total compensatory mitigation proposed for each species; and the acres of habitat that would be created with construction of the initial mitigation sites.

Compensatory mitigation, either protection, creation, or enhancement (described in Section 3B.4, *Mitigation Work Plan),* will stay ahead of the cumulative, permanent suitable habitat loss by 10%. Documentation demonstrating that this stay-ahead provision has been met for the previous year will be provided in the Annual Status Report. If the 10% stay-ahead requirement cannot be met and habitat is protected or restored after the impact occurs, the mitigation amount would be increased by 5% for every year protection is delayed to offset the temporal loss of habitat. For example, if protection, creation, or enhancement occurs 2 years after the impact occurs, mitigation would be 10% greater than required if protection, creation, or enhancement occurs prior to or concurrent with the impact.

**Table 3B.S-1. Estimated Permanent Habitat Loss with the Proposed Action and Corresponding Mitigation Commitments for Special-Status Species**

| Species – Project Related Effect | Status [a] | Permanent Modeled Habitat Loss (acres unless noted) [b] | Mitigation Ratio [c] | Compensatory Mitigation Type | Compensatory Mitigation Acreage Commitment | Acres of Habitat Estimated to Be Created or Enhanced at Initial Mitigation Sites [d] |
|---|---|---|---|---|---|---|
| **AQUATIC – CONSTRUCTION** | | | | | | |
| ***Permanent*** | | | | | | |
| Delta smelt & longfin smelt | FT, CE (delta smelt), FPE, CT (longfin smelt) | 5.57 | 3:1 | Creation and enhancement | 16.71 | 0.0 [e] |
| Green sturgeon, Southern DPS | FT | 5.57 | 3:1 | Creation and enhancement | 16.71 | 0.0 [e] |
| Juvenile salmonids | - | 5.57 | 3:1 | Creation and enhancement | 16.71 | 0.0 [e] |
| Sacramento River winter-run Chinook salmon | FE, CE | 5.57 | 3:1 | Creation and enhancement | 16.71 | 0.0 [e] |
| Central Valley spring-run Chinook salmon | FT, CT | 5.57 | 3:1 | Creation and enhancement | 16.71 | 0.0 [e] |
| Central Valley steelhead | FT | 5.57 | 3:1 | Creation and enhancement | 16.71 | 0.0 [e] |
| ***Temporary*** | | | | | | |
| Delta smelt & longfin smelt | FT, CE (delta smelt), FPE, CT (longfin smelt) | 1.55 | 1:1 | Creation and enhancement | 1.55 [f] | 0.0 [e] |
| Green sturgeon, Southern DPS | FT | 1.55 | 1:1 | Creation and enhancement | 1.55 [f] | 0.0 [e] |
| Juvenile salmonids | - | 1.55 | 1:1 | Creation and enhancement | 1.55 [f] | 0.0 [e] |
| Sacramento River winter-run Chinook salmon | FE, CE | 1.55 | 1:1 | Creation and enhancement | 1.55 [f] | 0.0 [e] |
| Central Valley spring-run Chinook salmon | FT, CT | 1.55 | 1:1 | Creation and enhancement | 1.55 [f] | 0.0 [e] |

| Species – Project Related Effect | Status [a] | Permanent Modeled Habitat Loss (acres unless noted) [b] | Mitigation Ratio [c] | Compensatory Mitigation Type | Compensatory Mitigation Acreage Commitment | Acres of Habitat Estimated to Be Created or Enhanced at Initial Mitigation Sites [d] |
|---|---|---|---|---|---|---|
| Central Valley steelhead | FT | 1.55 | 1:1 | Creation and enhancement | 1.55 [f] | 0.0 [e] |
| Juvenile salmonids | - | 3,124 (linear feet) | 1:1 | Creation and enhancement | 3,124 (linear feet) | 0.0 [e] |
| Sacramento River winter-run Chinook salmon | FE, CE | 3,124 (linear feet) | 1:1 | Creation and enhancement | 3,124 (linear feet) | 0.0 [e] |
| Central Valley spring-run Chinook salmon | FT, CT | 3,124 (linear feet) | 1:1 | Creation and enhancement | 3,124 (linear feet) | 0.0 [e] |
| Central Valley steelhead | FT | 3,124 (linear feet) | 1:1 | Creation and enhancement | 3,124 (linear feet) | 0.0 [e] |
| **AQUATIC – OPERATIONS** | | | | | | |
| Delta smelt | FT, CE | N/A [f] | N/A [g] | Creation and enhancement | 1,352 [g] | 0.0 [e] |
| Longfin smelt | FPE, CT | N/A [f] | N/A [g] | Creation and enhancement | 135 [g] | 0.0 [e] |
| Juvenile salmonids: Tidal perennial aquatic | - | N/A | N/A | Creation and enhancement | Up to 3,500 (acres) [h, i] | 0.0 [e] |
| Sacramento River winter-run Chinook salmon | FE, CE | N/A | N/A | Creation and enhancement | Up to 3,500 (acres) [h, i] | 0.0 [e] |
| Central Valley spring-run Chinook salmon | FT, CT | N/A | N/A | Creation and enhancement | Up to 3,500 (acres) [h, i] | 0.0 [e] |
| Central Valley steelhead | FT | N/A | N/A | Creation and enhancement | Up to 3,500 (acres) [h, i] | 0.0 [e] |
| Juvenile salmonids: Channel margin habitat | - | 2,540 (linear feet) | 1:1 | Creation and enhancement | 2,540 (linear feet) | 0.0 [e] |

| Species – Project Related Effect | Status [a] | Permanent Modeled Habitat Loss (acres unless noted) [b] | Mitigation Ratio [c] | Compensatory Mitigation Type | Compensatory Mitigation Acreage Commitment | Acres of Habitat Estimated to Be Created or Enhanced at Initial Mitigation Sites [d] |
|---|---|---|---|---|---|---|
| Sacramento River winter-run Chinook salmon | FE, CE | 2,540 (linear feet) | 1:1 | Creation and enhancement | 2,540 (linear feet) | 0.0 [e] |
| Central Valley spring-run Chinook salmon | FT, CT | 2,540 (linear feet) | 1:1 | Creation and enhancement | 2,540 (linear feet) | 0.0 [e] |
| Central Valley steelhead | FT | 2,540 (linear feet) | 1:1 | Creation and enhancement | 2,540 (linear feet) | 0.0 [e] |
| **TERRESTRIAL – CONSTRUCTION** | | | | | | |
| San Joaquin kit fox | FE, CT | 38.98 | 1:1 | Mitigation credits or site protection instrument | 38.98[j] | 0.0 [e] |
| California red-legged frog, aquatic | FT | 0.21 | 3:1 | Mitigation credits or site protection instrument | 0.63 | 0.0 [e] |
| California red-legged frog, upland | FT | 7.06 | 1:1 | Mitigation credits or site protection instrument | 7.06 | 0.0 [e] |
| California tiger salamander, aquatic | FT, CT | 0.20 | 3:1 | Mitigation credits or site protection instrument | 0.60 | 0.0 [e] |
| California tiger salamander, upland | FT, CT | 60.20 | 3:1 | Mitigation credits or site protection instrument | 180.60 | 0.0 [e] |
| Giant garter snake, aquatic | FT, CT | 9.65 | 2:1 | Creation and enhancement | 19.3 | 150.54 [k] |
| Giant garter snake, upland | FT, CT | 71.24 | 2:1 | Creation and enhancement | 142.48 | 189.81 [k] |
| Least Bell's vireo | FE, CE | 9.68 | 2:1 | Creation and enhancement | 19.36 | 204.79 |
| Northwestern pond turtle, aquatic | FPT | 33.68 | 1:1 | Creation and enhancement | 33.68 | 233.94 |
| Northwestern pond turtle, upland | FPT | 116.09 | 1:1 | Creation and enhancement | 116.09 | 456.10 |
| Valley elderberry longhorn beetle | FT | 19.47 | 3:1 or 1:1 [l] | Creation and enhancement | 58.41 or 19.47 | 204.79 |

| Species – Project Related Effect | Status [a] | Permanent Modeled Habitat Loss (acres unless noted) [b] | Mitigation Ratio [c] | Compensatory Mitigation Type | Compensatory Mitigation Acreage Commitment | Acres of Habitat Estimated to Be Created or Enhanced at Initial Mitigation Sites [d] |
|---|---|---|---|---|---|---|
| Vernal pool fairy shrimp and vernal pool tadpole shrimp, direct effects | VPFS – FT<br>VPTS – FE | 0.42 | 1:1 or 2:1 | Conservation bank credits or non-bank site | 0.42 or 0.84 | 0.0 [e] |
| Vernal pool fairy shrimp and vernal pool tadpole shrimp, indirect effects | VPFS – FT<br>VPTS – FE | 14.64 | 2:1 or 3:1 | Conservation bank credits or non-bank site | 29.28 or 43.92 | |
| Western yellow-billed cuckoo | FT, CE | 9.68 | 2:1 | Creation and enhancement | 19.36 | 204.79 |
| Western spadefoot, aquatic | FPT | 0.20 | 3:1 | Conservation bank credits or non-bank site | 0.60 | 0.0 [e] |
| Western spadefoot, upland | FPT | 32.90 | 1:1 | Conservation bank credits or non-bank site | 32.90 | 0.0 [e] |

Notes: CMP = Compensatory Mitigation Plan; VPFS = vernal pool fairy shrimp; VPTS = vernal pool tadpole shrimp.

[a] Protected Status: FE = Federal Endangered, FT = Federal Threatened, FPT = Federal Proposed Threatened, FPE = Federal Proposed Endangered, CE = California Endangered, CT = California Threatened, C Rare = California Rare, CC = California Candidate Endangered.

[b] Permanent modeled habitat loss includes loss from project construction, operation, and maintenance for all species. For all species with habitat that overlaps with the initial mitigation sites, habitat loss is assumed to be temporary and offset by the long-term benefit of habitat creation and enhancement (at the initial mitigation sites).

[c] Mitigation ratio for protected, created, and restored habitat to offset permanent habitat loss. Unless noted otherwise, mitigation ratios in the column are consistent with the BA (Chapter 5, *Effects Analysis for Chinook Salmon, Central Valley Steelhead, Green Sturgeon, and Killer Whale*, and Chapter 6, *Effects Analysis for Delta Smelt, Longfin Smelt, and Terrestrial Species*).

[d] Habitat acres are habitat acres created or enhanced at initial mitigation sites on Bouldin Island (Mitigation Sites B1 and B2) and at the DWR I-5 ponds (Pond 6 and Ponds 7 and 8), from Table 3B-4 in Appendix 3B of the BA.

[e] Creation and enhancement on Bouldin Island and at the DWR I-5 ponds, as they are currently described in the CMP (Appendix 3B of the BA), would not create habitat for this species.

[f] Compensatory mitigation is proposed to offset temporary habitat loss as the affected habitat cannot be restored to pre-project conditions within one year.

[g] Tidal habitat restoration extent to mitigate for potential flow-related impacts on longfin and Delta smelt calculated using the method of Kratville (2010), consistent with other project efforts. Therefore, mitigation ratios are not applicable for this mitigation approach.

[h] The hydrodynamic mitigation acreage upper bound described here is based on preliminary modeling efforts to identify the appropriate extent and location of tidal restoration to fully offset potential hydrodynamic effects (e.g., reverse flows at Georgiana Slough) to juvenile migrating salmonids (winter-run and spring-run).

[i] The extent to which tidal habitat restoration can mitigate for operational changes identified for both delta and longfin smelt can contribute to the appropriate type and degree of hydrodynamic mitigation necessary to address the modeled, project-driven, flow changes (e.g., changes in frequency of Sacramento River reverse flows below Georgiana Slough) will be considered here.

[j] The 180.60 acres of grassland, vernal pool complex, and alkali seasonal wetland protection and enhancement for California tiger salamander (as described in Attachment 3B.1, Table 3B.1-3, CMP-13: *California Tiger Salamander Habitat*) would overlap with the Livermore recovery unit and is expected to meet the compensatory mitigation commitment for San Joaquin kit fox.

[k] Giant garter snake mitigation acres would be created and enhanced at the DWR I-5 ponds. Acres created and enhanced at Bouldin Island would not count as mitigation for giant garter snake habitat. The total acres of creation and enhancement for giant garter snake presented in this table are the total acres of giant garter snake aquatic habitat (nontidal freshwater emergent wetland, nontidal perennial aquatic, agricultural ditch) and upland habitat (grassland, agricultural, valley/foothill riparian) presented in Tables 3B-13 and 3B-14.

[l] The maximum compensation commitment assumes impacted habitat is all riparian and therefore a 3:1 mitigation ratio is applied. However, it is likely that impacted habitat will be a mix of riparian and non-riparian habitat. In those instances, a 1:1 mitigation ratio will be applied to lost non-riparian habitat consistent with the Valley Elderberry Longhorn Beetle Framework (U.S. Fish and Wildlife Service 2017).

# 3B.S.3 Compensatory Mitigation Plan Guide

As discussed in the previous sections, the CMP was written and organized to support the EIR. However, to facilitate agency review of the CMP, all cross-references in this document have been updated to the BA chapters and sections. Where relevant, cross-references to the Final EIR are also provided.

The compensatory mitigation design commitments and guidelines are described in Attachment 3B.1, *Compensatory Mitigation Design Parameters*. To help agency staff navigate the CMP in support of their review of the BA, Tables 3B.S-2 identifies the location of key information agency staff will need to make their determinations.[1]

[1] This appendix contains details on CMP-10 through CMP-16, CMP-19, and CMP-21 through CMP-30; however, all CMPs (CMP-0 through CMP-30) are described in Attachment 3B.1, *Compensatory Mitigation Design Parameters*.

**Table 3B.S-2. CMP Section References Necessary to Support the BA**

| Species | Relevant, Species-Specific Compensatory Mitigation Design Commitments and Guidelines in Appendix 3B, Attachment 3B.1, Table 3B.1-2 | Description of Mitigation Action(s) in Appendix 3B of the BA |
|---|---|---|
| **AQUATIC** | | |
| Delta smelt | CMP-23<br>CMP-27 | Section 3B.4.3.2.2, *Tidal Perennial Aquatic*<br>Section 3B.4.3.2.3, *Tidal Emergent Wetlands* |
| Longfin smelt | CMP-23<br>CMP-28 | Section 3B.4.3.2.2, *Tidal Perennial Aquatic*<br>Section 3B.4.3.2.3, *Tidal Emergent Wetlands* |
| Juvenile salmonids | CMP-24<br>CMP-25<br>CMP-26 | Section 3B.4.3.3, *Channel Margin Habitat Mitigation Approach*<br>Section 3B.4.3.2.2, *Tidal Perennial Aquatic*<br>Section 3B.4.3.2.3, *Tidal Emergent Wetlands* |
| Green sturgeon | CMP-24 | Section 3B.4.3.3, *Channel Margin Habitat Mitigation Approach* |
| **TERRESTRIAL** | | |
| California red-legged frog | CMP-14 | Section 3B.4.2.1, *Mitigation Credits from Approved Banks* |
| California tiger salamander | CMP-13 | Section 3B.4.2.1, *Mitigation Credits from Approved Banks* |
| Giant garter snake | CMP-15 | Section 3B.4.1.4, *DWR I-5 Ponds* |
| Least Bell's vireo | CMP-21 | Section 3B.4.1.3, *Bouldin Island Mitigation Sites* |
| Northwestern pond turtle | CMP-30 | Section 3B.4.1.3, *Bouldin Island Mitigation Sites*<br>Section 3B.4.1.4, *DWR I-5 Ponds* |
| Valley elderberry longhorn beetle | CMP-12 | Section 3B.4.1.3, *Bouldin Island Mitigation Sites* |
| Vernal pool branchiopods | CMP-11 | Section 3B.4.2.1, *Mitigation Credits from Approved Banks* |

| Species | Relevant, Species-Specific Compensatory Mitigation Design Commitments and Guidelines in Appendix 3B, Attachment 3B.1, Table 3B.1-2 | Description of Mitigation Action(s) in Appendix 3B of the BA |
|---|---|---|
| Western yellow-billed cuckoo | CMP-16 | Section 3B.4.1.3, *Bouldin Island Mitigation Sites* |
| Western spadefoot | CMP-31 | Section 3B.4.2.1, *Mitigation Credits from Approved Banks* |

BA = Biological Assessment; CMP = Compensatory Mitigation Plan; DWR = California Department of Water Resources; I- = Interstate.

# 3B.S.4 Species-Specific Monitoring and Performance Standards on Compensatory Lands

The CMP includes a description of the long-term maintenance and management plans, site protection instruments, and adaptive management programs that would be implemented on all non-mitigation bank compensatory lands in Sections 3B.6.3, *Long-Term Maintenance and Management*, and 3B.6.4, *Adaptive Management*, respectively, in the BA. In support of these programs, lands created, restored, or protected as part of the CMP would be monitored and that monitoring data would be evaluated against performance standards as described in Sections 3B.6.4 and 3B.7, *Performance Standards and Monitoring*, respectively. These site-specific maintenance, monitoring, and adaptive management plans would be developed and submitted to the relevant wildlife agency for review after acquisition of compensatory lands but before creation, enhancement, or management activities are begun.

Species-specific design commitments and guidelines for compensatory mitigation lands are described in Table 3B.1-2 in Attachment 3B.1 in this appendix. In support of this BA, Table 3B.S-3 below provides some additional design commitments and guidelines as well as specific monitoring actions and performance standards that supplement Section 3B.7. These supplemental details regarding performance standards and monitoring are meant to further detail the quality of compensation lands and to inform an assessment of take as a result of habitat creation and enhancement. As described in Section 3B.7.2, *Monitoring*, protected and created compensatory mitigation sites would be monitored every year for 5 years after initial acquisition/creation and then, for most species, every 5 years thereafter.

The performance standards and monitoring actions are subject to change in the final Long-Term Maintenance and Management and Adaptative Management plans that would be submitted to the wildlife agencies for each compensatory mitigation site prior to construction. Once the plans have been accepted and the site has been constructed, monitoring would take place and annual results would be compared against the performance standards. Where monitoring results do not meet the performance standards, the Adaptive Management Plan described above would be implemented.

**Table 3B.S-3. Proposed Effectiveness Monitoring Actions, Additional Design Commitments and Guidelines, and Performance Standards**

| Species | Monitoring Action | Design Commitments and Guidelines in Addition to those Presented in Table 3B.1-3. | Performance Standard |
|---|---|---|---|
| Least Bell's Vireo recolonization habitat | Habitat assessment | Willow riparian forest with a mix of tree size classes with the following characteristics:<br>• Dense, shrubby understory of mulefat (*Baccharis salicifolius*) and other mesic species with protected ground cover<br>• Large, intact patches of early successional habitat inhabiting low, dense riparian growth along water or along dry parts of intermittent streams | Meets design commitments and guidelines described in this table and in Table 3B.1-3. |
| Western yellow-billed cuckoo migration habitat | Habitat assessment | • All valley/foothill riparian forest types within 5 miles of riverine habitat | Meets design commitments and guidelines described in this table and in Table 3B.1-3. |
| California red-legged frog aquatic habitat | Habitat assessment<br>Presence/ absence surveys | • Deep, coldwater ponds and stream pools with emergent and submergent vegetation, that remain inundated for a sufficient length of the season to allow metamorphosis (approximately 7 months) | Successful breeding<br>Or<br>If ponds unoccupied, meets design commitments and guidelines described in this table and in Table 3B.1-3. |
| California red-legged frog upland habitat | Habitat assessment | • Rodent holes in grassland or oak woodland communities<br>• Blackberry thickets, leaf litter, logjams and root tangles in riparian areas<br>• Within 300 feet of suitable aquatic habitat | Meets design commitments and guidelines described in this table and in Table 3B.1-3. |
| California tiger salamander, aquatic habitat | Habitat assessment<br>Presence/ absence surveys | • Vernal and seasonal pools, seasonal and permanent stock ponds with sufficient depth and duration of inundation to allow successful breeding | Successful breeding<br>Or<br>If ponds unoccupied, meets design commitments and guidelines described in this table and in Table 3B.1-3. |
| California tiger salamander, upland habitat | Habitat assessment | • Grassland and woodlands with rodent burrows within 1.24 miles of suitable aquatic habitat | Meets design commitments and guidelines described in this table and in Table 3B.1-3. |

| Species | Monitoring Action | Design Commitments and Guidelines in Addition to those Presented in Table 3B.1-3. | Performance Standard |
|---|---|---|---|
| Giant garter snake, aquatic habitat | Habitat assessment | No additional design commitments and guidelines proposed. | Meets design commitments and guidelines described in this table and in Table 3B.1-3. |
| Giant garter snake, upland habitat | Habitat assessment | No additional design commitments and guidelines proposed. | Meets design commitments and guidelines described in Table 3B.1-3. |
| Vernal pool branchiopods | Habitat assessment | Vernal pools and alkali seasonal wetland within the species' range. | Meets design commitments and guidelines described in this table and in Table 3B.1-3. |
| Delta green ground beetle | Habitat assessment | Vernal pool complex and grassland within the species' range. | Meets design commitments and guidelines described in this table and in Table 3B.1-3. |
| Valley elderberry longhorn beetle | Habitat assessment | No additional design commitments and guidelines proposed. | Meets design commitments and guidelines described in Table 3B.1-3. |
| Vernal pool grasses | Habitat assessment | Vernal pools with sufficient water depth and duration of inundation to allow germination and maturation. | Meets design commitments and guidelines described in this table and in Table 3B.1-2 for vernal pool complex. |
| Northwestern pond turtle | Habitat assessment<br>Presence/ absence surveys | No additional design commitments and guidelines proposed. | Meets design commitments and guidelines described in this table and in Table 3B.1-3. |
| Western spadefoot | Habitat assessment | No additional design commitments and guidelines proposed. | Meets design commitments and guidelines described in Table 3B.1-3. |

# 3B.1 Introduction

This Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources (CMP) identifies compensatory mitigation options to address impacts on habitat for special-status plant and wildlife species (including fish) as well as natural communities (including wetlands and other waters or "aquatic resources") that may result from the construction and operation of the Delta Conveyance Project (project).[2] This CMP has been developed using best scientific information to identify the ecological requirements of wetland communities (Final EIR Chapter 13, *Terrestrial Biological Resources)*, natural history and habitat requirements of special-status species (Chapter 4, *Action Area and Environmental Baseline*), and ecological restoration practices is germane to the Sacramento–San Joaquin Delta (Delta) ecosystem and inclusive of relevant information from multiple disciplines (California Department of Water Resources 2023a).

Specifically, in order to propose feasible mitigation to offset adverse effects to aquatic resources and species habitat, the document first identifies several sites that could support habitat creation and enhancement actions. From among those sites where habitat creation and enhancement are deemed feasible, specific mitigation actions would be implemented to minimize adverse effects to aquatic resources and species habitat. This document further explains the methodology used to identify those sites and discusses other approaches that may be used to secure appropriate compensatory mitigation for the project.

The compensatory mitigation approach described herein is based on anticipated mitigation needs for the proposed action (which is the preferred alternative, Alternative 5, in the EIR) as described in Chapter 3, *Description of the Proposed Action.* The final compensatory habitat mitigation needs for the project will be determined once all regulatory permits and approvals are secured. The conceptual approaches described herein would contribute to the mitigation of significant impacts of project construction, operation, and maintenance on affected resources, including special-status species and aquatic resources, as described in *BA*. Although the mitigation approaches described in this appendix (including the mitigation work plan described in Section 3B.4 and Attachment 3B.1) are of sufficient detail to meet the requirements of CEQA, National Environmental Protection Act (NEPA), and other laws, it is anticipated that additional design and management planning, including additional details on performance standards, monitoring methods, and adaptive management actions, may be added between the project approval under CEQA and NEPA and project initiation. Other mitigation actions, including mitigation/conservation bank credit purchases and habitat protection, may also occur during that time.

The initial sites described herein are proposed to address the compensatory mitigation needs for many terrestrial and aquatic resources (Figure 3B-1). However, not all compensatory mitigation needs would likely be met through these sites; for those additional needs, mitigation credits from approved banks (with service areas that overlap with the location of impact unless otherwise approved by the USFWS or NMFS) as well as other approaches are expected to be used, including a proposed "Tidal Habitat Mitigation Framework." The effects of mitigation implementation on species are evaluated, to the level of detail available. At this time, siting and design detail is available

[2] Although there are many potential compensatory mitigation needs for resources as described in the EIR, this document focuses on the needs for special status terrestrial species and aquatic species and for natural communities including aquatic resources (including wetlands and other waters of the United States and waters of the State).

for the initial mitigation sites. As siting and design detail becomes available for additional mitigation sites, DWR will confer with the applicable regulatory agencies regarding the efficacy of these initial site-specific mitigation options as well as the other potential approaches to compensatory mitigation described herein.

Table 3B-1 summarizes the compensatory mitigation approaches that are addressed in this document by resource type. In some cases, multiple approaches may be considered for mitigation, such as the use of mitigation banks in combination with a tidal wetland restoration approach.

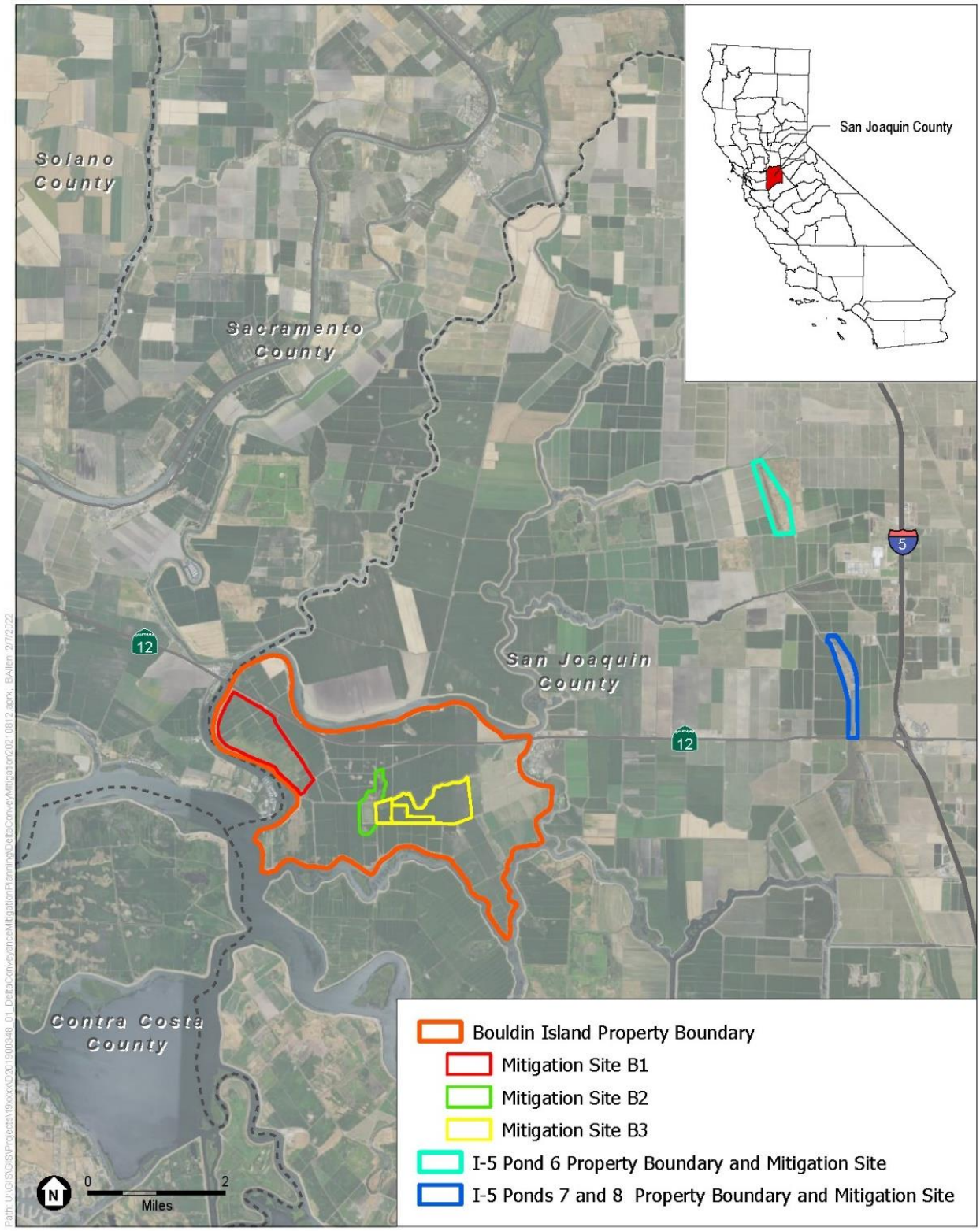


**Figure 3B-1. Mitigation Site Locations**

**Table 3B-1. Compensatory Mitigation Approaches**

| Aquatic Resources and Species Habitats | Habitat Description | Initial Mitigation Sites | | | Mitigation Credits & Site Protection Instruments | Tidal Habitat Mitigation Framework |
|---|---|---|---|---|---|---|
| | | Bouldin Island | I-5 Pond 6 | I-5 Ponds 7 & 8 | | |
| **Aquatic Resources** | | | | | | |
| ***Wetlands*** | – | – | – | – | – | – |
| Alkaline wetland | – | X | – | – | X | – |
| Forested and scrub shrub wetland | – | X | – | – | – | – |
| Emergent wetland | – | X | – | – | X | X |
| Seasonal wetland | – | X | – | – | – | – |
| Vernal pool | – | – | – | – | – | – |
| ***Other Waters*** | | – | – | – | – | – |
| Agricultural ditch | – | X | – | – | – | – |
| Conveyance channel | – | X | – | – | – | – |
| Depression (lake/pond) | – | X | – | – | – | – |
| Natural channel | – | X | – | – | – | – |
| Tidal channel | – | – | – | – | X | X |
| **Species Habitats** | | | | | | |
| Special-status plant species | Vernal pool, alkaline seasonal wetland, emergent wetland, perennial aquatic | X | X | X | X | X |
| California red-legged frog | Aquatic and upland | – | – | – | X | – |
| California tiger salamander | Aquatic and upland | – | – | – | X | – |
| Fisheries [a] | Tidal wetland | – | – | – | – | X |
| Fisheries [a] | Channel margin | X | – | – | – | X |
| Giant garter snake | Aquatic (freshwater marsh) | – | X | X | – | – |
| Giant garter snake | Upland (grassland) | – | X | X | – | – |
| Least Bell's vireo | Recolonization (riparian) | X | – | – | – | – |
| Valley elderberry longhorn beetle | Riparian | X | – | – | – | – |
| Vernal pool fairy shrimp, vernal pool tadpole shrimp | Vernal pool complex | – | – | – | X | – |
| Western yellow-billed cuckoo | Migration (riparian) | X | – | – | – | – |
| Northwestern pond turtle | Aquatic (freshwater emergent wetland, open water) | X | X | X | – | – |

| Aquatic Resources and Species Habitats | Habitat Description | Initial Mitigation Sites | | | Mitigation Credits & Site Protection Instruments | Tidal Habitat Mitigation Framework |
|---|---|---|---|---|---|---|
| | | Bouldin Island | I-5 Pond 6 | I-5 Ponds 7 & 8 | | |
| Northwestern pond turtle | Upland nesting (grassland, riparian, agricultural herbaceous near aquatic habitat) | X | X | X | – | – |
| Western spadefoot | Aquatic (Vernal pool complex, nontidal perennial aquatic) | | | | X | |
| Western spadefoot | Upland (grassland, alkaline seasonal wetland, vernal pool complex) | | | | X | |

I- = Interstate.

[a] With reference to the covered fish species, "Fisheries" includes tidal wetland for winter-run and spring-run Chinook salmon, delta smelt, and longfin smelt; and channel margin for winter-run and spring-run Chinook salmon.

## 3B.1.1 Plan Purpose

The purpose of this CMP is to describe the approaches used to provide compensatory aquatic resource and special-status species habitat mitigation for the project, including the associated habitat creation and enhancement actions that would be taken. This CMP does not address other, non-habitat compensatory mitigation needs, such as replacing the loss of agricultural lands. In addition to providing for the compensatory mitigation needs necessary under CEQA, the CMP may be used to support several environmental and regulatory compliance efforts for the project, include the following.

1. Fulfilling the joint requirements of the U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (EPA) under Code of Federal Regulations (CFR) Title 33, Parts 325 and 332 (*Compensatory Mitigation for Losses of Aquatic Resources*, or Mitigation Rule).
2. Fulfilling the requirements of the State Water Resources Control Board's (State Water Board's 2019 *State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State* (State Wetland Procedures, particularly Appendix A, Subpart J (*Compensatory Mitigation for Losses of Aquatic Resources*).
3. Supporting applications for incidental take under Section 2081 of the California Endangered Species Act and consultations under Section 7 of the federal Endangered Species Act (ESA), particularly as those consultations relate to the compensatory mitigation needs associated with the loss of habitat for listed species as it relates to the potential for incidental take as defined under the ESA.
4. Supporting the process to develop an agreement with the CDFW under Section 1602 of the California Fish and Game Code, if needed, particularly as it relates to reasonable measures necessary to protect the resource associated with impacts on fish and wildlife resources regulated under that section of code.

### 3B.1.2 Parties Responsible for Implementation

As the CMP is a component of the project, the primary party responsible for implementing it is DWR. Other parties that may be involved in implementation of the CMP as the landowner include, but are not limited to, the Metropolitan Water District of Southern California (Metropolitan) for the Bouldin Island mitigation sites.

### 3B.1.3 Document Overview and Organization

This CMP has been prepared to guide planning for the compensatory mitigation needs of the project. It consists of the following sections.

- **Section 3B.1, *Introduction***, provides an overview of the document purpose and parties responsible for implementation.
- **Section 3B.2, *Project Impacts***, summarizes the aquatic resources and listed species habitat potentially impacted by the construction and operation of the project.
- **Section 3B.3, *Mitigation Approach*,** outlines the approach taken for providing compensatory mitigation for aquatic resources and special-status species.
- **Section 3B.4, *Mitigation Work Plan*,** describes the initial compensatory mitigation sites and other potential compensatory mitigation sites that are under consideration. This section also summarizes approaches for providing compensatory mitigation for tidal wetland and channel margin habitats, as well as the potential use of mitigation/conservation banks and site protection instruments.
- **Section 3B.5, *Assurances,*** describes DWR's financial commitments associated with construction, operation and maintenance of the mitigation sites as well as a summary of the site protection instrument.
- **Section 3B.6, *Maintenance and Management,*** discusses short- and long-term management actions for the mitigation sites, and adaptive management.
- **Section 3B.7, *Performance Standards and Monitoring,*** discusses performance standards, metrics, monitoring and reporting.
- **Section 3B.8, *References Cited*,** provides the full references for the literature and other resources cited in this document.
- **Section 3B.9, *Description of Figures***, provides a text description of the figures shown in this document.

## 3B.2 Project Impacts

### 3B.2.1 Project Overview

The proposed action consists of the construction, operation, and maintenance of new State Water Project (SWP) water diversion and conveyance facilities in the Delta in coordination with the existing SWP facilities. The new water conveyance facility would create a new conveyance mechanism that would divert water from the north Delta and convey it through a single tunnel

directly to a new pumping plant along Byron Highway for conveyance to the Bethany Reservoir on an eastern. Operating the new conveyance facilities in conjunction with SWP's existing south Delta export facilities at Clifton Court Forebay would create a *dual conveyance* system. Please see Chapter 3, for more details on the project.

#### 3B.2.1.1 Project Location

The project is located in the Delta and adjacent regions, an expansive inland river delta and estuary in Northern California. Portions of six counties—Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo—make up the Delta (Figure 3B-2). The Delta is formed at the western edge of the Central Valley by the confluence of the Sacramento and San Joaquin Rivers and lies just east of where the rivers enter Suisun Bay. The watersheds of the Sacramento and San Joaquin Rivers are at the core of California's water system, which conveys water to millions of Californians throughout the San Francisco Bay Area (Bay Area), Central Valley, Central Coast, and Southern California.

The study area, defined as the area in which impacts may occur, primarily comprises the statutory Delta, as delineated under the Delta Protection Act (California Water Code [Wat. Code] § 12220) as well as a few areas east of this boundary, to capture project infrastructure and areas to the southwest of the statutory Delta to include the area around Bethany Reservoir for the proposed action (Chapter 3).

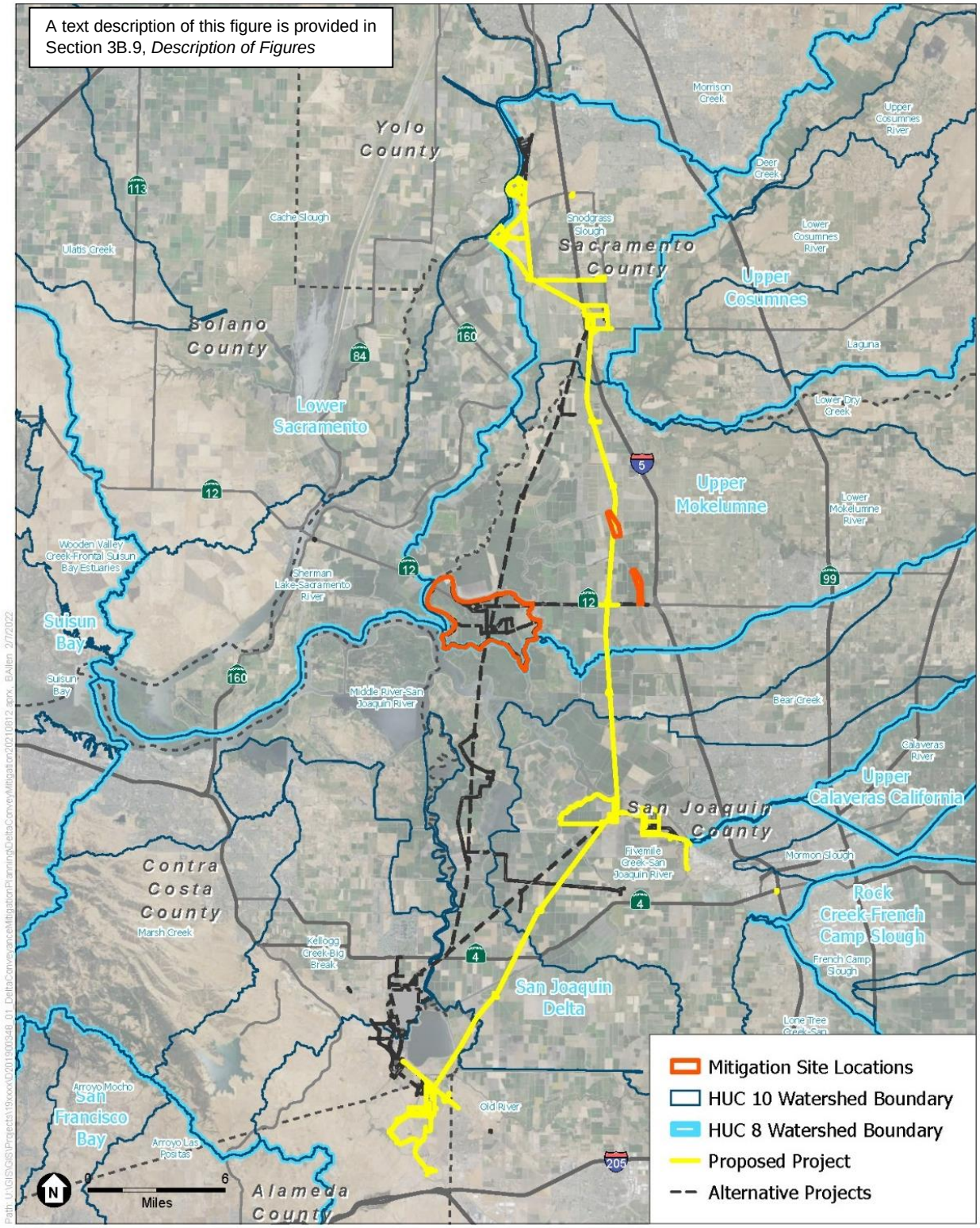


**Figure 3B-2. Watershed Boundaries**

### 3B.2.1.2 Affected Watersheds

Figure 3B-2 displays the hydrologic unit codes (HUC) 8 and HUC 10 watersheds that the project occurs within. This includes watersheds associated with the Sacramento and San Joaquin Rivers. As indicated in the figure, the proposed mitigation sites are located within the same watersheds as where impacts would occur under multiple project alternatives.

#### Basin Plan Considerations

As stated in the *Delta Conveyance Project Final EIR*, beneficial uses of surface waters are designated by California's nine Regional Water Quality Control Boards (RWQCBs) for waters in their jurisdictions within their respective water quality control plans (WQCPs). In addition, the State Water Board has designated beneficial uses for the statutory Delta in its WQCP for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (Bay-Delta WQCP). The Delta also falls within the jurisdictions of the Central Valley and San Francisco Bay RWQCBs, which have designated uses for the Delta within their respective WQCPs. More information regarding Basin Plan considerations, including beneficial uses, can be found in Appendix 6B, *Water Quality*.

### 3B.2.1.3 Mitigation Measures

Chapter 3, Section 3.6, *Conservation Measures*, describes measures to avoid, minimize, or mitigate impacts on sensitive resources, including aquatic resources and special-status species habitat. This includes siting facilities under each alternative to avoid sensitive resources such as wetlands and suitable habitat to the greatest extent feasible. All the mitigation measures in Chapter 3 and related appendices would apply during construction of mitigation sites.

## 3B.2.2 Impacts on Waters of the United States and State

The term *waters of the United States* is an encompassing term for areas that are subject to federal regulation under the Clean Water Act (CWA), including Section 404 (Chapter 3, Section 3.1.11.1, *U.S. Army Corps of Engineers Permits*). For purposes of Section 404, waters of the United States are categorized as wetlands (i.e., wetlands that meet the definition of waters of the United States) or other waters. Wetlands are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Other waters of the United States are waterbodies but do not typically display all three of the wetland indicators identified above. Linear features and open water habitats that may qualify as other waters of the United States were categorized based on tidal influence as nontidal or tidal. Nontidal waters include natural channels, depressions, and agricultural ditches. Tidal classifications include tidal channel, including major waterways, which was used for conveyance features associated with the SWP and CVP. As described in Chapter 13, Section 13.1.4, *Wetlands and Other Waters of the United States,* of the Final EIR, an aquatic resources delineation was conducted via aerial imagery interpretation for the study area. All aquatic resources are depicted on Figure 3B-5, Figure 3B-8, and Figure 3B-9, which show the existing conditions for each mitigation site (Section 3B.4).

In accordance with the Porter-Cologne Water Quality Control Act and the associated State Wetland Procedures (State Water Resources Control Board 2019), the State Water Board and the RWQCBs also regulate discharges of waste, which includes discharges of dredged and fill material, that may

affect the quality of waters of the State. Waters of the State include features that are defined as wetlands, as well as other waters that meet the definition of waters, including the oceans, lakes, and rivers. The wetland definition used by the state encompasses the full range of wetland types commonly recognized in California, including some features not considered in the federal definition of wetlands.

To determine effects to these aquatic resources that may result from project construction, a geographic information system (GIS) layer of potentially jurisdictional wetlands and other waters was intersected with the layer of project footprint surface features for each proposed alternative. The resulting polygons identify the areas of potential impacts on potentially jurisdictional waters. Acreages of each type of affected wetland or other water were calculated for each alternative and are presented in the wetlands and waters impact discussions in Chapter 13 of the Final EIR. Based on this assessment, the following aquatic resources would be potentially impacted by the project and are therefore addressed within this CMP.

- Agricultural ditch
- Alkaline wetland
- Conveyance channel
- Depression (lake/pond)
- Forested and scrub shrub wetland
- Emergent wetland
- Natural channel
- Seasonal wetland
- Tidal channel
- Vernal pool

Because the delineation includes all aquatic resources in the study area, DWR intended that the delineation also represents what would be considered waters of the State. Therefore, the analyses and conclusions for effects on waters of the United States in Chapter 13 of the Final EIR also apply to waters of the State.

## 3B.2.3 Impacts on Special-Status Species

For the purposes of the BA (Chapter 1, Table 1-6.1), special-status species are species that are legally protected or otherwise considered sensitive by federal, state, or local resource agencies. Detailed information on the species habitat requirements, distribution, and occurrences within the study area is presented in Chapter 4, *Action Area and Environmental Baseline*. Permanent and temporary (i.e., generally limited to one construction season) impacts on terrestrial species from construction were quantified in GIS by overlaying the project alternative facility footprints on conservatively modeled habitat for the species and species occurrences (Appendix 6A, *Terrestrial Take Analysis Methods*). Impacts on aquatic species from construction were analyzed by examining location and type of in-water construction activities (Chapter 5, *Effects Analysis for Chinook Salmon, Central Valley Steelhead, Green Sturgeon, and Killer Whale,* and Chapter 6, *Effects Analysis for Delta Smelt, Longfin Smelt, and Terrestrial Species*), while impacts from operations (such as entrainment of fish) and maintenance were analyzed by with various qualitative and quantitative analyses (Chapter

5 and 6, specifically species-specific sections under *Operations and Maintenance Effects*). It is anticipated that preconstruction field surveys will verify habitat suitability for special-status species. Therefore, these preliminary impact estimates may be revised once surveys are completed. Because the modeling is conservative, field surveys likely will result in reduced acreages of impacts. Agency coordination between permitting and final implementation could also lead to changes to the restoration design, location, and construction timing.

The CMP is designed to define compensatory habitat mitigation for impacts on special-status species where compensatory mitigation is proposed as discussed in the BA (Chapters 3 through 6). This includes the species and habitats presented in Table 3B-2.

**Table 3B-2. Special-Status Fish and Wildlife Species and Habitats**

| Species | Life Stage/ Habitat Function | Habitats |
|---|---|---|
| California red-legged frog | Aquatic | Nontidal perennial aquatic (depression/pond), tidal perennial aquatic, tidal and nontidal freshwater emergent wetland |
| California red-legged frog | Upland | Grassland, alkaline seasonal wetland, valley/foothill riparian |
| California tiger salamander | Aquatic and upland | Vernal pool complex, alkaline seasonal wetland, grassland |
| Fisheries [a] | Migration/rearing | Tidal perennial aquatic, tidal freshwater emergent wetland |
| Fisheries [a] | Migration/rearing | Channel margin/riparian (linear feet) |
| Giant garter snake | Aquatic | Nontidal freshwater and tidal emergent wetland (freshwater marsh) nontidal perennial aquatic (depression), tidal perennial aquatic, agricultural (ditch/drain, rice) |
| Giant garter snake | Upland | Grassland, agricultural (upland herbaceous, mixed pasture), valley/foothill riparian |
| Least Bell's vireo | Recolonization | Valley/foothill riparian |
| Valley elderberry longhorn beetle | All | Valley/foothill riparian |
| Vernal pool fairy shrimp, vernal pool tadpole shrimp | All | Vernal pool complex |
| Western yellow-billed cuckoo | Migration | Valley/foothill riparian (forested) |
| Northwestern pond turtle | Aquatic | Tidal perennial aquatic, nontidal perennial aquatic, agricultural ditch, tidal freshwater emergent wetland, nontidal freshwater perennial emergent wetland, freshwater emergent wetland, brackish emergent wetland |
| Northwestern pond turtle | Upland | Grassland, valley foothill riparian, alkaline seasonal wetland complex, vernal pool complex, agricultural (upland herbaceous) |
| Western spadefoot | Aquatic | Vernal pool complex, nontidal perennial aquatic |

| Species | Life Stage/ Habitat Function | Habitats |
|---|---|---|
| Western spadefoot | Upland | Grassland (all types), alkaline seasonal wetland complex, vernal pool complex |

[a] With reference to the covered fish species, "Fisheries" includes tidal wetland for winter-run and spring-run Chinook salmon, delta smelt, and longfin smelt; and channel margin for winter-run and spring-run Chinook salmon.

### 3B.2.4 Mitigation Design Parameters

Design commitments and guidelines for compensatory mitigation are provided in Attachment 3B.1. These design parameters address critical life functions for certain species. These provisions also describe a framework to ensure that any habitat conversions associated with site development are accounted for so adverse effects related to these conversions are avoided or minimized.

In addition to these parameters, DWR will request input from California Native American Tribes that are traditionally and culturally affiliated with the action area and chose to consult with DWR about the project on siting, design, construction, management, and stewardship of compensatory mitigation sites. The "good neighbor" policies in the *Agriculture and Land Stewardship Framework and Strategies* (California Department of Water Resources 2018:8, 31–39) would also be implemented, which includes the creation of buffer zones between habitat preserves and farmland, which would help to reduce or eliminate exposure to pests and diseases on neighboring lands, prevent overspray of chemicals onto habitat lands, and assist with a successful transition between different land uses.

## 3B.3 Mitigation Approach

This CMP outlines three primary approaches in providing compensatory mitigation to mitigate impacts associated with the construction and operation of the project alternatives. The first approach is to develop and implement several initial mitigation actions at specific sites that would provide compensatory mitigation for many of the affected special-status species habitats and aquatic resources. The second approach is to use existing or proposed mitigation banks to secure credits for certain types of habitats and natural communities, including vernal pools and alkaline seasonal wetlands, as well as species habitat such as California tiger salamander (*Ambystoma californiense*) and California red-legged frog (*Rana draytonii*). This second approach also includes the potential use of site protection instruments, such as conservation easements, to protect or enhance existing land uses such as agriculture. Agricultural land features such as levees, canals, and ditches, when protected and managed in perpetuity, can provide basking and foraging habitat function for species such as giant garter snake or northwestern pond turtle. The third approach, a combination of these, is to propose a mitigation framework under which future compensatory mitigation actions may be delivered for tidal freshwater perennial aquatic (tidal channel), tidal freshwater emergent wetland, and channel margin communities. Each of these approaches is described in greater detail in Section 3B.4.

## 3B.3.1 Applicable Policies and Guidance Documents

The selection of potential mitigation sites described in this document was informed by the mitigation policies and guidance documents from several resource agencies, including the following.

- USACE and EPA's joint requirements under 33 CFR Parts 325 and 332 (*Compensatory Mitigation for Losses of Aquatic Resources*, or Mitigation Rule)
- The State Water Board's State Wetland Procedures, particularly Appendix A, Subpart J (Compensatory Mitigation for Losses of Aquatic Resources) (State Water Resources Control Board 2019:25–42)
- U.S. Fish and Wildlife Service (USFWS) Mitigation Policy and Endangered Species Act Compensatory Mitigation Policy (2023a, 2023b)

In addition to these general guidance documents and policies, several additional resources such as the Delta Plan (Delta Stewardship Council 2013) were reviewed to guide site selection and design criteria for special-status species presented in Attachment 3B-1.

## 3B.3.2 Approach to Aquatic Resources Mitigation

### 3B.3.2.1 Hierarchal Approach

For aquatic resources, including mitigation for impacts on waters of the United States and State, the approach to compensatory mitigation considered the requirements of 33 CFR Section 332.3(b), including the hierarchal order when considering compensatory mitigation options, as follows: (1) Mitigation bank credits; (2) In-lieu fee program credits; (3) Permittee-responsible mitigation under a watershed approach; (4) Permittee-responsible mitigation through on-site and in-kind mitigation; and (5) Permittee-responsible mitigation through off-site and/or out-of-kind mitigation. Note, however, that the last option, off-site and/or out-of-kind mitigation, is not part of the compensatory mitigation plan for the proposed action.

When considering these options, credit or site availability was often a controlling factor. For example, where the compensatory mitigation need for an aquatic resource type (e.g., vernal pools) was expected to be relatively small and mitigation banks with agency-approved service areas (typically based on watersheds and eco-regions for aquatic resources) covering the impact footprint that are known to have available credits for the aquatic resource type to be affected, option 1 was selected. However, in many circumstances, the compensatory mitigation needs of the project are such that mitigation banks or in-lieu fee programs are not an option due to lack of credit availability based on the number of credits that are potentially needed. In these cases, and as noted in 33 CFR Section 332.3(b)(4), compensatory mitigation may then be provided through option 3, permittee-responsible mitigation under a watershed approach. Therefore, compensatory mitigation for aquatic resources would be provided in accordance with the procedures set forth in 33 CFR Section 332.3(b) and would be provided for through either mitigation bank credits or permittee-responsible mitigation under a watershed approach.

### 3B.3.2.2 Watershed Approach

A watershed approach was used to avoid a net loss in the overall abundance, diversity, and condition of aquatic resources within the watershed profile. Because compensatory mitigation for

aquatic resources would be typically located within the same watersheds as where project impacts would occur, no net loss is anticipated on a watershed basis. Per the State Wetland Procedures, "*[i]f the compensatory mitigation and project impacts are located in multiple watersheds, no net loss will be determined considering all affected watersheds collectively*" (State Water Resources Control Board 2019:8). Figure 3B-1 shows the location of proposed mitigation sites for several aquatic resources. Figure 3B-2 shows the location of these sites in relation to local watersheds and project alternatives.

#### 3B.3.2.3 Emergent Wetland, Seasonal Wetlands, Valley/Foothill Riparian, and Other Nontidal Waters

Compensatory mitigation for these aquatic resources would be located on Bouldin Island at Mitigation Site B1 (detailed in Section 3B.4.1.3, *Bouldin Island Mitigation Sites*) (Figure 3B-1). This site includes areas that already exhibit wetland characteristics due to a high groundwater table, seepage, site elevation, and drainage patterns, as explained further in Section 3B.4.1.3. In addition, peat soils are prevalent at the site, providing a suitable combination of surface and subsurface hydrology as well as hydric soils. Lastly, the majority of project impacts on these aquatic resource types occur in similar ecological conditions to those found at Bouldin Island; namely, remnant wetlands and man-made channels found adjacent to existing agricultural fields.

The design approach to Mitigation Site B1 was to develop an analog of a remnant oxbow of the Mokelumne River near the junction of the San Joaquin River, including open water, valley riparian habitat (including scrub-shrub and forested), freshwater emergent wetland, and seasonal wetlands. This mix of wetland habitats once dominated the Delta (Whipple et al. 2012:xx–xxiii), and the re-creation of these aquatic resources at the mitigation site would result in compensatory mitigation that has a higher number of functions and services than the affected resources.

#### 3B.3.2.4 Vernal Pools and Alkaline Wetlands

Compensatory mitigation for impacts on vernal pools and alkali seasonal wetlands would be provided through purchasing wetland creation credits at an approved mitigation bank. Several existing and proposed mitigation banks have available or soon-to-be-available credits with service areas that encompass the project. In the instance that bank credits are not available, a non-bank site approved by the relevant regulatory agencies supporting the necessary habitat would be used as mitigation.

#### 3B.3.2.5 Tidal Wetlands and Waters

Compensatory mitigation for tidal emergent wetlands and tidal channel would be provided by the proposed Tidal Habitat Mitigation Framework (Section 3B.4.3, *Tidal Habitat Mitigation Framework*). A secondary option that may be used is to purchase wetland creation credits at an approved mitigation bank. Several existing and proposed mitigation banks have available or soon-to-be-available credits with service areas that encompass the project's impacts on this habitat type.

### 3B.3.3 Approach to Special-Status Species Mitigation

The general approach to identifying suitable mitigation sites and developing conceptual restoration plans for special-status species included reviewing life history information for affected species, with a specific emphasis on federally listed and state-listed species. Design parameters were also considered in the siting and design of compensatory mitigation (Attachment 3B.1). In addition,

recovery plans, mitigation plans, and conservation guidance documents were reviewed, include the following.

- *Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*)* (U.S. Fish and Wildlife Service 2017a:II-1–II-11)
- *Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)* (U.S. Fish and Wildlife Service 2017b)
- *Recovery Plan for the California Red-legged Frog (*Rana aurora draytonii*)* (U.S. Fish and Wildlife Service 2002:12–16)
- *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service 2005)
- *Recovery Plan for the Central California Distinct Population Segment of the California Tiger Salamander (*Ambystoma californiense*)* (U.S. Fish and Wildlife Service 2017c:II-3–II-6)
- *Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the DPS of California Central Valley Steelhead* (National Marine Fisheries Service 2014:128–142)
- *Final Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*)* (National Marine Fisheries Service 2018:12–13, 18)
- *Sacramento–San Joaquin Delta Native Fishes Recovery Plan* (U.S. Fish and Wildlife Service 1995:27–29, 48–49)
- *Species status assessment report for the northwestern pond turtle (*Actinemys marmorata*) and southwestern pond turtle (*Actinemys pallida*), Version 1.1, April 2023* (U.S. Fish and Wildlife Service 2023).
- *Western Pond Turtle Range-wide Management Strategy* (Western Pond Turtle Range-wide Conservation Coalition 2020:15–20)

The mitigation needs for special-status species may be addressed through the creation or enhancement of natural communities so they may provide suitable conditions for various life functions of the species. Often, these communities can provide benefits for more than one species. For example, freshwater marsh habitat hydrologically connected or adjacent to open water can provide suitable aquatic habitat for giant garter snake (*Thamnophis gigas*) while also providing suitable foraging and basking habitat for northwestern pond turtle (*Actinemys marmorata*). This correlation makes it possible to provide compensatory habitat for more than one species at a particular mitigation site.

The final designs for targeted habitats will be informed by species-specific parameters. This includes design parameters that target key life cycle needs for the targeted species, such as water (including water quality), cover, and foraging habitat. It also includes parameters that enhance the long-term resiliency of the created habitat, such as buffer distances, consideration of predators, and hydrological factors. Lastly, other design parameters consider landscape and movement/migration dynamics to ensure species can both access the created habitat as well as disperse to adjacent suitable habitat. Measures that specifically address design goals for species are highlighted in Attachment 3B.1.

Mitigation sites will be designed, managed, and maintained to support multiple special-status species and will incorporate species-specific habitat requirements such as structural complexity and patch size. See Appendix 13B, *Species Accounts*, of the Final EIR for detailed habitat requirements special-status species. For example, the enhancement and management of grasslands will focus on maintaining a mosaic of grassland alliances and vegetation heights to increase biological and structural diversity for targeted species (Fuhlendorf and Engle 2001). Structural heterogeneity of riparian vegetation will be maintained and enhanced and structural complexity—including understory (low shrubs), midstory (large shrubs and small trees), and overstory (upper canopy formed from large trees)—will be maintained to provide habitat requirements for a diversity of targeted wildlife species.

#### 3B.3.3.1 Freshwater Marsh and Riparian Terrestrial Species

The Interstate (I-) 5 pond mitigation sites were selected as the primary location for developing compensatory mitigation for species dependent on freshwater marsh and associated uplands, including giant garter snake. The sites are located within the White Slough Management Unit of the Delta Basin Recovery Unit for giant garter snake (U.S. Fish and Wildlife Service 2017a:II-10–II-11) and would extend connectivity between occupied sites at Stone Lakes National Wildlife Refuge and the CDFW Woodbridge Ecological Reserve further south with the creation of protected suitable habitat (Pond 6 is located approximately 0.7 mile southeast and Ponds 7 and 8 are located approximately 2 miles south of Woodbridge). The location also has suitable elevations, water supply, and access. These mitigation sites would also provide suitable aquatic foraging and basking habitat for northwestern pond turtle. Upland adjacent to these sites could also provide breeding habitat for northwestern pond turtle.

Significant impacts on riparian-dependent species, including valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), least Bell's vireo (*Vireo bellii pusillus*), and western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), would be mitigated by the creation of habitat at Bouldin Island Mitigation Sites B1 and B2.

#### 3B.3.3.2 Grassland Species and Agricultural Lands

Bouldin Island Mitigation Site B3 would provide suitable mitigation for grassland species. Grassland adjacent to suitable aquatic habitat could also provide suitable upland habitat for northwestern pond turtle and giant garter snake.

Additional acres of grassland mitigation could also occur at sites disturbed by the project and no longer needed following construction completion, including at the proposed intake sites, Twin Cities Complex, Lower Roberts Island, and the Bethany Complex.

In addition, as described in more detail below, site protection instruments may also be used to protect and enhance agricultural and other lands that provide suitable habitat for other nonfederal listed species.

#### 3B.3.3.3 Vernal Pool Species, California Tiger Salamander, and California Red-legged Frog

For species associated with the vernal pool complexes and alkali wetland habitats, as well as perennial pond features and grasslands in the south Delta, compensatory mitigation would be provided in the form of species conservation credits at a USFWS- and CDFW-approved

mitigation/conservation bank. This includes mitigation credits for vernal pool invertebrates, California tiger salamander, and California red-legged frog. Several existing and proposed mitigation banks have available or soon-to-be-available credits with service areas that encompass the project. Credits for California tiger salamander will be prioritized in the Concord/Livermore Recovery Unit, if possible. Mitigation bank credits purchased for these species would also provide suitable aquatic and upland habitat for western spadefoot. Creation and enhancement of vernal pool complexes and alkali wetland habitats would likely provide seasonal aquatic habitat for northwestern pond turtle and western spadefoot.

#### 3B.3.3.4 Fisheries

Compensatory mitigation for fisheries, including salmonids, delta smelt (*Hypomesus transpacificus*), longfin smelt (*Spirinchus thaleichthys*), and green sturgeon (*Acipenser medirostris*), would be provided through the Tidal Habitat Mitigation Framework (Section 3B.4.3), which includes the development of tidal wetland mitigation sites and channel margin habitat. These sites would be constructed ahead of project impacts on these habitat types.

# 3B.4 Mitigation Work Plan

Three general types of mitigation proposed under this CMP: initial mitigation sites, mitigation credits and site protection instruments, and tidal habitat. Each of these types are described in the following sections of the same names.

## 3B.4.1 Initial Mitigation Sites

### 3B.4.1.1 Purpose

The purpose of the initial compensatory mitigation actions are to partially offset impacts on federal and state wetlands and a subset of terrestrial species. The initial mitigation projects will create and enhance freshwater emergent wetland, riparian, and seasonal wetland natural community types, among others. These mitigation sites will also create and enhance compensatory habitat for several special-status species including giant garter snake, valley elderberry longhorn beetle, least Bell's vireo, and northwestern pond turtle. For the giant garter snake, northwestern pond turtle, and valley elderberry longhorn beetle, initial mitigation sites will meet mitigation needs for the species. For a full list of mitigation acreage requirements see Table 3B-S.1.

The initial mitigation sites are focused on lands owned by DWR (I-5 Ponds 6, 7 and 8) or partners (Bouldin Island). This approach allows compensatory mitigation for many resources to be quickly advanced following final designs and receipt of permits and approvals, thereby in many cases allowing for the establishment of created and enhanced habitats ahead of impacts.

The net gain in habitat, once changes from existing land cover are accounted for, are summarized for wetlands and other waters in Table 3B-3. As noted previously, mitigation sites on Bouldin Island (specifically Mitigation Sites B-1 and B-2) would be designed to provide compensatory mitigation for aquatic resources impacts. The mitigation acres provided below (Table 3B-3) include habitat creation for species (Table 3B-4), hence the additional acreage shown for some habitat types that far exceed the anticipated compensatory mitigation needs for federal and state wetlands (e.g., freshwater emergent wetland). Compensatory mitigation for special-status species, which

would be constructed at all the proposed mitigation sites, is summarized in Table 3B-4. Site protection instruments, including conservation easements, may also be implemented at or near the sites.

The detailed restoration design work and management planning, which will include fully detailing performance standards, monitoring methods, and adaptive management actions, will occur between the project permitting phase and project completion. Other mitigation actions, including bank credit purchases and habitat protection, will also occur between permitting and project construction completion. To inform the mitigation planning process between permit issuance and mitigation land construction or preservation, DWR will prepare Draft and Final Habitat Mitigation Plans for affected species and wetlands. Compensatory mitigation would be secured in phases in accordance with the progress of construction.

**Table 3B-3. Summary of Compensatory Mitigation for Wetlands and Other Waters Created at Bouldin Island Mitigation Sites B1 and B2 (acres)**

| Aquatic Resources | Created (Loss) (Acres) [a] |
|---|---|
| **Wetlands** | |
| Alkaline seasonal wetland | 0 |
| Nontidal freshwater emergent wetland | 49.87 |
| Valley/foothill riparian (forested and scrub-shrub) [b] | 193.94 |
| Seasonal wetland | 92.22 |
| Tidal freshwater emergent wetland | 0 |
| Vernal pool | 0 |
| Total wetlands | 336.03 |
| **Other Waters** | |
| Agricultural ditch | (13.32) |
| Conveyance channel | 0 |
| Depression (lake/pond) | 10.29 |
| Natural channel | 0 |
| Tidal channel | 0 |
| Total other waters | (3.03) |
| Total all aquatic resources (net gain) | 333.00 |

[a] Land cover types with a negative value reflect conversion to another type of wetland and other waters (not to uplands). Acreage subject to rounding.

[b] Valley/foothill riparian, as a natural community, could include a subset of jurisdictional waters, namely forested and scrub-shrub wetland.

**Table 3B-4. Summary of Special-Status Species Habitat That Will Be Created or Enhanced with Full Implementation of the Initial Mitigation Sites (acres) [a]**

| Species (Life requirement) | Land Cover Types | Created at Initial Sites? | Total Habitat Created or Enhanced (acres) [b] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | B1 | B2 | B3 | I-5 Pond 6 | I-5 Ponds 7/8 | Total by Land Cover | Total by Species Habitat Type |
| California red-legged frog (aquatic) | Nontidal perennial aquatic (depression), tidal perennial aquatic, nontidal freshwater emergent wetland, tidal freshwater emergent wetland | N/A | – | – | – | – | – | 0 | 0 |
| California red-legged frog (upland) | Grassland, valley/foothill riparian, Alkaline seasonal wetland | N/A | – | – | – | – | – | 0 | 0 |
| California tiger salamander (aquatic) | Vernal pool complex | N/A | – | – | – | – | – | 0 | 0 |
| California tiger salamander (upland) | Grassland, vernal pool complex, Alkaline seasonal wetland | N/A | – | – | – | – | – | 0 | 0 |
| Fisheries | Tidal emergent wetland | N/A | – | – | – | – | – | 0 | 0 |
| Fisheries | Channel margin/riparian (linear feet) [c] | N/A | Up to 4,900 linear feet [d] | | – | – | – | 0 | 0 |
| Giant garter snake (aquatic) [e] | Nontidal freshwater emergent wetland | I-5 Ponds | – | – | – | 40.68 | 59 | 99.68 | 150.54 |
| | Nontidal perennial aquatic (depression) | | – | – | – | 14.23 | 30.55 | 44.78 | |
| | Tidal freshwater emergent wetland | | – | – | – | 0 | 0 | 0 | |
| | Tidal perennial aquatic | | – | – | – | 0.8 | 0 | 0.80 | |
| | Agricultural ditch/ drain | | – | – | – | 3.32 | 1.96 | 5.28 | |
| Giant garter snake (upland) [d] | Agricultural | I-5 Ponds | – | – | – | 0.55 | 0 | 0.55 | 189.81 |
| | Grassland | | – | – | – | 114.14 | 67.78 | 181. 92 | |
| | Valley/foothill riparian | | – | – | – | 5.38 | 1.96 | 7.34 | |
| Least Bell's vireo [b] | Valley/foothill riparian | Bouldin, I-5 Ponds | 103.15 | 94.3 | 0 | 5.38 | 1.96 | 204.79 | 204.79 |
| Northwestern pond turtle | Nontidal freshwater emergent wetland | Bouldin, I-5 Ponds | 72.39 | 0 | 0 | 40.68 | 59 | 172.07 | 233.94 |
| | Nontidal perennial aquatic (depression) | | 10.29 | 0 | – | 14.23 | 30.55 | 55.07 | |

| Species (Life requirement) | Land Cover Types | Created at Initial Sites? | Total Habitat Created or Enhanced (acres) [b] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | B1 | B2 | B3 | I-5 Pond 6 | I-5 Ponds 7/8 | Total by Land Cover | Total by Species Habitat Type |
| (aquatic) | Tidal freshwater emergent wetland | | 0 | 0 | – | 0 | 0 | 0 | |
| | Tidal perennial aquatic | | 0 | 0 | – | 0.8 | 0 | 0.80 | |
| | Agricultural ditch/ drain | | 0.72 | 0 | – | 3.32 | 1.96 | 6.00 | |
| Northwestern pond turtle (upland) | Agricultural | Bouldin, I-5 Ponds | 0 | 0 | – | 0.55 | 0 | 0.55 | 456.10 |
| | Grassland | | 68.84 | 0 | – | 114.14 | 67.78 | 250.76 | |
| | Valley/foothill riparian | | 103.15 | 94.3 | - | 5.38 | 1.96 | 204.79 | |
| | Vernal pool complex, alkaline seasonal wetland, other seasonal wetland | N/A | – | – | – | – | – | 0 | |
| Valley elderberry longhorn beetle | Valley/foothill riparian | Bouldin, I-5 Ponds | 103.15 | 94.3 | 0 | 5.38 | 1.96 | 204.79 | 204.79 |
| Vernal pool fairy shrimp/ tadpole shrimp (Direct effect) | Vernal pool complex | N/A | – | – | – | – | – | 0 | 0 |
| Vernal pool fairy shrimp/ tadpole shrimp (Direct & indirect effect) | Vernal pool complex | N/A | – | – | – | – | – | 0 | 0 |
| Western yellow-billed cuckoo (migration) | Valley/foothill riparian | Bouldin, I-5 Ponds | 103.15 | 94.3 | 0 | 5.38 | 1.96 | 204.79 | 204.79 |
| Western spadefoot (aquatic) | Vernal pool complex, nontidal perennial aquatic (depression) | N/A | – | – | – | – | – | 0 | 0 |
| Western spadefoot (upland) | Grassland, alkaline seasonal wetland, vernal pool complex | N/A | – | – | – | – | – | 0 | 0 |

N/A = Suitable habitat not created at site.

[a] This table shows the net gain in special-status species habitat with full implementation of the initial mitigation sites. This table does not include habitat that will be created, enhanced, or protected under mitigation credits or site protection instruments, as described under Section 3B.4.2, *Mitigation Credits and Site Protection Instruments*, or created as part of the tidal habitat mitigation framework described in Section 3B.4.3, *Tidal Habitat Mitigation Framework*. For a full list of required compensation for all species-status species, see Table 3B-S.1.

[b] Acreage subject to rounding.

[c] Rearing and refuge needs for out migrating juvenile salmonids could also be met by tidal wetland and floodplain habitats in addition to channel margin habitat. While the creation of channel margin habitat at Bouldin is not currently proposed as an initial mitigation project, it is listed here as a potential future phase (Section 3B.4.3).

[d] Bouldin Island is not being designed specifically for the giant garter snake, although Bouldin Island could potentially be used by the species.

### 3B.4.1.2 Natural Communities Targeted at Initial Mitigation Sites

The initial mitigation sites are designed to compensate for several types of aquatic and upland habitats that may be affected by the project. This section provides a general description of the major habitat types that were targeted for creation and enhancement at the initial sites. The descriptions below are based on the Final EIR (Chapter 13, Section 13.1.2.2, *Natural Community Descriptions*, and Section 13.1.4). Types used in the wetland delineation are shown in parentheses, where applicable.

#### Aquatic Resources

##### Valley/Foothill Riparian (Forested and Scrub-Shrub)

Riparian habitats are plant communities that support woody vegetation. Scrub-shrub wetlands within the study area are dominated by woody vegetation less than 20 feet tall, often forming dense thickets. Shrubs include sandbar willow (*Salix exigua*), Himalayan blackberry (*Rubus armeniacus*), red twig dogwood (*Cornus sericea* [syn. *C. alba*]) buttonwillow (*Cephalanthus occidentalis*), and California wild rose (*Rosa californica*). Fremont's cottonwood (*Populus fremontii* [syn. *P. deltoides*]) seedlings or saplings may also be present. Herbaceous species are generally lacking or are a minor component of the vegetation assemblage, as the canopy cover in scrub-shrub wetlands is high and low-growing herbaceous species do not receive sufficient light for survival.

Forested wetlands are defined by woody vegetation that is 20 feet tall or taller with a tree canopy cover equal to or greater than 25%. Riparian trees common in the study area include Goodding's black willow (*Salix gooddingii*), red willow (*S. laevigata*), box elder (*Acer negundo*), Oregon ash (*Fraxinus latifolia*), Fremont's cottonwood, white alder (*Alnus rhombifolia*), black walnut (*Juglans hindsii*), and valley oak (*Quercus lobata*). Forested wetlands generally have a shrub component, typically in canopy openings and along the forested edge. The presence of an herbaceous layer is variable.

The valley/foothill riparian natural community usually occurs as long, linear patches separating other terrestrial biological communities and agricultural or urban land, or in low-lying, flood-prone patches near river bends, canals, or breached levees. Patches of riparian vegetation are also found on the interior of leveed Delta islands, along drainage channels and pond margins, and in abandoned low-lying fields.

Riparian habitat provides important food, nesting habitat, cover, and movement corridors. Over 135 species of California birds such as the willow flycatcher (*Empidonax traillii*), western yellow-billed cuckoo, and red-shouldered hawk (*Buteo lineatus*) completely depend upon riparian habitats or may use them preferentially at a particular stage of their life history. Riparian habitat also provides riverbank protection, erosion control, and improved water quality.

##### Nontidal Freshwater Emergent Wetland

Nontidal freshwater emergent wetlands, including freshwater marshes, are perennial wetlands frequently or continually inundated with water, and dominated by herbaceous emergent plants such as California tule (*Schoenoplectus californicus*), hard-stem tule (*S. acutus*), narrow-leaf cattail (*Typha angustifolia*), broad-leaf cattail (*T. latifolia*), and floating water primrose (*Ludwigia peploides*). Shallow emergent wetlands (water less than 3 feet deep) are dominated by thick, tall, highly productive stands of tules and cattails. The higher elevation edges of freshwater marsh gradients may be characterized by abrupt transitions to terrestrial vegetation, or they may transition into

vegetation of alkali seasonal wetlands, riparian woodland, or riparian scrub. These perennial wetlands are among the most productive habitats for wildlife. Covered wildlife species that depend on nontidal freshwater marsh include giant garter snake and northwestern pond turtle (*Actinemys marmorata*).

Proposed freshwater marshes would maximize localized topography and hydrology to limit the amount of grading. Freshwater marsh habitat would be interwoven with seasonal wetlands, riparian, and grassland habitats as conditions allow.

### Seasonal Wetland

Seasonal wetlands are areas that may only be saturated or hold water from late fall to late spring. In the Central Valley and Delta, seasonal inundation events are typically associated with winter storms or Sierra snowmelt. The hydrology of these features is driven by winter storm events or when increased flows raise the water table to an elevation sufficient to wet the area. By midsummer, most seasonal wetlands are dry or moist. Numerous seasonal wetlands were mapped in active agricultural fields in the Delta. Although groundwater levels are controlled on many Delta islands, including Bouldin, using a system of pumps and drainage ditches to maintain water levels on the subsided islands, a high water table persists in some areas.

At the landscape level, most seasonal wetlands are less than an acre (or even a half-acre) in size. Vegetation tends to be dominated by hydrophytic grasses, sedges (*Carex* spp.), or rushes (*Juncus* spp.). Seasonal wetlands provide an important food source for migratory birds, waterfowl, breeding and feeding areas for amphibians and reptiles, and critical winter food supplies for birds and mammals that may be present.

### Depression (Lake/Pond)

Depressions are nontidal open-water features that are permanently or seasonally inundated, with little to no rooted vegetation on an unconsolidated or mud bottom. At the mitigation sites, these features may be artificially created as a result of borrow material excavations, agricultural activities, or for stormwater detention, or may result from a high water table. Depressions are generally less than 20 acres in size and have a water depth of less than 6 feet. These waterbodies are often created by excavation and are diked or otherwise artificially impounded.

Depressions may be colonized by floating plant species such as common duckweed (*Lemna minor*), mosquito fern (*Azolla* spp.), or water hyacinth (*Eichhornia crassipes*), but generally lack rooted vegetation except on depression margins. Waterfowl in particular use this habitat type for foraging and rest.

## Upland Communities

### Grasslands

The grassland natural community is dominated by introduced or native annual and perennial grasses and herbaceous forbs. Native perennial grasses are generally found only in areas that have not been converted to agricultural uses. Native grasslands support over 300 species of native grasses and about 40% of California's total native plant species. Grasslands provide important breeding and foraging habitat for many species of wildlife, including covered wildlife species such as giant garter snake. Grasslands adjacent to suitable aquatic habitat can also support breeding and overwintering sites for northwestern pond turtle.

### 3B.4.1.3 Bouldin Island Mitigation Sites

#### Site Objectives

The proposed compensatory mitigation actions to be undertaken on Bouldin Island would create or enhance habitat in areas where it could be sustained with little maintenance. The Bouldin Island mitigation sites would support multiple habitat types, including freshwater marsh, seasonal wetland, riparian, ponds (depressions), and grasslands.

Three separate mitigation sites are proposed on Bouldin Island: B1, B2, and B3. Sites B1 and B2 would support the creation and enhancement of extensive wetland habitat and other aquatic resources and would provide compensatory mitigation for losses to waters of the U.S. and State. They would be designed and managed specifically to fulfill federal and state wetland mitigation requirements, while also providing suitable habitat for several special-status species. Mitigation Site B3 would support the creation of native perennial grassland habitat.

#### Site Selection Criteria and Baseline Conditions

##### Site Selection Criteria

Bouldin Island was selected because it is located within the same watersheds where impacts would occur and because existing soils and hydrology provide ideal conditions for the establishment of wetland habitats. Bouldin Island is owned by Metropolitan, who was coordinated with in selecting the sites and developing the habitat restoration concepts. Therefore, construction activities to enhance and create aquatic resources could begin shortly after project approval once an agreement between Metropolitan and DWR for the mitigation sites is finalized. The existing land cover, hydrology (high water table), and soils (hydric soils) would facilitate creation and enhancement of wetland habitats. Habitat creation and enhancement would result in the establishment of sustainable aquatic resources, while also benefitting species such as western yellow-billed cuckoo, least Bell's vireo, northwestern pond turtle, and valley elderberry longhorn beetle. It was also noted that areas that have become too wet to farm over the years have reverted in many cases to wetland habitat (primarily riparian and seasonal wetland), as observed in several areas within Mitigation Sites B1 and B2 (see Figure 3B-3 and Figure 3B-4).

##### Property Location and Description

Bouldin Island is an approximately 5,900-acre island that is bounded to the north by the South Mokelumne River, to the east by Little Potato Slough, to the south by Potato Slough, and to the west by the Mokelumne and San Joaquin Rivers (Figure 3B-5) (portions of APNs 069-030-360-000, 069-030-370-000, 069-030-390-000, 069-100-020-000). State Route (SR) 12 crosses the northern part of Bouldin Island. A swing bridge over the Mokelumne River on SR 12 connects the northwestern part of the island to Andrus Island. Near the northeastern tip of Bouldin Island, a high-level bridge on SR 12 spans Little Potato Slough, connecting the island to the small community of Terminous. Currently the island consists of roughly 98% farmland with the remaining 2% being wetlands, riparian, or open water habitat. Site elevations on Bouldin Island range from -24 feet North American Vertical Datum of 1988 (NAVD 88) to 19 feet NAVD 88, with an average elevation of -13 feet NAVD 88. Current land use is predominately agricultural, including corn, alfalfa, and row crops. The land is leased to farmers for this production, with primary farming activities taking place between March and November of each year. Fields are typically flooded in the winter months for soil management, weed control, stubble decomposition, and duck hunting.

**Figure 3B-3. Emergent and Forested Wetland Habitat on Bouldin Island**

**Figure 3B-4. Emergent, Scrub-Shrub, and Seasonal Wetland Habitat on Bouldin Island**

There are three mitigation sites being proposed for Bouldin Island: B1, B2, and B3 (Figure 3B-5). Mitigation Site B1 is located near the northwest corner of the island, just south of SR 12. The site is currently dominated by agricultural fields (primarily row crops) as well as seasonal wetlands within the farmed fields. Ditches and maintenance roads are also present. It is bounded by the perimeter levee to the west, SR 12 to the north, and irrigation ditches to the south and east. Mitigation Site B2 and Mitigation Site B3 are near the center of the island. Mitigation Site B2 contains a mixture of agricultural fields, patches of valley/foothill riparian habitat, and open water (remnants of a borrow pit). Mitigation Site B3 includes agricultural fields and roads.

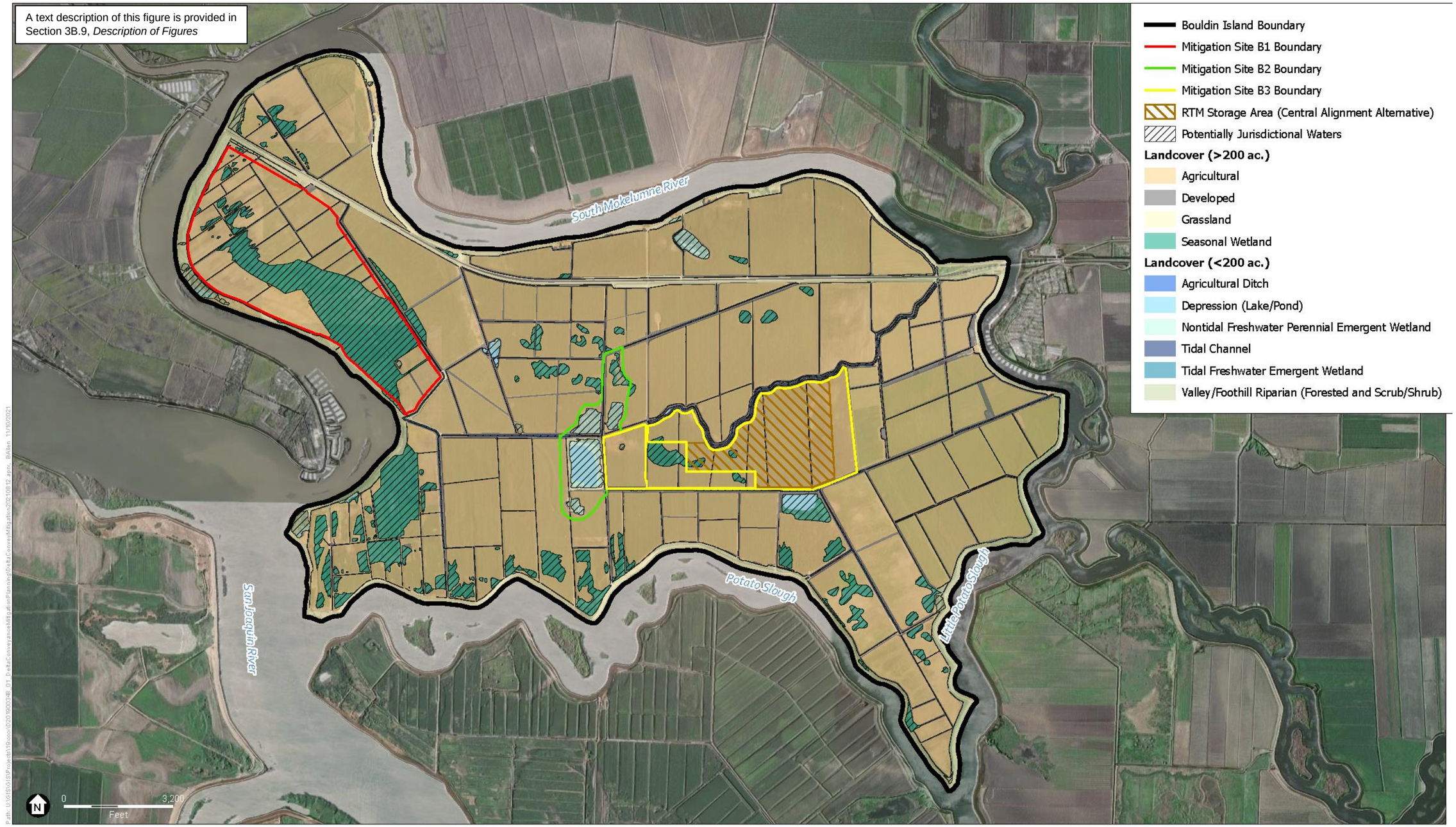


**Figure 3B-5. Bouldin Island Existing Conditions**

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### Soils

Soils on the sites primarily consist of muck, including Rindge muck, Valdez silt loam, Ryde clay loam, and Valdez silt loam (Natural Resources Conservation Service 2021:11). The soils on Bouldin Island consist of organic and highly organic mineral soils. All of the soils are hydric.

### Existing Land Cover

The proposed mitigation sites include agricultural fields, roads, irrigation ditches and canals, borrow pits, and several wetland features. Existing aquatic features mapped for the project consist of farmed seasonal wetlands, forested and scrub-shrub riparian, perennial depressions (ponds), and ditches. Table 3B-5 summarizes the approximate acreages of existing land cover types at Bouldin Island, which are also shown in Figure 3B-5.

**Table 3B-5. Bouldin Island Baseline Land Cover (acres)**

| Land Cover | Mitigation Site | | | Remainder on Bouldin | Total for Bouldin [a] |
|---|---|---|---|---|---|
| | B1 | B2 | B3 | | |
| Agricultural | 337.52 | 42.77 | 291.13 | 3,697.28 | 4,368.70 |
| Agricultural ditch | 8.60 | 3.51 | 1.93 | 95.03 | 109.06 |
| Developed [b] | 8.77 | 12.21 | 11.86 | 337.96 | 370.79 |
| Grassland | 0 | 7.13 | 0 | 446.45 | 453.58 |
| Nontidal freshwater emergent wetland | 0 | 22.49 | 0.03 | 25.85 | 48.37 |
| Seasonal wetland | 196.71 | 3.52 | 4.37 | 293.54 | 498.14 |
| Tidal channel | 0 | 0 | 0 | 18.89 | 18.89 |
| Tidal freshwater emergent wetland | 0 | 0 | 0 | 2.54 | 2.54 |
| Valley/foothill riparian [c] | 0.61 | 2.67 | 0.46 | 93.60 | 97.34 |
| Total | 552.21 | 94.30 | 309.78 | 5,043.69 | 5,999.97 |

[a] Acreages to the nearest 0.01, may be subject to rounding.
[b] Baseline developed land cover includes project infrastructure.
[c] Valley/foothill riparian vegetation community includes potentially jurisdictional wetlands (forested and scrub-shrub) and other riparian vegetation.

### Potential Waters of the United States and State

A delineation of potentially jurisdictional wetlands and other waters mapped from aerial imagery for Bouldin Island (California Department of Water Resources and GEI Consultants 2020; California Department of Water Resources 2020, 2021) is summarized in Table 3B-6. For additional information about the methods used to delineate aquatic resources, see the *Aquatic Resources Delineation Data* portion of Chapter 13, Section 13.1.2.1, *Land Cover Mapping Methods*, of the Final EIR.

**Table 3B-6. Bouldin Island Baseline Potentially Jurisdictional Wetlands and Other Waters (acres)**

| Aquatic Resource | Mitigation Site [a] | | | Remainder on Bouldin | Total for Bouldin |
|---|---|---|---|---|---|
| | B1 | B2 | B3 | | |
| **Wetlands** | | | | | |
| Nontidal freshwater emergent wetland | 0 | 22.49 | 0.03 | 25.85 | 48.37 |
| Forested and scrub/ shrub wetland | 0.61 | 2.48 | 0.42 | 24.34 | 27.85 |
| Seasonal wetland | 196.71 | 3.52 | 4.37 | 293.54 | 498.14 |
| Tidal freshwater emergent wetland | 0 | 0 | 0 | 2.54 | 2.54 |
| **Other Waters** | | | | | |
| Agricultural ditch | 8.60 | 3.51 | 1.93 | 95.02 | 109.06 |
| Depression (lake/pond) | 0 | <0.01 | 0 | 32.55 | 32.55 |
| Tidal channel | 0 | 0 | 0 | 18.52 | 18.52 |
| **Total** | 205.92 | 32.00 | 6.75 | 492.36 | 737.03 |

Sources: California Department of Water Resources and GEI Consultants 2020; California Department of Water Resources 2020, 2021.

[a] Acreages to the nearest 0.01, may be subject to rounding

## Site Design and Development

Conceptual plans for Mitigation Sites B1, B2, and B3 are shown in Figure 3B-6. Mitigation Site B1 would include a mosaic of open water, nontidal freshwater emergent wetland, scrub-shrub wetland, forested wetland, and seasonal wetland habitats. This habitat complex would be designed to provide habitat diversity and complexity to support multiple target species, including western yellow-billed cuckoo, least Bell's vireo, and northwestern pond turtle. Aquatic features would be designed to sustain wetland hydrology through considering existing elevations and drainage infrastructure.

In general, target habitats would be created through grading (at Mitigation Site B1), planting, adjusting water management and active maintenance in the establishment period. Habitat creation and enhancement at Mitigation Sites B2 and B3 would require minimal, if any, grading. Mitigation Site B1 would require more extensive earthwork to create the targeted habitats. The proposed land cover (created and enhanced) and the changes to existing conditions that would occur at all of the proposed mitigation sites are summarized in Table 3B-7.

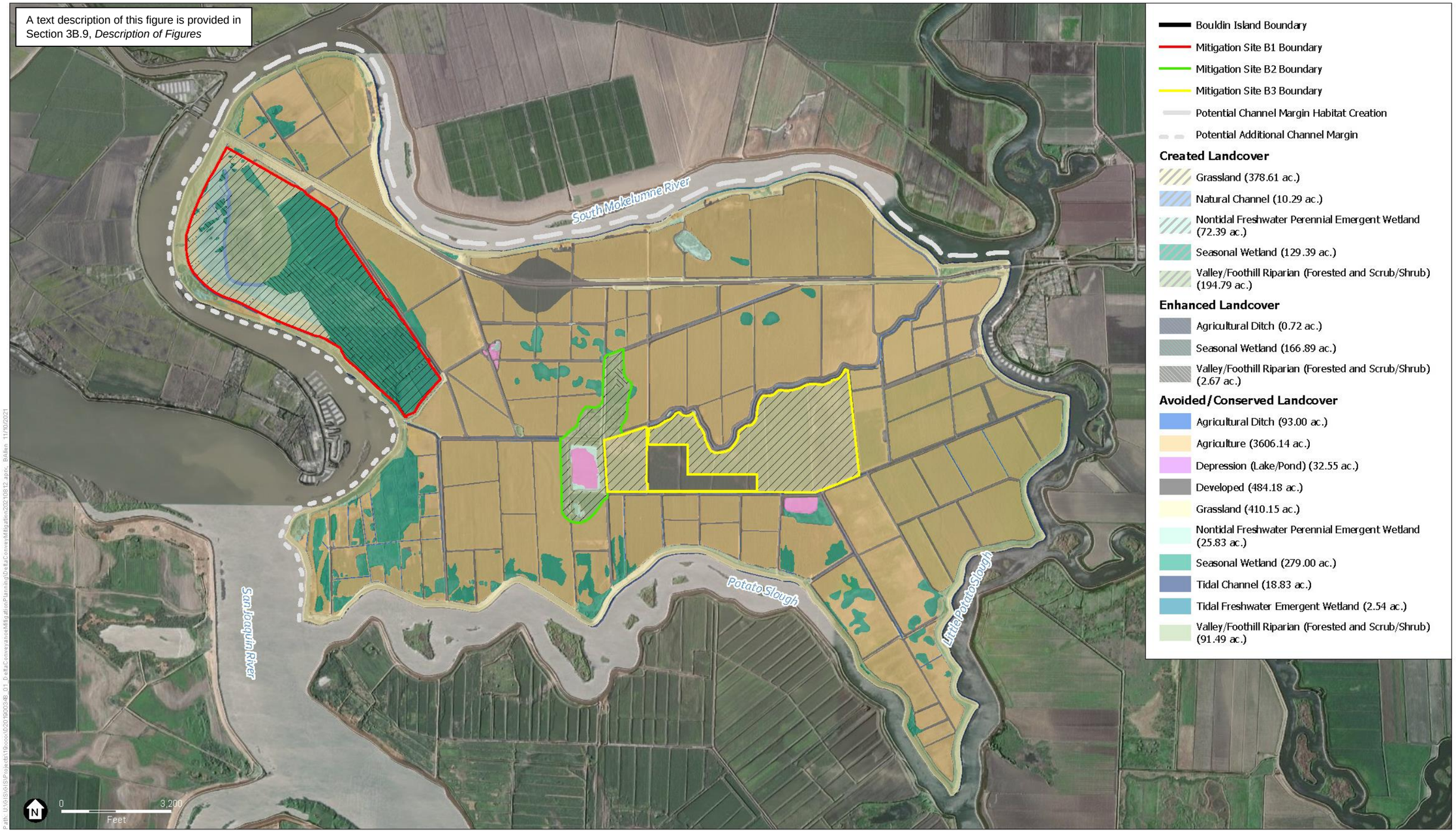


**Figure 3B-6. Bouldin Island Conceptual Design**

A text description of this figure is provided in Section 3B.9, *Description of Figures*

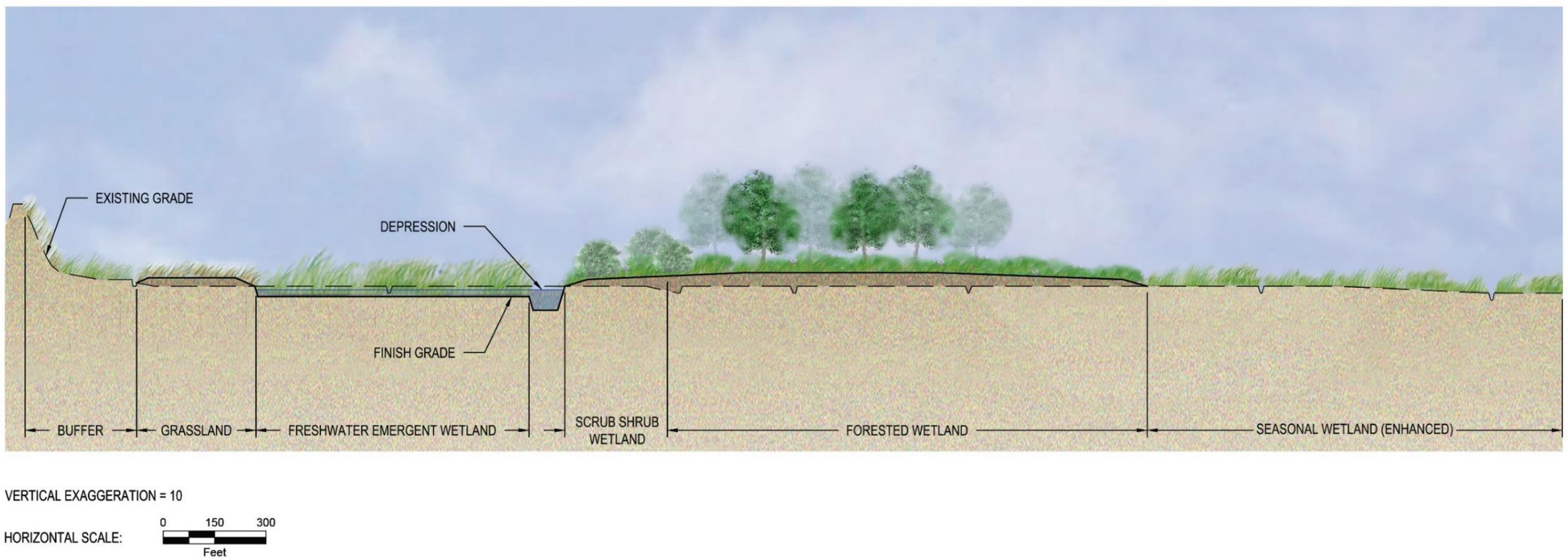


**Figure 3B-7. Bouldin Island Conceptual Section**

**Table 3B-7. Comparison of Bouldin Island Sites B1, B2 and B3 Existing with Total Created or Enhanced Habitat with Full Implementation (acres)**

| Existing Land Cover Class | Acres [a] | Habitat Created or Enhanced (acres) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | Agricultural Ditch | Deve loped | Grassland | Nontidal Freshwater Emergent Wetland | Nontidal Perennial Aquatic | Seasonal Wetland | Tidal Freshwater Emergent Wetland | Tidal Perennial Aquatic | Valley/ Foothill Riparian [b] | Subtotal Habitat Loss | Subtotal Habitat Gain | Total Post-Project Habitat |
| **SITE B1** | | | | | | | | | | | | | | |
| Agricultural | 337.52 | 0 | 0 | 0 | 68.53 | 70.20 | 7.78 | 119.82 | 0 | 0 | 71.19 | -337.52 | 0 | 0 |
| Agricultural Ditch | 8.60 | 0 | 0.72 | 0 | 0 | 1.15 | 0.5 | 4.25 | 0 | 0 | 1.98 | -7.88 | 0 | 0.72 |
| Developed | 8.77 | 0 | 0 | 0 | 0.29 | 0.59 | 0.06 | 5.25 | 0 | 0 | 2.58 | -8.77 | 0 | 0 |
| Grassland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 68.84 | 68.84 |
| Nontidal Freshwater Emergent Wetland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 72.39 | 72.39 |
| Nontidal Perennial Aquatic (depression, lake/pond, natural channel) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.29 | 10.29 |
| Other Seasonal Wetlands | 196.71 | 0 | 0 | 0 | 0.02 | 0.45 | 1.95 | 166.89 | 0 | 0 | 27.40 | -29.82 | 129.93 | 296.82 |
| Valley/ Foothill Riparian [b] | 0.61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.61 | 103.15 | 103.15 |
| Site B1 Total | 552.21 | 0 | 0.72 | 0 | 68.84 | 72.39 | 10.29 | | 0 | 0 | 103.15 | | | 552.21 |
| **SITE B2** | | | | | | | | | | | | | | |
| Agricultural | 42.77 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42.77 | -42.77 | 0 | 0 |
| Agricultural Ditch | 3.51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.51 | -3.51 | 0 | 0 |
| Developed | 12.21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.21 | -12.21 | 0 | 0 |
| Grassland | 7.13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.13 | -7.13 | 0 | 0 |
| Nontidal Freshwater Emergent Wetland | 22.49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22.49 | -22.49 | 0 | 0 |
| Nontidal Perennial Aquatic (depression, lake/pond, natural channel) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Seasonal Wetlands | 3.52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.52 | -3.52 | 0 | 0 |

| Existing Land Cover Class | Acres [a] | Habitat Created or Enhanced (acres) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | Agricultural Ditch | Deve loped | Grassland | Nontidal Freshwater Emergent Wetland | Nontidal Perennial Aquatic | Seasonal Wetland | Tidal Freshwater Emergent Wetland | Tidal Perennial Aquatic | Valley/ Foothill Riparian [b] | Subtotal Habitat Loss | Subtotal Habitat Gain | Total Post-Project Habitat |
| Valley/ Foothill Riparian | 2.67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.67 | 0 | 91.63 | 94.30 |
| Site B2 Total | 94.30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 94.30 | | | 94.30 |
| **SITE B3** | | | | | | | | | | | | | | |
| Agricultural | 291.13 | 0 | 0 | 0 | 291.13 | 0 | 0 | 0 | 0 | 0 | 0 | -291.13 | 0.00 | 0.00 |
| Agricultural Ditch | 1.93 | 0 | 0 | 0 | 1.93 | 0 | 0 | 0 | 0 | 0 | 0 | -1.93 | 0.00 | 0.00 |
| Developed | 11.86 | 0 | 0 | 0 | 11.86 | 0 | 0 | 0 | 0 | 0 | 0 | -11.86 | 0.00 | 0.00 |
| Grassland | 0.00 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 309.78 | 309.78 |
| Nontidal Freshwater Emergent Wetland | 0.03 | 0 | 0 | 0 | 0.03 | 0 | 0 | 0 | 0 | 0 | 0 | -0.03 | 0.00 | 0.00 |
| Nontidal Perennial Aquatic (depression, lake/pond, natural channel) | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Other Seasonal Wetlands | 4.37 | 0 | 0 | 0 | 4.37 | 0 | 0 | 0 | 0 | 0 | 0 | -4.37 | 0.00 | 0.00 |
| Valley/ Foothill Riparian | 0.46 | 0 | 0 | 0 | 0.46 | 0 | 0 | 0 | 0 | 0 | 0 | -0.46 | 0.00 | 0.00 |
| Site B3 Total | 309.78 | 0 | 0 | 0 | 309.78 | 0 | 0 | 0 | 0 | 0 | 0 | | | 309.78 |

[a] Acreages to the nearest 0.01, may be subject to rounding.

[b] Valley/foothill riparian vegetation community includes potentially jurisdictional wetlands (forested and scrub-shrub) and other riparian vegetation.

### Mitigation Site B1 Design and Development

The following outlines the general sequence of anticipated construction activities for Mitigation Site B1.

- **Weed Control:** Herbicide application and/or mowing would begin several seasons before site grading commences to remove several crops of nonnative annual grass weed seed from the soil's seed bank.
- **Wildlife Protection:** Before commencement of ground-disturbing activities, suitable wildlife avoidance and minimization measures (e.g., pond dewatering, exclusion fencing) would be implemented to protect wildlife. See Attachment 3B.1 for additional measures to protect wildlife during construction.
- **Site Preparation:** An on-site staging area would be established that would include construction trailer, staging of any delivered materials and equipment refueling area. On-site utilities would be protected and/or relocated as needed.
- **Earthmoving:** Existing vegetation would be removed (grubbed) prior to grading. Large equipment would excavate material and move material to create desired elevations. Soils may be temporarily stored on-site in stockpiles. Ditches will be rerouted where necessary to protect adjacent farming operations.
- **Planting and Seeding:** All disturbed areas would be revegetated with native plants. Plants and seeds would be sourced locally to the greatest extent possible. Temporary irrigation equipment would be installed for select plantings for the first 3 to 5 years of plant establishment.
- **Access Improvements:** Improvements would be needed for access during construction, as well as for future site access.
- **Optional Water Control Structures:** Improvements such as temporary pumps and piping may be installed to connect the habitat creation areas with existing drainage ditches or siphons to support target habitats and provide flexibility in future water management.

Portions of this site would be graded to support target habitats. The natural variability in the land surface, existing hydrology, and existing habitat features would be considered in the design to limit the amount of earthwork needed. The most significant earthmoving would be associated with excavations to create freshwater emergent wetland and depressions (lake/pond). Excess fill material would be placed on-site to create suitable elevations to support forested wetland and grassland habitat, resulting in a balanced earthwork site. Existing drainages and canals would be incorporated into the design to support wetland hydrology and site drainage. A large area of the existing farmed seasonal wetlands would not be graded, but rather would be enhanced via plantings and long-term management such as weed control.

Planting palettes would be developed based upon the habitat goals, localized topography, and hydrology. Freshwater wetlands would be planted with native sedges, grasses, and emergent plants, with the most hydrophytic species placed in the most frequently inundated locations. Forested wetland areas would include a mix of overstory and understory species, dominated by Fremont cottonwood and willow, to create structural diversity to support yellow-billed cuckoo and least Bell's vireo. Seasonal wetlands (newly created and/or enhanced existing) would be planted with grasses, sedges, or rushes.

Vegetation, soil and hydrologic components of created aquatic resources would be supported by existing soil and groundwater conditions (i.e., peat soils with a high-water table). During the interim establishment period, the site may experience additional irrigation in the summer months using existing siphons and pumps to pull water from adjacent waterways under existing water rights. This water would be provided by Metropolitan through an agreement with DWR. It is anticipated that the volume of water needed for the establishment period would not exceed that used for existing agricultural practices. Existing intakes would be screened where needed to prevent entrainment of protected fish species from Delta waterways. Additional modifications may be made to the drainage system adjacent to the site to further support habitat creation goals during the establishment period. It is anticipated that agricultural land uses would continue surrounding the site, and that the pumping of water on and off the island at large would continue as it has for decades, including pumping water onto the island in fall for weed control and off in late winter for planting.

Based on the existing on-site conditions and site hydrology, including existing elevations, drainage patterns, and groundwater conditions, it is anticipated that Mitigation Site B1 will be self-sustaining after the establishment period and not reliant on the adjacent irrigation system or other artificial hydrology outside of the existing pumping system used for the entire island. As noted in both federal and state wetland regulations for creating compensatory mitigation sites, long-term sustainability is critical for mitigation site success. In particular, assurances are needed to demonstrate that wetland hydrology will be achieved in the long term, especially when that hydrology is supported by pumping actions. In this case, Mitigation Site B1 would be constructed in a location that would largely revert to wetland habitats absent farming practices based on existing soils, elevation, and hydrology. Nevertheless, when considering long-term sustainability for Mitigation Site B1, site maintenance needs for the existing drainage systems and siphons will be considered as needed to ensure habitats are maintained in perpetuity.

Once constructed, the mitigation site will be monitored on an annual basis during the establishment period (generally 3–5 years) to ensure performance criteria, including wetland hydrology and water quality, are being met. Water supply and drainage management practices may be altered at this time if monitoring indicates improvements are needed. Most of the water would be retained on-site, although during high-flood conditions in winter, some water may be discharged from the wetlands to adjacent Delta waterways through existing drains or outfalls. Based on existing groundwater conditions, water management is not anticipated. Following the establishment period, long-term monitoring would continue to occur on a more infrequent basis (typically once every 5 years).

Creation of freshwater emergent perennial wetlands, seasonal wetlands, and tidal habitats has the potential to impact water quality within the Delta relative to existing conditions (Appendix 6B, *Water Quality*). Mercury methylation occurs under anoxic conditions in sediments, flooded shoreline soils, and, to a lesser degree, in the water column. Increased methylmercury is also associated with wetting and drying cycles. These new sources of methylmercury could result in higher methylmercury concentrations in adjacent Delta waters and uptake into the tissues of fish residing within and immediately adjacent to these wetland habitats where elevated levels of methylmercury could be created.

Several factors would minimize the potential impact of the initial Bouldin Island compensatory mitigation sites on methylmercury within the Delta. First, the freshwater emergent perennial wetlands and seasonal wetlands located on Bouldin Island would not be directly connected hydrodynamically with adjacent Delta waters; instead, discharge from the site would be circulated through the island's large ditch drainage system. Second, the source water for these wetlands would

be predominantly groundwater, which is expected to have a lower mercury concentration than Delta surface water. Third, as part of adaptive management, monitoring of the discharge from the wetlands to the existing island drainage system would be conducted and the discharges modified if necessary (e.g., to a detention basin), should monitoring results show the wetland discharges to be a net exporter of methylmercury to Delta waters. Implementation of AMM-23: *Develop and Implement a Mercury Management and Monitoring Plan* (Appendix 3A, *General Avoidance and Minimization Measures*) would minimize generation of methylmercury in new habitats. Thus, the wetlands to be created on Bouldin Island would not contribute to measurable increases in methylmercury concentrations in waters and biota of the Delta or make the existing mercury-related CWA Section 303(d) impairment within the Delta measurably worse.

#### Mitigation Sites B2 and B3 Design and Development

Two additional mitigation sites near the center of Bouldin Island would be restored without excavation or grading (Figure 3B-6). Mitigation Site B2 would expand and enhance existing riparian vegetation around an existing depression to create a larger patch of forested wetland through plantings. Mitigation Site B3 near the center of Bouldin Island would create grasslands through vegetation clearing and grubbing, soil preparation/disking, and planting with native grasses (Figure 3B-8).

### Construction Methods and Equipment

Wetland grading at Mitigation Site B1 would entail up to approximately 500,000 cubic yards of excavation and fill, assuming 10% losses between cut and fill. The material would be placed to construct a riparian planting island, seasonal wetlands, and grasslands. Large land-based earthmoving equipment like bulldozers, excavators, loaders, dump trucks, water trucks, scrapers and compactors would move earth around the sites to meet finish grades. Earthwork volumes are approximate and may change as necessary to meet site design requirements in later design phases.

#### Nontidal Freshwater Emergent and Seasonal Wetlands

Earthmoving and targeted active revegetation are the primary activities needed for habitat creation. The most significant construction activity would be earthmoving, including excavating existing ground to create open water channels and freshwater emergent wetland. Open water channels would be excavated to an average depth of 6 feet and freshwater marsh would be excavated to an average depth of approximately 3 feet. It is anticipated approximately 400,000 cubic yards of excavation will be required for freshwater emergent wetland while no excavation or fill will be required for seasonal wetland.

#### Valley/Foothill Riparian (Forested and Scrub-Shrub)

At Mitigation Site B1, forested and scrub shrub wetlands would be created adjacent to newly created open water and freshwater emergent wetland habitat. These riparian areas would be raised an average of 1 to 2 feet to create suitable elevations to support plantings. Grading would be achieved by placing approximately 240,000 cubic yards of fill generated from excavating open water and emergent wetlands. At Mitigation Site B2, no excavation or fill would be required for riparian wetland enhancements and creation.

Riparian planting areas at Mitigation Sites B1 and B2 would be disked and planted with native materials. Vegetative materials (e.g., cuttings, seed, plugs, container plants) would be transported on

the site using trailers pulled by pickup trucks and all-terrain vehicles. A temporary irrigation system would be installed to support plant establishment. The riparian areas would be managed during a 3- to 5-year establishment period, during which small farm tractors and all-terrain vehicles would be used to mow and apply herbicides.

#### Depression (Lake/Pond)

An open water feature (depression) would be created in the southwest portion of Mitigation Site B1 to provide aquatic habitat and support wetland and riparian habitats. This open water feature would be excavated to an average of 6 feet below grade, requiring approximately 100,000 cubic yards of excavation. It is assumed that excavated material would be used to support adjacent riparian and grassland habitats. Large land-based earthmoving equipment like bulldozers, excavators, loaders, dump trucks, water trucks, scrapers and compactors would move earth around the sites to meet finish grades. Trucks and other vehicles would transport construction workers and equipment to the site. Other lakes and ponds that currently exist on the island and the mature riparian habitats surrounding them would be avoided.

#### Native Grasslands

Native grassland habitats would be created along the western and northern edge of the site grading limits at Mitigation Site B1. It is assumed that approximately 260,000 cubic yards of material generated from on-site excavation will be placed to raise native grassland areas 1 to 3 feet to suitable elevations. Native grasslands could also be restored at Mitigation Site B3 existing ground and/or spoil from excavation of wetlands and open water features at Site B1. Native grassland areas would be disked using a large farm tractor to prepare the soil for seeding. Native grassland habitats would be drill seeded with a blend of native grasses and forbs that mimic interior and or coastal grasslands. The seed drill would be pulled using a medium-sized farm tractor.

### Construction Equipment

Table 3B-8 provides the estimated total days that various construction equipment would be operated to complete the work. The estimated number of “equipment days” assumes that excavation of open water and freshwater wetlands and fill placement for riparian and grassland habitats is performed as one coordinated operation. It is anticipated that most construction, including excavation and grading, would occur during the summer months (May–September). Construction activities would be coordinated with ongoing agricultural activities.

**Table 3B-8. Estimated Construction Equipment Use—Bouldin Island**

| Equipment | Total Working Days [a] | Average Days/Year (over 2 years) |
|---|---|---|
| Excavators | 98 | 49 |
| Off-road trucks | 98 | 49 |
| Scrapers large | 287 | 144 |
| Rubber tired loaders | 98 | 49 |
| Track-mounted bulldozer | 483 | 242 |
| Tractors/backhoes | 37 | 19 |

| Equipment | Total Working Days [a] | Average Days/Year (over 2 years) |
|---|---|---|
| Sheepsfoot compactor | 287 | 144 |
| Water truck | 770 | 385 |

[a] Total working days is independent of the number of equipment in each category. To calculate the number of working days for a single equipment unit, divide the total working days by the number of equipment units (i.e., 10 excavator working days can represent 10 excavators working 1 day each or 1 excavator working 10 days). Construction equipment quantities shall be determined by the construction contractor.

### Construction Schedule

The mitigation sites would be built over a period of several years, with construction beginning once relevant permits and approvals have been acquired for the project. Construction would likely occur over a period of 2 to 4 years given the scale of the three mitigation sites on Bouldin Island. Each site would be protected in perpetuity under a conservation easement.

### Water Quality

Freshwater emergent wetland and depressions on Bouldin Island (Mitigation Site B1) have potential to create conditions favorable for methylmercury formation. However, these emergent wetlands would not be hydrodynamically connected to Delta channels except during winter when high flood conditions could result in discharge, which would be monitored for mercury and discharged to a detention basin, if necessary. CHABs form in the summer months and thus do not have potential to be discharged into Delta waters. However, there is potential for CHABs to form within the newly created emergent wetlands where terrestrial species such as giant garter snake, least Bell's vireo, and yellow-billed cuckoo occur. While CHAB formation is not expected, monitoring would be performed, and any identified concerns would be adaptively managed. Valley/foothill riparian habitats are not associated with these water quality stressors. As such, these other types of new habitats would not affect methylmercury, selenium, or CHAB formation within Delta waterways, relative to existing conditions. For nontidal sites, methylmercury and CHABs would be monitored and adaptively managed to meet specific performance criteria as part of the site-specific maintenance and management plans described in Section 3B.6, *Maintenance and Management*, and Section 3B.7, *Performance Standards and Monitoring*.

## 3B.4.1.4 DWR I-5 Ponds

### Site Objectives

DWR owns three rectangular former borrow pits near West Woodbridge Road and SR 12, known as I-5 Ponds 6, 7, and 8 (Figure 3B-1). They are located within the White Slough Wildlife Area and within 2 miles of Woodbridge Ecological Reserve. The three ponds, totaling approximately 345 acres, were excavated between 1974 and 1978 to provide fill for freeway construction. Currently, all three ponds are managed under an interagency agreement with CDFW as Class C wildlife areas that are open to the public for hunting and fishing. The borrow pits are fed by groundwater and via periodic overland flow from precipitation, irrigation runoff, and high canal flows, creating three perennial ponds characterized by deep open water, steep vegetated banks, and relatively flat adjacent uplands.

The proposed design at these sites would reconfigure the three ponds to develop compensatory habitat to mitigate project impacts on giant garter snake and other species. The creation of

additional perennial wetland habitat in this area is consistent with the recovery goals identified in the *Revised Draft Recovery Plan for the Giant Garter Snake* (U.S. Fish and Wildlife Service 2017a:I-2–I-4). The proposed mitigation design would incorporate all habitat requirements for giant garter snake, including:

- Adequate water during the giant garter snake active season (approximately May 1 to October 1) to provide habitat for prey.
- Emergent, herbaceous wetland vegetation for escape, cover, and foraging habitat during the active season.
- Sloped grassy banks, habitat rock and openings in waterside vegetation for basking sites and hibernation burrows.
- Higher-elevation uplands for cover and refuge from flood waters during the giant garter snake dormant season (winter).
- Critical north-south habitat linkages for known giant garter snake populations in San Joaquin County.

## Site Selection Criteria and Baseline Conditions

### Site Selection Criteria

Site selection is consistent with siting and design criteria from the Final EIR (Attachment 3B.1). The creation of additional perennial wetland habitat in this area is consistent with recovery goals (U.S. Fish and Wildlife Service 2017a:II-1). The I-5 Ponds are well suited for providing giant garter snake habitat, due to their location within the White Slough Management Unit of the Delta Basin Recovery Unit (U.S. Fish and Wildlife Service 2017a:II-10–II-11), which is known to support the Caldoni Marsh/White Slough giant garter snake population. Between the mid-1970s and mid-1990s, giant garter snakes were observed in the White Slough region with observations near Pond 7 and between Ponds 6 and 7. In 2009 and 2010, the area was surveyed again and giant garter snake were found to be isolated to an area west of Pond 9, also known as Caldoni Marsh (Hansen 2011). In 2019, two female giant garter snakes were captured in the Shin Kee wetland adjacent to Pond 9 (Fouts et al. 2020). The presence of known populations just south of the sites and its proximity to Woodbridge Ecological Reserve less than 2 miles to the north, as well as the direct hydrologic connection each site has to these areas through White Slough and Hog Slough, respectively, suggests that recolonization of the ponds could occur without intervention. Creating and enhancing wetland habitat in this area would promote population viability and genetic connectivity between populations associated with Hog Slough and White Slough in the Delta (Wood et al. 2015), which is consistent with USFWS recovery strategy goals (U.S. Fish and Wildlife Service 2017a:III-1).

### Property Location and Description

#### *Pond 6*

Pond 6 lies north of West Woodbridge Road, approximately 1.65 miles west of I-5 (APN 011-070-070-000). The north edge of the site includes Hog Slough and its earthen levee, with an on-site water delivery ditch extending from a tide gate in the slough around the north and eastern edges of the property. To the east is the CDFW Woodbridge Ecological Reserve. To the west are agricultural fields in grape vines and row crops. Pond 6's current site uses are as a Class C wildlife area open to the public for hunting and fishing, managed by CDFW. The main access point is from the southeastern corner off of West Woodbridge Road.

Pond 6 is long and relatively narrow, approximately 5,000 feet long, 50 feet wide, and 20 feet deep. It is located along the western edge of the site. The site generally slopes from the perimeter toward the pond. Past soil excavation activities have created many depressions, artificial drains, grade breaks and impediments to overland flow. Perimeter ditches and existing water conveyance systems surround the site on all sides, leaving the site isolated from surface flows except during exceptionally high-water events. The site has a relatively high groundwater table depth.

#### *Ponds 7 and 8*

Ponds 7 and 8 lie directly south of West Cotta Road approximately 1 mile west of I-5, bounded by a high-line irrigation delivery canal on the west and row crops to the east (APN 025-100-140-000; eastern portion not assigned an APN). The access point for both ponds is off West Cotta Road in the north via a gravel parking area. Pond 7 sits in the northern half of the site, while Pond 8 occupies the narrow southern portion of the site. Pond 7 is approximately 3,000 feet long by 300 feet wide and roughly 20 feet deep. Pond 8 is approximately 3,500 feet long, 400 feet wide, and 18 feet deep. Currently, the site is maintained by CDFW as a Class C wildlife area open to the public for hunting and fishing.

Pond 7 runs from northwest to south with a bend of approximately 30 degrees in the middle of the pond along the old canal alignment. Slopes on the site generally fall away from a perimeter berm around the edge of the pond. This berm is relatively steeply sloped on the water side, with a level or gently sloping grade away from the top of the berm on the west side of the pond. Site topography is relatively flat east of the pond's perimeter berm. Perimeter ditches, levees, and existing water conveyance systems surround the site on all sides, leaving the site isolated from surface flows except during exceptionally high-water events. Depressions along the toe of the levee on the western side of the site indicate possible borrow areas that may be up to 2 feet lower than surrounding grade. Several old water delivery and drainage structures also exist on the site. One feature contains parts of an old concrete-lined highline, while another deep drainage ditch bisects the parcel north to south and divides Pond 7 in the north from Pond 8 in the south. This ditch drains irrigation water from adjacent agricultural fields.

Pond 8 has a rim of high ground around the pond that generally slopes away from the pond toward the edge of the site on the west. Unlike Pond 7, Pond 8 has a gentle slope from the top of the berm to the water's edge. There are depressional areas adjacent to the levee on the west side, and a high, flat bench on the east side near the neighboring agricultural fields.

### Soils

#### *Pond 6*

Pond 6 soils are dominated by Guard clay loam and Dello soil series (Natural Resources Conservation Service 2018). Guard clay loam is an alluvial soil with some clay content characteristic to basin rims and floors. The series may exhibit inclusions of coarser soil series or textures like sands and silts but usually has slow permeability and is poorly drained (Natural Resources Conservation Service 2018). Dello soils typically consist of sands or sandy loams sometimes overlaying clay lenses. Upper horizons tend toward high permeability and would not support wetland hydrology unless underlying clay lenses were present and intact. Soils on-site would have historically supported seasonal and semi-permanent marsh.

#### *Ponds 7 and 8*

Ponds 7 and 8 soils are dominated by Guard clay loam soil series, which is described for Pond 6. Soils on the site would have historically supported seasonal and semi-permanent marsh. Ponds 7 and 8 have a relatively high groundwater table depth.

### Existing Land Cover

#### *Pond 6*

The Pond 6 site includes a historic irrigated pasture, an intermediate bench around the pond that contains riparian vegetation and depressional wetlands, and a long and narrow pond surrounded by a high berm with nearly vertical banks. In some places, the high berm has "blown out" and seasonal high groundwater from the pond inundates shallow depressions fringing the pond. Existing land cover at Pond 6 is displayed in Figure 3B-8, and approximate acreages of existing land cover are summarized in Table 3B-9.

Vegetation at the Pond 6 site includes common nonnative annual grasses and forbs in uplands to hydrophytes in marsh areas. Mature willows and Fremont cottonwood have established naturally in low-elevation depressions near the pond. Tule patches occur in some lower areas around the pond. Higher terrace vegetation includes upland herbaceous plants (e.g., filaree [*Erodium* spp.], hemlock [*Conium maculatum*], and thistle [*Cirsium* spp.]), as well as some species that are more indicative of wetland soil conditions (e.g., salt grass [*Distichlis* spp.] and rushes). Woody plants in the higher terrace include Himalayan blackberry and quail bush (*Atriplex lentiformis*).

**Table 3B-9. Pond 6 Baseline Land Cover**

| Land Cover | Acres |
|---|---|
| Agricultural | 0.55 |
| Agricultural ditch | 3.41 |
| Developed | 2.47 |
| Grassland | 130.73 |
| Nontidal freshwater emergent wetland | 3.11 |
| Nontidal freshwater aquatic (depression, lake/pond, natural channel) | 4.02 |
| Tidal freshwater emergent wetland | 0.02 |
| Tidal perennial aquatic (tidal channel) | 0.80 |
| Valley/foothill riparian (forested and scrub-shrub) [a] | 36.36 |
| Total | 181.47 |

[a] Valley/foothill riparian vegetation community includes potentially jurisdictional wetlands (forested and scrub-shrub) and other riparian vegetation

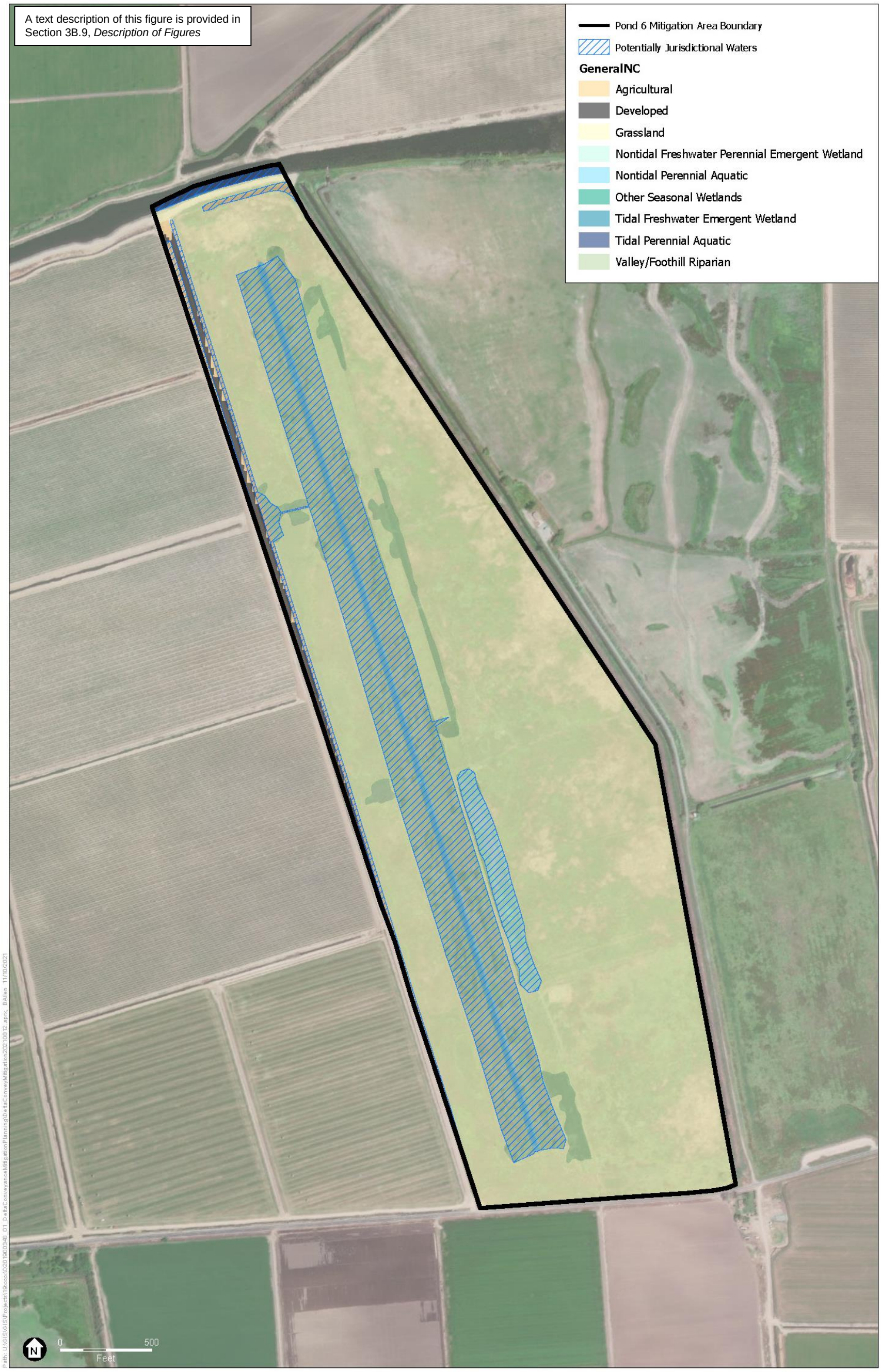


**Figure 3B-8. DWR I-5 Ponds, Pond 6 Existing Land Cover**

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***Ponds 7 and 8***

Ponds 7 and 8 are both rimmed with tules. The Pond 7 area includes an existing wetland/riparian marsh complex in the northeast along West Cotta Road. An upland area spans the west side of both ponds. Additional upland is located immediately north and south of Pond 7. Existing land cover at Ponds 7 and 8 is displayed in Figure 3B-9, and approximate acreages of habitat types are summarized in Table 3B-10.

**Table 3B-10. Ponds 7 and 8 Baseline Land Cover**

| Land Cover | Acres |
|---|---|
| Agricultural ditch | 2.25 |
| Grassland | 90.00 |
| Nontidal freshwater emergent wetland | 0.41 |
| Nontidal perennial aquatic (depression, lake/pond, natural channel) | 60.57 |
| Seasonal wetland | 0.24 |
| Valley/foothill riparian (forested and scrub-shrub) [a] | 7.78 |
| Total | 161.25 |

[a] Valley/foothill riparian vegetation community includes potentially jurisdictional wetlands (forested and scrub-shrub) and other riparian vegetation

Vegetation at the Pond 7 site ranges from annual grasses and forbs in the uplands to hydrophytes in marsh areas. Mature valley oaks, willows, and cottonwoods have naturally recruited along relict agricultural features in the uplands, in the riparian forest at the northwest corner of the site area, and along the toe of the levee on the west side of the pond. A narrow thicket of tule circles the entire perimeter of the pond with only small breaks in cover where fishermen have trampled vegetation to access the water. Higher terrace vegetation includes upland herbaceous plants like filaree, hemlock, and thistle, as well as salt grass and rushes. Woody plants in the higher terrace generally consist of coyote brush (*Baccharis* spp.), sandbar willow, and quail bush.

Vegetation at the Pond 8 site ranges from annual grasses and forbs in the uplands to hydrophytes in wetland areas. A narrow band of tule circles the perimeter of the pond with occasional small breaks in cover along the pond's edge. Mature oaks, willows, and cottonwoods have naturally recruited in low-elevation depressions along the toe of the levee to the west of the pond. Higher terrace vegetation includes upland herbaceous plants like filaree, hemlock, and thistle, as well as salt grass and rushes. Woody plants in the higher terrace consist of coyote brush, sandbar willow, and quail bush.

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**Figure 3B-9. DWR I-5 Ponds, Ponds 7 and 8 Existing Land Cover**

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***Potential Waters of the United States and State***

Aquatic resources delineation was conducted via aerial imagery interpretation for the study area, which encompassed the I-5 ponds (Final EIR Chapter 13, Section 13.1.4). Potentially jurisdictional wetlands and other waters are summarized in Table 3B-11 for Pond 6 and in Table 3B-12 for Ponds 7 and 8.

**Table 3B-11. Pond 6, Baseline Potentially Jurisdictional Wetlands and Other Waters**

| Aquatic Resource | Acres |
|---|---|
| **Wetlands** | |
| Nontidal freshwater emergent wetland | 3.10 |
| Forested and scrub/ shrub wetland | 31.49 |
| **Other Waters** | |
| Agricultural ditch | 3.41 |
| Depression (lake/pond) | 4.00 |
| Tidal channel | 0.80 |
| Total | 42.80 |

Sources: California Department of Water Resources and GEI Consultants 2020; California Department of Water Resources 2020, 2021.

**Table 3B-12. Ponds 7 and 8, Baseline Potentially Jurisdictional Wetlands and Other Waters**

| Land Cover Type | Acres |
|---|---|
| **Wetlands** | |
| Nontidal freshwater emergent wetland | 0.41 |
| Forested and scrub-shrub wetland | 0.40 |
| Seasonal wetland | 0.24 |
| **Other Waters** | |
| Agricultural ditch | 2.25 |
| Depression (lake/pond) | 59.83 |
| Total | 63.13 |

Sources: California Department of Water Resources and GEI Consultants 2020; California Department of Water Resources 2020, 2021.

## Site Design and Development

The sites would be graded to create a gradient of complex freshwater marsh habitats at varying elevations across the site, including:

- Maximizing “hemi-marsh,” consisting of a mix of open water/submerged vegetation and emergent vegetation.
- Creating basking shelves that are near open water, and preferably south and east facing.
- Creating a mix of open water (6–8 feet maximum depth) interspersed with emergent vegetation benches (approximately 3-foot depth), of varying width (average of 60–80 feet wide).

Conceptual restoration plans for Pond 6 and Ponds 7 and 8 are shown on Figure 3B-10 and Figure 3B-11, respectively. A schematic cross-section of the Pond 7 conceptual plan is shown in Figure 3B-12. Site-specific grading by pond is described further below.

The goal is to create a mosaic of high-quality, low-maintenance freshwater emergent wetland, open water, and associated natural habitats for giant garter snake. In addition, existing riparian habitat would be preserved to the extent feasible. If any existing riparian habitat is affected by construction, it would be replaced with newly created riparian habitat.

**Pond 6 Design**

Select upland areas would be excavated at Pond 6 to lower elevations to access the groundwater table and be recolonized by native wetland vegetation (e.g., tule and rushes) similar to that which currently exists near the pond's edge. Existing wetlands and riparian vegetation along the existing pond edge would be preserved to the extent possible.

Large open water areas would also be excavated (to approximately 6.0 feet elevation below existing grade or lower) to provide aquatic habitat for giant garter snake prey. Hemi-marsh and smaller open water channels would be excavated to create foraging and refugia habitat for giant garter snake. In addition, the remnant pasture on the west of the pond would be lowered to match the elevation of existing wetlands around the pond. Some excavated material would be placed on-site to grade uplands in a manner that improves habitat conditions for giant garter snake. Excess excavated material would be transported and placed on Ponds 7 and 8, as described in the next section.

Pond 6 proposed land cover (created and enhanced) and the change from existing conditions are summarized in Table 3B-13. Restoration would result in a net gain of freshwater marsh and open water (pond or depression), and a loss of riparian and grassland. Habitat loss would be mitigated by restoration at Bouldin Island of riparian wetland (Mitigation Sites B1 and B2) and grassland (Mitigation Site B3) (Table 3B-7).

**Table 3B-13. Comparison of I-5 Pond 6 Existing Land Cover with Total Habitat Created and Enhanced with Full Implementation (acres)**

| Existing Land Cover Class | Acres | Habitat Created or Enhanced (acres) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | Agricultural Ditch | Developed | Grassland | Nontidal Freshwater Emergent Wetland | Nontidal Perennial Aquatic | Seasonal Wetland | Tidal Freshwater Emergent Wetland | Tidal Perennial Aquatic | Valley/ Foothill Riparian | Subtotal Habitat Loss | Subtotal Habitat Gain | Total Post-Project Habitat |
| Agricultural | 0.55 | 0.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.55 |
| Agricultural Ditch | 3.42 | 0 | 3.32 | 0 | 0.08 | 0.02 | 0 | 0 | 0 | 0 | 0 | -0.10 | 0 | 3.32 |
| Developed | 2.48 | 0 | 0 | 2.39 | 0.09 | 0 | 0 | 0 | 0 | 0 | 0 | -0.09 | 0 | 2.39 |
| Grassland | 130.75 | 0 | 0 | 0 | 107.46 | 14.76 | 8.34 | 0 | 0 | 0 | 0.19 | -23.29 | 6.68 | 114.14 |
| Nontidal Freshwater Emergent Wetland | 3.11 | 0 | 0 | 0 | 2.73 | 0.19 | 0.19 | 0 | 0 | 0 | 0 | -2.92 | 40.49 | 40.68 |
| Nontidal Perennial Aquatic (depression, lake/pond, natural channel) | 4.02 | 0 | 0 | 0 | 0 | 0.01 | 4.01 | 0 | 0 | 0 | 0 | -0.01 | 10.22 | 14.23 |
| Other Seasonal Wetlands | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tidal Freshwater Emergent Wetland | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tidal Perennial Aquatic (tidal channel) | 0.80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.80 | 0 | 0 | 0 | 0.80 |
| Valley/ Foothill Riparian | 36.36 | 0 | 0 | 0 | 3.78 | 25.70 | 1.69 | 0 | 0 | 0 | 5.19 | -31.17 | 0.19 | 5.38 |
| Total | 181.49 | 0.55 | 3.32 | 2.39 | 114.14 | 40.68 | 14.23 | 0.00 | 0.00 | 0.80 | 5.38 | | | 181.49 |

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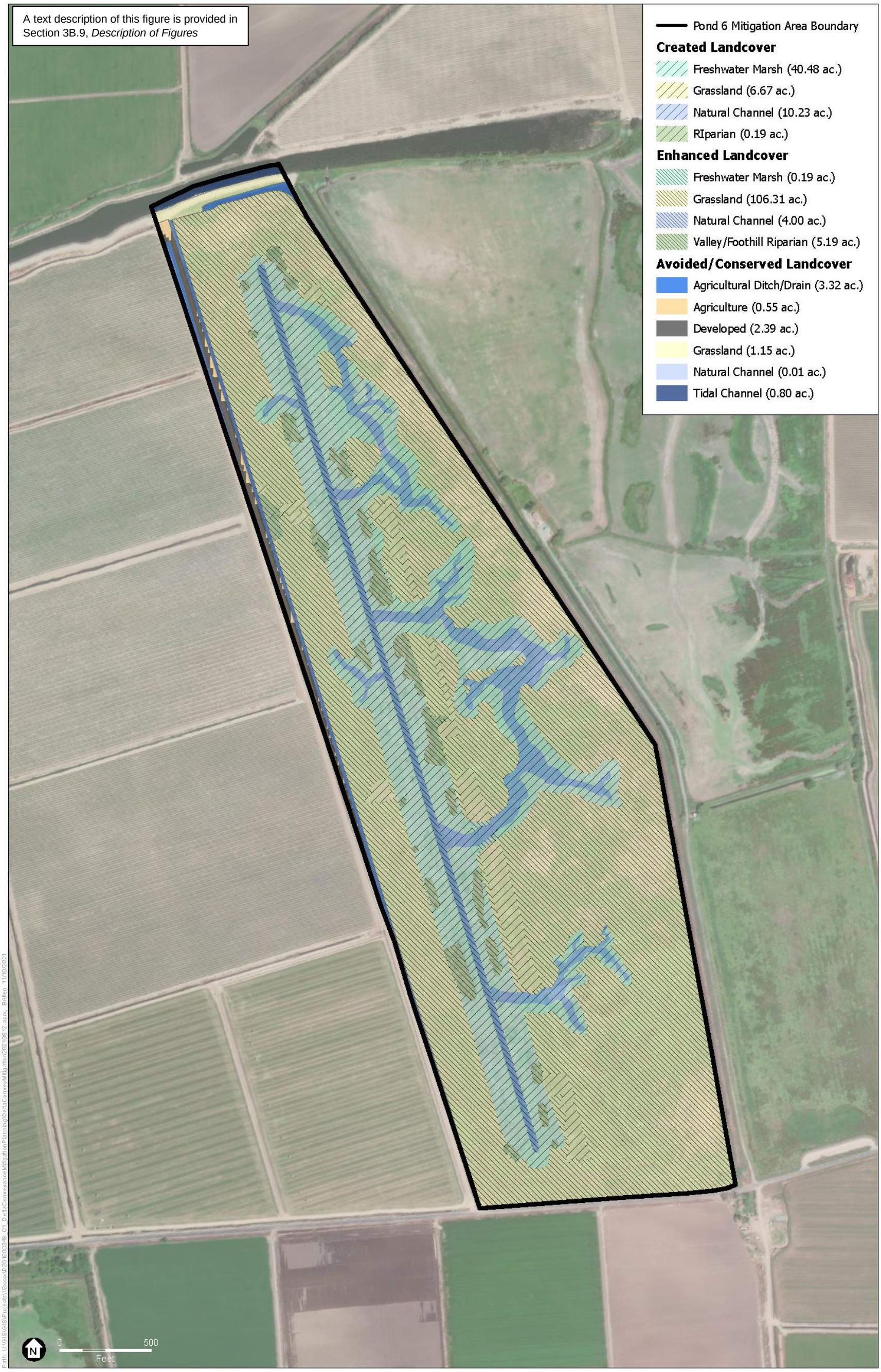
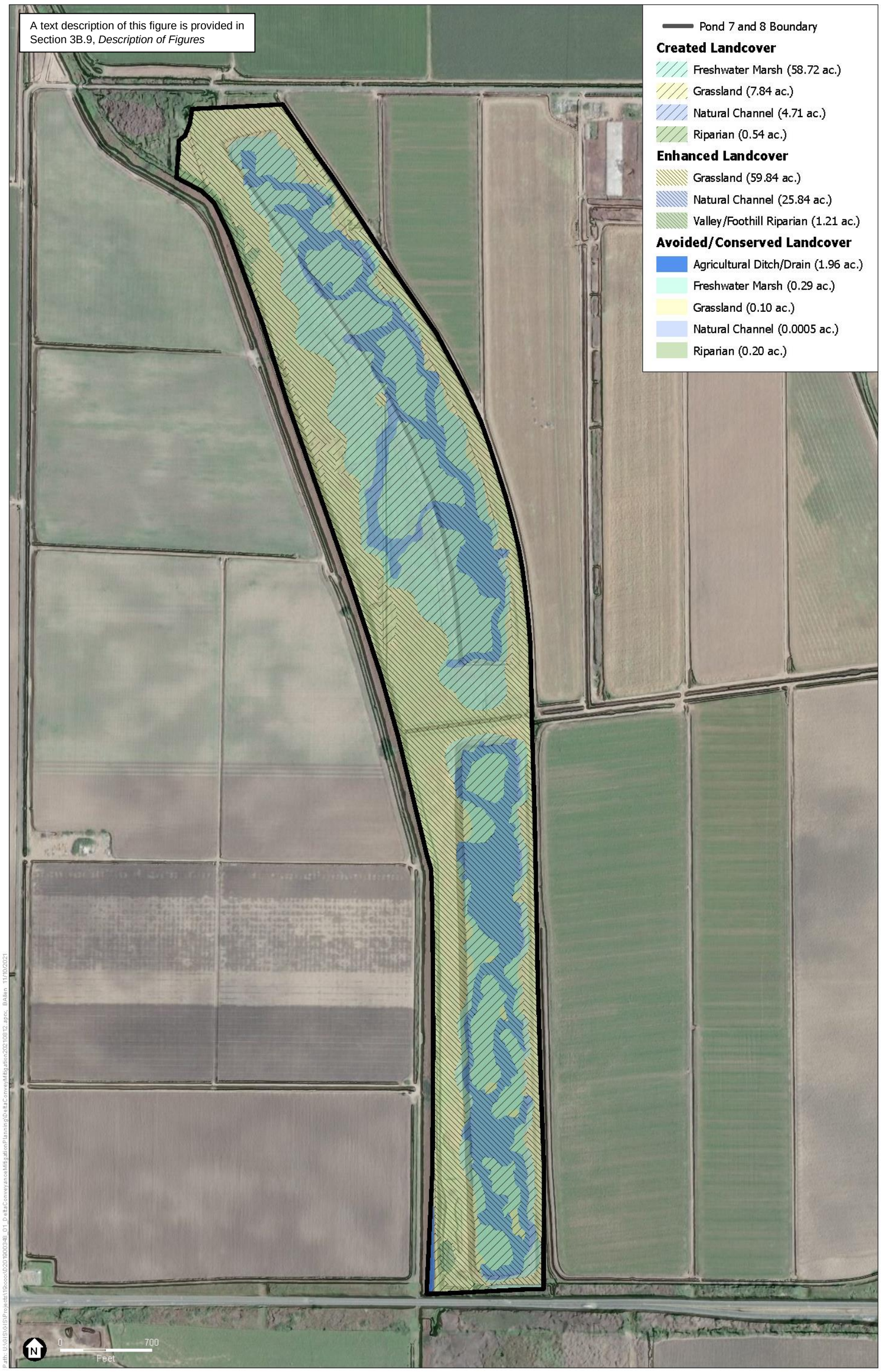



**Figure 3B-10. DWR I-5 Ponds, Pond 6 Conceptual Design**

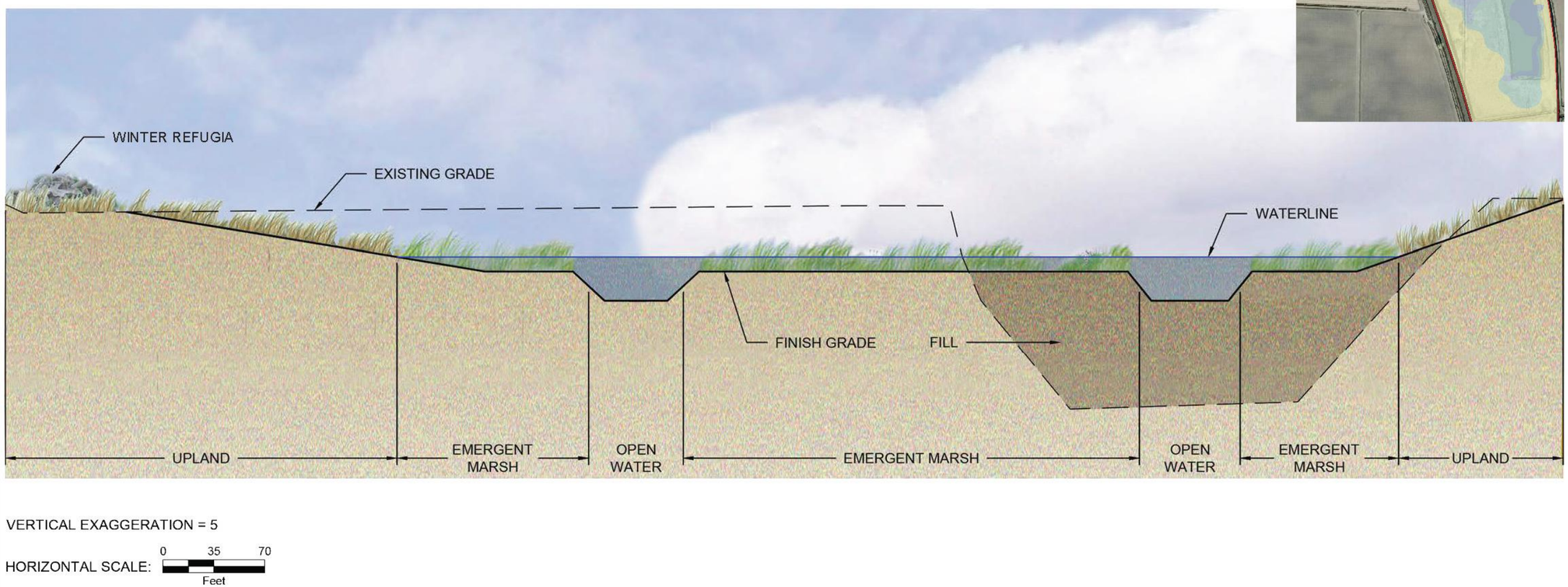



SOURCE: Esri, 2018; DWR, 2021; ESA, 2021

Delta Conveyance Mitigation Planning

**Figure 3B-11. DWR I-5 Ponds, Ponds 7 and 8 Conceptual Design**

A text description of this figure is provided in Section 3B.9, *Description of Figures*




SOURCE: ESA, 2021

Delta Conveyance Mitigation Planning

**Figure 3B-12. DWR I-5 Ponds, Pond 7 Conceptual Section**

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### Ponds 7 and 8 Design

Pond 7 would be graded to create a large side channel to the west of the pond that would be fed by groundwater. Large open water areas would also be excavated (to approximately 6.0 feet elevation below existing grade or lower) to improve giant garter snake dispersal and foraging on the site. Hemi-marsh and smaller open water channels would also be excavated to create habitat for young snakes and aquatic prey species and provide refugia for giant garter snakes. An expanded tule bench with occasional berms and open water fingers would be created around the edge of the pond to increase habitat complexity and increase multi-species benefits. Portions of the uplands would be excavated several feet to provide fill material for raising the bottom elevation of the existing ponds to a depth better suited for giant garter snake. Other portions of the site's uplands would be graded into mounds to provide high-elevation refugia from seasonal flooding.

Given that Pond 8 takes up most of its site, portions of the pond would be filled or raised to create a marsh complex that better supports a range of giant garter snake habitats. Open water expanses would be maintained to enhance water quality via wind mixing and to increase tule edge habitat. Hemi-marsh areas and upland islands would also be included to create a full set of giant garter snake habitats.

Ponds 7 and 8 proposed land cover (created and enhanced) and the change from existing conditions are summarized in Table 3B-14. Restoration would result in a net gain of freshwater marsh and grassland, and a loss of open water (depression) and riparian. Habitat creation at Bouldin Island would fully mitigate losses of riparian wetland (Mitigation Sites B1 and B2) and open water (Mitigation Site B1) (Table 3B-7).

**Table 3B-14. Comparison of I-5 Ponds 7 and 8 Existing Land Cover with Total Habitat Created and Enhanced with Full Implementation (acres)**

| Existing Land Cover Class | Acres | Habitat Created or Enhanced (acres) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural | Agricultural Ditch | Developed | Grassland | Nontidal Freshwater Emergent Wetland | Nontidal Perennial Aquatic | Seasonal Wetland | Tidal Freshwater Emergent Wetland | Tidal Perennial Aquatic | Valley/ Foothill Riparian | Subtotal Habitat Loss | Subtotal Habitat Gain | Total Post-Project Habitat |
| Agricultural | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Agricultural Ditch | 2.25 | 0 | 1.96 | 0 | 0.29 | 0 | 0 | 0 | 0 | 0 | 0 | -0.29 | 0 | 1.96 |
| Developed | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grassland | 90.00 | 0 | 0 | 0 | 59.94 | 25.51 | 4.13 | 0 | 0 | 0 | 0.42 | -30.06 | 7.84 | 67.78 |
| Nontidal Freshwater Emergent Wetland | 0.41 | 0 | 0 | 0 | 0 | 0.29 | 0 | 0 | 0 | 0 | 0.12 | -0.12 | 58.71 | 59.00 |
| Nontidal Perennial Aquatic (depression, lake/pond, natural channel) | 60.57 | 0 | 0 | 0 | 3.46 | 31.26 | 25.84 | 0 | 0 | 0 | 0.01 | -34.73 | 4.71 | 30.55 |
| Other Seasonal Wetlands | 0.24 | 0 | 0 | 0 | 0.24 | 0 | 0 | 0 | 0 | 0 | 0 | -0.24 | 0 | 0 |
| Tidal Freshwater Emergent Wetland | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tidal Perennial Aquatic (tidal channel) | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Valley/ Foothill Riparian | 7.78 | 0 | 0 | 0 | 3.85 | 1.94 | 0.58 | 0 | 0 | 0 | 1.41 | -6.37 | 0.55 | 1.96 |
| Total | 161.25 | 0.00 | 1.96 | 0.00 | 67.78 | 59.00 | 30.55 | 0.00 | 0.00 | 0.00 | 1.96 | | | 161.25 |

## Construction Methods and Equipment

The following outlines the general sequence of anticipated construction activities for the three pond sites.

- **Weed Control**—Herbicide application and/or mowing would begin several seasons before site grading commences to remove several crops of nonnative annual grass weed seed from the soil's seed bank.
- **Wildlife Protection**—Before commencement of ground-disturbing activities, suitable wildlife avoidance and minimization measures (e.g., pond dewatering, exclusion fencing) would be implemented to protect any giant garter snake or other protected wildlife. See Appendix 3A for additional measures to protect wildlife during construction.
- **Site Preparation**—An on-site staging area would be established which would include construction trailer, staging of any delivered materials and equipment refueling area. On-site utilities would be protected and/or relocated as needed.
- **Earthmoving**—Existing vegetation would be removed (grubbed) prior to grading. Large equipment would move material from uplands into the existing ponds to create higher-quality giant garter snake aquatic habitat in the footprint of existing ponds and uplands. Soils may be temporarily stored on-site in stockpiles. In addition, some fill would be placed to repair the existing perimeter berm that protects neighboring farms.
- **Planting and Seeding**—All disturbed areas would be revegetated with native plants. Plant and seeds would be sourced locally to the greatest extent possible. Temporary irrigation equipment would be installed for select plantings for the first 3 to 5 years of plant establishment.
- **Access Improvements**—Improvements would be needed for access during construction, as well as for future site access. A new gravel-surfaced access road would be created on the west boundary of the Ponds 7 and 8 site and would include a vehicular crossing at the agricultural drainage ditch separating Ponds 7 and 8. A boat ramp may be installed for future water access for maintenance. Finally, cattle exclusion fencing would be installed as needed if future land uses of the site include grazing. Site access could also be improved for limited public access for recreation (such as fishing) within designated areas outside of suitable habitat if resource agency approves of such uses.
- **Optional Water Control Structures**—Improvements such as temporary pumps and/or piping may be installed to connect the expanded ponds with existing drainage ditches and/or Hog Slough to support target habitats and provide flexibility in future water management for maintenance.
- **Culvert Improvement**—The existing culvert under SR 12 would be replaced with a larger bridge and/or arch culvert so that giant garter snakes have a mud-substrate-bottomed link to provide connectivity between Pond 8 and adjacent giant garter snake habitat south of SR 12.

Earthmoving and targeted active revegetation are the primary construction activities. The most significant construction activity would be earthmoving, including excavating uplands to create new wetlands and expanded open water, and fill placement to improve upland habitat conditions for giant garter snake and partially fill Ponds 7 and 8. Assuming approximately 10% losses between cut and fill, grading would entail up to approximately 1.2 million cubic yards of on-site cut and on-site

fill. Approximately 0.4 million cubic yards of excess material generated on the Pond 6 site would be transported and used as fill at Ponds 7 and 8.

Large land-based earthmoving equipment like bulldozers, excavators, loaders, dump trucks, water trucks, scrapers and compactors would move earth around and between the sites to meet finish grades. Excess Pond 6 material would be transported to Ponds 7 and 8 using highway-rated haul trucks. Large delivery trucks and dump trucks would bring construction materials to the sites. Trucks and other vehicles would transport construction workers and equipment to the sites.

The estimated total days that various construction equipment would be operated to complete the work is summarized in Table 3B-15**.** The average number of days per year is based on an assumed 3-year construction period.

**Table 3B-15. Estimated Construction Equipment Use—DWR Ponds 6, 7 and 8**

| Equipment | Total Working Days [a] | Average Days/Year (over 3 years) |
|---|---|---|
| Excavators | 1,190 | 397 |
| Off-road trucks | 1,763 | 588 |
| Rubber tired loaders | 1,224 | 408 |
| Highway-rated trucks | 1,854 | 618 |
| Track-mounted bulldozer | 2,414 | 805 |
| Water truck | 1,224 | 408 |
| Tractors/backhoes | 10 | 3 |

[a] Total Working Days is independent of the number of equipment in each category. To calculate the number of working days for a single equipment unit, divide the total working days by the number of equipment units (i.e., 10 excavator working days can represent 10 excavators working 1 day each or 1 excavator working 10 days). Construction equipment quantities shall be determined by the construction contractor.

### Construction Schedule

The mitigation sites would be built out over a period of several years, with construction beginning once relevant permits and approvals have been acquired for the project. Each parcel would require approximately one construction season for initial establishment; however, the timing could overlap so various parcels would undergo restoration simultaneously.

Construction would likely occur over a period of 2 to 4 years. Pond 6 would most likely be built first due to the abundance of upland habitat that could be created. Construction would likely occur on the Pond 7 site before the Pond 8 site given the site access constraints for Pond 8. Note that initial ground-disturbance activities would be conducted during the giant garter snake active season (May 1 to October 1) to minimize potential impacts on giant garter snake. Like the Bouldin Island sites, the I-5 Pond sites would be protected in perpetuity under a conservation easement.

### Water Quality

Risk of elevated methylmercury at the I-5 ponds is low because the ponds were not historically connected to Delta waters and are currently not tidally connected; therefore, it is unlikely that any mercury was deposited in soils. Risk of CHABs at the I-5 ponds is also low because the ponds are not tidally connected; water for the wetlands would come from ambient sources that would not contain

Microcystis. Because these water quality concerns are not present at the I-5 ponds, monitoring is not needed at these locations.

## 3B.4.2 Mitigation Credits and Site Protection Instruments

The second approach for this CMP is to obtain credits from approved mitigation/conservation banks or to develop site protection instruments to meet mitigation needs for certain natural community types, including some types of wetlands and other waters, and for species. There are a number of approved and pending mitigation/conservation banks with service areas that overlap the proposed alternatives footprints. For example, the Elsie Gridley Mitigation Bank with existing and pending alkaline wetland and vernal pool credits, along with vernal pool fairy shrimp (*Branchinecta lynchi*) and vernal pool tadpole shrimp (*Lepidurus packardi*) credits (Lee pers. comm. ). Additionally, the pending Doolan Canyon Conservation Bank is in the process of getting California tiger salamander, as well as California red-legged frog, credits approved (Moss pers. comm. ).

Although no mitigation/conservation banks are currently approved or in development for northwestern pond turtle or western spadefoot, it is possible that by the time of project implementation one may be available.

### 3B.4.2.1 Mitigation Credits from Approved Banks

The final amount of mitigation credits to be secured for aquatic resources and species habitats will be determined during the construction phase of the project, as preconstruction surveys have the potential to reduce mitigation needs. On-the-ground land cover surveys and presence/absence surveys will inform more precise impact calculations and likely reduce the final mitigation burden. In some instances, reduced impact calculations may not result in changes to restoration design and implementation. However, as described in Section 3B.S.2, mitigation implementation will stay ahead of the cumulative, permanent suitable habitat loss by 10%.

#### Wetlands and Other Waters

Impacts on the following wetlands/waters may be mitigated through use of an approved mitigation bank.

- Alkaline wetland
- Vernal pool
- Tidal emergent wetland
- Tidal channel

Alkaline wetlands occur on alkaline soils with ponded or saturated soil conditions for prolonged periods during the growing season. The vegetation of alkaline wetlands is composed of plant species adapted to wetland conditions and high alkalinity levels. These wetlands are rare in the study area (the statutory Delta and a few areas southwest around Bethany Reservoir), occurring primarily around Clifton Court Forebay and southern Solano County. Vernal pools are seasonal wetlands that form in shallow depressions underlain by hardpan or a dense clay subsurface layer. These depressions fill with rainwater and surface runoff; the subsurface layers restrict infiltration into the subsoil and the depressions remain inundated throughout the winter and sometimes as late as early summer. Vernal pools are found in areas of level or gently undulating topography in the lowlands of

California, especially in the grasslands of the Central Valley. Both of these wetland types require site-specific soil and hydrology factors to create. For these reasons, purchase of wetland creation credits at an approved mitigation bank whose service area includes the project may be the preferred option for compensating impacts on these resources.

Impacts on tidal habitats and fisheries may also be compensated through wetland creation credits or species conservation credits at approved banks. Another option is to compensate for these impacts through the Tidal Habitat Mitigation Framework, as described in Section 3B.4.3.

### Targeted Species

Agency-approved mitigation banks may be used to meet compensatory mitigation requirements for the following species that have habitat needs in excess of the habitat created at the identified mitigation sites or require habitat types that would not occur at those mitigation sites.

- California tiger salamander—aquatic and upland habitat
- California red-legged frog—aquatic and upland habitat
- Vernal pool fairy shrimp and vernal pool tadpole shrimp—vernal pool habitat
- Western spadefoot—aquatic and upland habitat

## 3B.4.2.2 Site Protection Instruments

Another approach to provide on- or off-site mitigation is to use real estate protection instruments and other site protection instruments to ensure the long-term protection of a mitigation site (Wood and Martin 2016:4–10). Examples include conservation easements, deed restrictions, transfer of title, or other documents such as Conservation Land Use Agreements. The site protection instrument would describe site ownership, management (e.g., vegetation or pest control, crop type requirements, water provisions for wildlife), and enforcement of any use restrictions (e.g., pesticide restrictions). Once the site protection instrument is drafted, DWR will share it with the Wildlife Agencies. This approach would be useful to protect habitat functions provided by certain lands for targeted species, such as the following.

- Northwestern pond turtle—aquatic foraging, basking habitat, and upland nesting, overwintering/aestivation habitat
- Western spadefoot—aquatic breeding sites and adjacent upland habitat

During identification of properties in support of site protection instruments, DWR will coordinate with the implementing entities for the adopted habitat conservation plans, natural community conservation plans, and other regional conservation plans that overlap with the targeted sites, before decisions are made on acquiring site protection instruments within their respective plan areas. The goal of this coordination is to ensure that DWR's acquisitions to meet mitigation needs do not result in conflicts with these plans and their ability to achieve their biological goals and objectives.

# 3B.4.3 Tidal Habitat Mitigation Framework

## 3B.4.3.1 Programmatic Approach

The construction and operations of water conveyance facilities would potentially affect tidal perennial aquatic habitat (e.g., permanent and temporary loss of habitat due to construction) and alter hydrodynamics (e.g., reduce Sacramento River flows downstream of the north Delta intakes) (Chapter 5, *Effects Analysis for Chinook Salmon, Central Valley Steelhead, Green Sturgeon, and Killer Whale,* and Chapter 6, *Effects Analysis for Delta Smelt, Longfin Smelt, and Terrestrial Species*).

In summary, approximately 18.3 acres of tidal perennial habitat 3,619 linear feet of channel margin habitat would be required as compensatory mitigation for construction impacts. 2,540 linear feet of channel margin habitat for salmonids, up to approximately 3,500 acres of tidal habitat for salmonids, approximately 1,352 acres of tidal habitat for delta smelt, and approximately 135.2 of tidal habitat for longfin smelt would be required as compensatory mitigation for operations impacts. Coordination is ongoing with the regulatory agencies to refine and finalize the tidal habitat mitigation requirements.

This section describes the general approach to identify and construct mitigation sites for channel margin and tidal wetland habitats. It includes a description of the factors considered for site selection as well as the design concepts that may be applied once a site is selected and acquired. Once developed, it is anticipated these mitigation sites will provide suitable habitat for affected fish and aquatic species, including salmonids, delta smelt, and longfin smelt. Creation of tidal wetlands in the North Delta could influence hydrodynamics in ways that may beneficially affect routing and survival conditions for outmigrating anadromous salmonids by decreasing the fraction of Sacramento River flow (and fish) that enters Georgiana Slough (Perry et al. 2018; California Department of Water Resources 2023b).

Opportunities for habitat restoration in the Delta are constrained by the elevation of land, which determines the potential to reestablish land-water connections that sustain wetland and floodplain habitat (Delta Stewardship Council 2020a:4–12). Much of the Delta has subsided too deeply to restore its original ecological functions. Farming practices on subsided islands that expose peat soils to oxidation contribute to ongoing subsidence. However, some practices can also reverse subsidence, by creating or promoting accumulation of new soil layers. Examples include managed wetlands, placement of fill, and levee breaching to reestablish hydrological connections (Delta Stewardship Council 2020b:Q2-3). Managed wetlands that are designed to promote subsidence reversal and carbon sequestration would be appropriate for lands at these elevations (Delta Stewardship Council 2020b:Q2-5). For example, restoration of freshwater wetlands on Bouldin Island would contribute to halting or reversing subsidence on the island and is therefore an important element proposed in this CMP.

For tidal habitats, wetland restoration is not appropriate at elevations that are too far below the intertidal range (i.e., below mean lower low water). The Tidal Habitat Mitigation Framework therefore focuses first on the suitable restoration areas identified in the Delta Plan, such as the tidally influenced regions of Cache Slough and lower Yolo Bypass. However, it is uncertain that all tidal wetland habitat needs can be feasibly met in this region. In addition, while the proposed approach considers existing elevations, it also considers other benefits beyond wetland habitat structure, such as hydrodynamic effects of tidal mitigation (subtidal, intertidal, and transition habitats) on fish migration and survival through the Delta. Therefore, other locations and project

types have been considered based on the best available science, as well as feasibility criteria. This includes the beneficial reuse of tunnel material to raise elevations if available nearby (with consideration of other impacts from moving material).

Similarly, enhancing and creating channel margin habitat along the lower Sacramento River mainstem from Freeport to Rio Vista may be challenging due to elevations or levee status (i.e., federal project levees), which could constrain opportunities for levee setbacks and waterside modifications. Other options will be considered to provide the functions of the impacted channel margin habitat, such as enhancing channel margin habitat on distributary sloughs (e.g., Sutter Slough, Steamboat Slough) and enhancing and creating additional foraging and refugia habitat in tidal wetlands and seasonally inundated floodplains (Takata et al. 2017).

## 3B.4.3.2 Targeted Habitats

### Channel Margin

The construction of flood protection levees throughout the Delta has led to a reduction in the range of shoreline habitats by eliminating the shallow, slow-velocity river margins, overhanging riparian vegetation, and future woody debris sources (Final EIR Chapter 13). Channel margin habitat occupies the transition zone between open water and upland terrestrial vegetation (e.g., grasslands, woodlands) along the shorelines of rivers and sloughs. This includes tidal freshwater marsh, riparian habitats, and associated shallow water. These habitats are needed for foraging and as refugia for juvenile fish and salmonids to escape fast currents, deep water, and predators (Bureau of Reclamation 2008:5-17; National Marine Fisheries Service 2009:78).

### Tidal Perennial Aquatic

The tidal perennial aquatic natural community is defined as deep-water aquatic (more than 10 feet deep from mean lower low tide) and shallow aquatic (less than or equal to 10 feet deep from mean lower low tide) zones of estuarine bays, river channels, and sloughs (Final EIR Chapter 13). Under existing conditions, tidal perennial aquatic in the Delta is mainly freshwater habitat, with brackish and saline conditions occurring in the western Delta at times of high tides and low flows into the western Delta. The Yolo Bypass is fresh water.

Tidal channels may have floating aquatic vegetation and submerged aquatic vegetation. Floating aquatic vegetation extends over the open water surface, either as free-floating plants or as colonies extending from plants rooted in banks. Most floating aquatic vegetation in the Delta consists of highly invasive nonnative plants such as water hyacinth, which commonly occurs in dense floating mats that can create anoxic conditions or smother marsh vegetation with decomposing masses of debris.

Submerged aquatic plants are fully submerged and often have root systems reduced to minimal anchorage structures. Many native species, including pondweeds and stoneworts, are valuable food plants for waterfowl and nursery habitat for aquatic invertebrates and fish. In the Delta, nonnative invasive submerged aquatic species such as Brazilian waterweed (*Egeria densa*) and alligatorweed (*Alternanthera philoxeroides*) dominate and replace native species in naturally open water slough beds. These plants create suitable cover and shelter for predatory nonnative fish in tidal slough beds.

Wildlife species associated with tidal aquatic habitats vary with water depth and other habitat features. Deeper open water areas without vegetation provide foraging habitat for wildlife such as terns, gulls, osprey, diving ducks (e.g., ring-necked duck [*Aythya collaris*] and canvasback [*Aythya valisineria*]), and river otters (*Lontra canadensis*), which feed primarily on fish, crayfish, and other aquatic organisms. Shallower water with submerged or floating aquatic vegetation provides foraging habitat for reptiles, such as northwestern pond turtle, and dabbling ducks, such as American widgeon (*Mareca americana*) and northern pintail (*Anas acuta*), which feed on a variety of invertebrates and plant material. Special-status wildlife species include giant garter snake and northwestern pond turtle.

Tidal channels serve as migration corridors for Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*), as well as migration, spawning, and rearing habitat for delta smelt and longfin smelt. Restored tidal habitat areas would have positive effects on delta smelt (Sommer and Mejia 2013) and longfin smelt (Lewis et al. 2020) through greater habitat extent (e.g., as shown for Liberty Island in the north Delta; Sommer and Mejia 2013) and greater food availability on-site or in nearby areas (Hammock et al. 2019).

## Tidal Emergent Wetlands

The tidal freshwater emergent wetland natural community is typically a transitional community between tidal perennial aquatic and valley/foothill riparian or terrestrial upland communities across a range of hydrologic and soil conditions (Final EIR Chapter 13). In the study area, the tidal freshwater emergent wetland community often occurs at the shallow, slow-moving or stagnant edges of freshwater waterways or ponds in the intertidal zone and is subject to frequent long-duration flooding. Tidal freshwater emergent wetland vegetation naturally occurs along a hydrologic gradient in the transition zone between open water and riparian vegetation or upland terrestrial vegetation such as grasslands or woodlands. In the study area, there are often abrupt transitions to agricultural cover, managed wetlands, and boundaries formed by levees and other artificial landforms.

Wildlife species composition in sparsely vegetated areas in low-elevation tidal freshwater emergent wetland is similar to the composition described above under tidal perennial aquatic natural community. Other wildlife species that could utilize these low-elevation tidal freshwater emergent wetlands include northwestern pond turtle, wading birds (egrets and herons), waterfowl (ducks, geese, and swans), shorebirds (e.g., rails, plovers, sandpipers), and perching birds. Common nesting birds include red-winged blackbird (*Agelaius phoeniceus*), marsh wren (*Cistothorus palustris*), common yellowthroat (*Geothlypis trichas*), and black-crowned night heron (*Nycticorax nycticorax*). American beaver (*Castor canadensis*) and muskrat (*Ondatra zibethicus*) forage on marsh plants and use them for cover and den material. Several special-status plant and wildlife species occur in the tidal freshwater emergent wetland natural community, including side-flowering skullcap (*Scutellaria lateriflora*) and giant garter snake.

Restored tidal habitat areas would have the potential for positive effects on juvenile salmonids, for example by providing foraging habitat along marsh edges (Brown 2003) or a greater extent of inundated vegetated habitat for occupancy (Hellmair et al. 2018).

### 3B.4.3.3 Channel Margin Habitat Mitigation Approach

#### Purpose

Channel margin enhancements would seek to improve rearing and outmigration habitat for juvenile salmonids along migration corridors that has been degraded by construction of flood protection levees. Channel margin restoration would be expected to increase rearing habitat; improve conditions along migration corridors by providing increased habitat complexity, overhead and in-water cover, and prey resources for covered fish species; and improve connectivity between patches of existing, higher-value channel margin habitat. Creation of this habitat would also have the potential to increase resting habitat for migrating adult covered fish species, as well as increase spawning habitat for covered fish that spawn in area, including delta smelt and longfin smelt. There could be some rearing benefit for green sturgeon and white sturgeon (*Acipenser transmontanus*) from channel margin enhancement as well.

The focus would be to provide enhanced channel margin habitat along important juvenile salmonid migration routes; consequently, the measure would improve connectivity between patches of higher-value enhanced channel margins and primary channels. This is particularly necessary for reaches that currently have low habitat value for covered fishes and are heavily used by migrating and rearing fish—for example, the Sacramento River between Freeport and Georgiana Slough. Enhanced channel margin in the vicinity of the proposed north Delta intakes (upstream, between the intakes, and downstream) would provide resting spots and refuge for fish moving through this reach.

It is anticipated that channel margin habitat would be restored to mitigate construction impacts, depending on alternative. Channel margin restoration would be accomplished by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids in particular, similar to what is current practice by USACE and other flood management agencies when implementing levee improvements. Channel margin restoration associated with federal project levees would not be implemented on the levee, but rather on benches to the waterward side of such levees, and flood conveyance will be maintained as designed. Channel margin enhancements associated with federal project levees may require permission from USACE in accordance with USACE's authority under the Rivers and Harbors Act (33 United States Code § 408) and levee vegetation policy. Any restoration will be designed, constructed, and maintained to ensure no reduction in performance of the federal flood project.

Channel margin restoration would be achieved by site-specific projects. The following habitat suitability factors would be considered when evaluating sites for potential location and design of restored channel margins.

- Existing poor habitat quality and biological performance for listed species of fish combined with extensive occurrence of listed species of fish.
- Locations where migrating salmon and steelhead are likely to require rest during high flows.
- The length of channel margin that can be practicably restored and the distance between restored areas (there may be a tradeoff between restoring multiple shorter reaches that have less distance between them and enhancing relatively few longer reaches with greater distances between them).

- The potential for native riparian plantings to augment habitat for non-aquatic listed species using riparian habitat, such as least Bell's vireo and western yellow-billed cuckoo, in proximity to known occurrences.
- The potential cross-sectional profile of enhanced channels (elevation of habitat, topographic diversity, width, variability in edge and bench surfaces, depth, and slope).
- The potential amount and distribution of installed woody debris along restored channel margins.
- The extent of shaded riverine aquatic overstory and understory vegetative cover needed to provide future input of large woody debris.

As with tidal wetland restoration, siting, design, and performance criteria for channel margin restoration will be developed. As necessary and reflecting permitting requirements, a collaborative technical team that includes DWR and fishery agency representatives will be formed to select the most biologically appropriate and cost-effective restoration sites, as well as review designs, performance criteria, and management plans for the sites.

## Site Selection Criteria

Approaches to creating channel margin habitat can vary and are dependent on location. Channel margin enhancements would likely occur along migration corridors that also provide a certain level of flood protection for adjacent properties. To maintain the current extent of in-water habitat and level of flood protection, the existing levee would need to be reconstructed to be further set back from the shoreline. Waterside and landside improvements would be implemented to create enhanced channel margin habitat and provide continued flood protection.

The following criteria would be used to screen potential sites for channel margin habitat enhancement.

- **Benefits to species**—Consider the geography and functions of targeted habitat features for affected species, population segment, and life stages where appropriate. Projects that benefit multiple species will be prioritized, to be cost-effective and efficient with restoration efforts.
- **Ownership**—Focus first on lands owned by DWR, other publicly owned lands, or land owned by project partners.
- **Existing opportunities**—Look for opportunities to incorporate habitat restoration or creation into project construction, such as channel margin habitat creation as part of levee improvements.
- **Engineering feasibility**—Consider geotechnical or other issues that might limit options, be cost-prohibitive, or delay implementation.
- **Enhance habitat function**—Channel margin habitat projects should be focused in the migration corridor for listed anadromous fishes in the Sacramento River (winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, and southern distinct population segment of green sturgeon). For the purposes of this program, sites would be targeted within the same general geography of the project, including the north Delta along the Sacramento River mainstem, north Delta along Sacramento River tributaries (e.g., Steamboat, Sutter, and Elk Sloughs), lower Yolo Bypass, and the Cache Slough Complex.

- **Velocity**—Sites that have a lower-velocity environment or where a lower-velocity environment can be created are well suited to channel margin enhancement. However, sedimentation in this depositional environment can bury instream woody material and plantings, so the potential for deposition of sediment must be taken into consideration. Another consideration is locations where migrating salmon and steelhead are likely to require rest during high flows.
- **Depth**—Sites where shallow-water habitats can be created. Avoid sites with steep banks, as it would likely be cost prohibitive because of the amount of necessary material and feasibility of placement.
- **Proximity**—Prioritize sites near each other or existing suitable habitat to create more continuous habitat. Another consideration is the length of channel margin that can be practicably restored and the distance between restored areas (there may be a tradeoff between restoring multiple shorter reaches that have less distance between them and enhancing relatively few longer reaches with greater distances between them).
- **Elevation**—Existing land surface/relationship connectivity to adjacent hydrologic stage range. Channel margin defined as zone within the waterline -5 feet to +10 feet.
- **Linear miles of channel margin**—Projects should seek to maximize the length of channel margin at a single site. Maximize cost effectiveness and ecological function by selecting few sites with longer channel margin. Linear miles of enhancement will be measured along one side of a given channel segment (e.g., if both sides of a channel were enhanced for a length of 1 mile, this would account for a total of 2 miles of channel margin enhancement).
- **Human disturbance**—Avoid areas with heavy recreational uses.
- **Multispecies benefit**—The potential for native riparian plantings to augment habitat for non-aquatic listed species using riparian habitat, such as least Bell's vireo and western yellow-billed cuckoo, in proximity to known occurrences.

## Design Criteria and Concepts

The following criteria were considered in the development of concept designs for channel margin habitat.

- **Bank slope**—Gentle bank slopes of 10:1 provide shallow-water habitat that creates areas of refuge from predators and high velocity flows and feeding and rearing opportunities. Additionally, it is more difficult to maintain soil on steep slopes.
- **Benches**—Rock benches are relatively flat areas within the levee slope that create a buffer against toe scour and shear stress, provide a space for planting riparian vegetation, and create a platform for aquatic habitat features. They also create shallow-water habitat for juvenile fish rearing and refugia.
- **Instream woody material**—Provides habitat complexity and high-quality cover and velocity refugia for juvenile Chinook salmon.
- **Bank substrate and emergent vegetation**—Vegetation can provide bank stabilization as well as habitat complexity, refugia for fish, and shade. Riparian vegetation is planted on rock benches that are seasonally inundated.
- **Shade**—Riparian vegetation also contributes to instream woody material and overhanging shade.

Design criteria should also take into account geotechnical issues and feasibility, since many areas in the Delta could have challenges with new loading on existing levees or construction of new setback levees.

Enhancement would generally entail replacing armored or otherwise altered channel banks with more natural shoreline habitats that provide shallow, slow-velocity river margins, overhanging riparian vegetation, and future woody debris sources. Approaches to creating channel margin habitat enhancement can vary and are location-dependent. Channel margin enhancements would likely occur along migration corridors that also provide a certain level of flood protection for adjacent properties. To maintain the current extent of in-water habitat and level of flood protection, the existing levee would need to be reconstructed to be set back from the shoreline. Waterside and landside improvements would be implemented to create enhanced channel margin habitat and provide continued flood protection.

Waterside improvements would entail degrading the existing levee to create gently sloping banks that gradually transition from tule marsh to riparian vegetation on the face of the new setback levee. While enhanced habitat would primarily be provided by native vegetation, ballasted large wood may be incorporated into the channel bank in some locations for enhanced complexity and refugia. While the heavily vegetated bank would provide some wave attenuation value, erosion protection may still be required along the waterside of the setback levee. Bio-technical bank treatments, which combine cobble and other erosion resistant materials with willows and other plantings, would be employed as much as possible. Following all grading, the site would be revegetated, likely through a combination of active and passive methods. Riparian and upland areas would be actively seeded, planted, and temporarily irrigated during the initial establishment period. Intertidal wetland areas would be revegetated through a combination of active planting and passive natural recruitment.

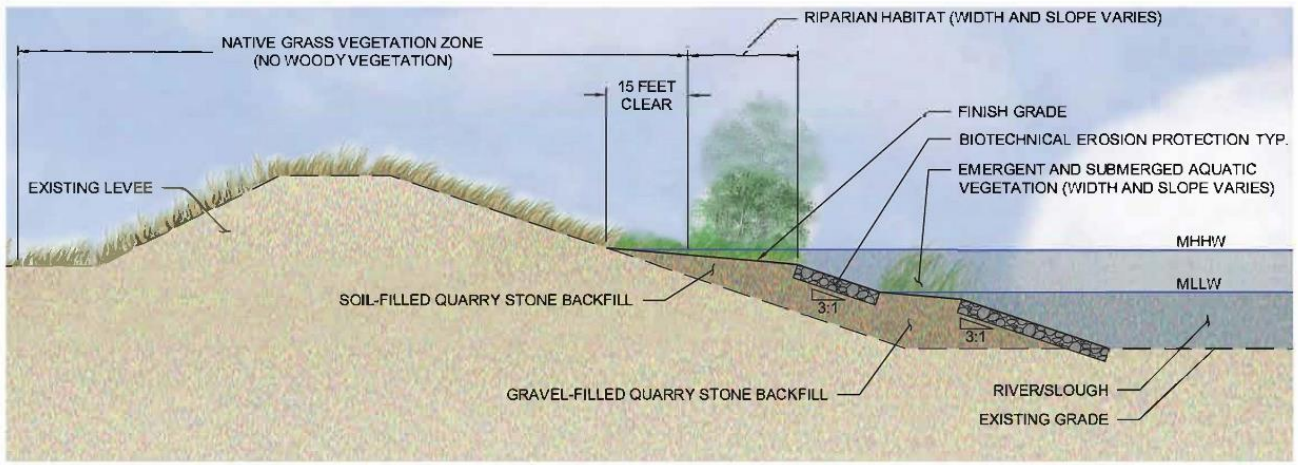
Landside improvements would include the construction of a new setback levee behind and connected to the existing levee. The actual extent of earthmoving required for levee construction would vary significantly by site depending on the degree of land subsidence and the level of flood protection needed. It is generally anticipated that imported fill would be needed to construct some or all of the new setback levee. Material generated by degrading the existing levee would be reused in the new levee construction as much as feasible based on timing, soil suitability, and other factors.

Figure 3B-13 provides a conceptual design for channel margin habitat creation with no setback levee while Figure 3B-14 depicts a design for sites needing a setback levee.

Channel margin enhancement construction is expected to be performed in the following manner.

- Use of large, mechanized equipment (typically, a trackhoe) to remove riprap from channel margins.
- Use of grading equipment such as trackhoes and bulldozers to modify the channel margin side of levees or setback levees to create low floodplain benches with variable surface elevations that create hydrodynamic complexity and support emergent vegetation.
- Use of construction equipment such as trackhoes, bulldozers, and cranes to install large woody material (e.g., tree trunks, stumps) into constructed low benches or into existing riprapped levees to provide physical complexity.

A text description of this figure is provided in Section 3B.9, *Description of Figures*




SECTION

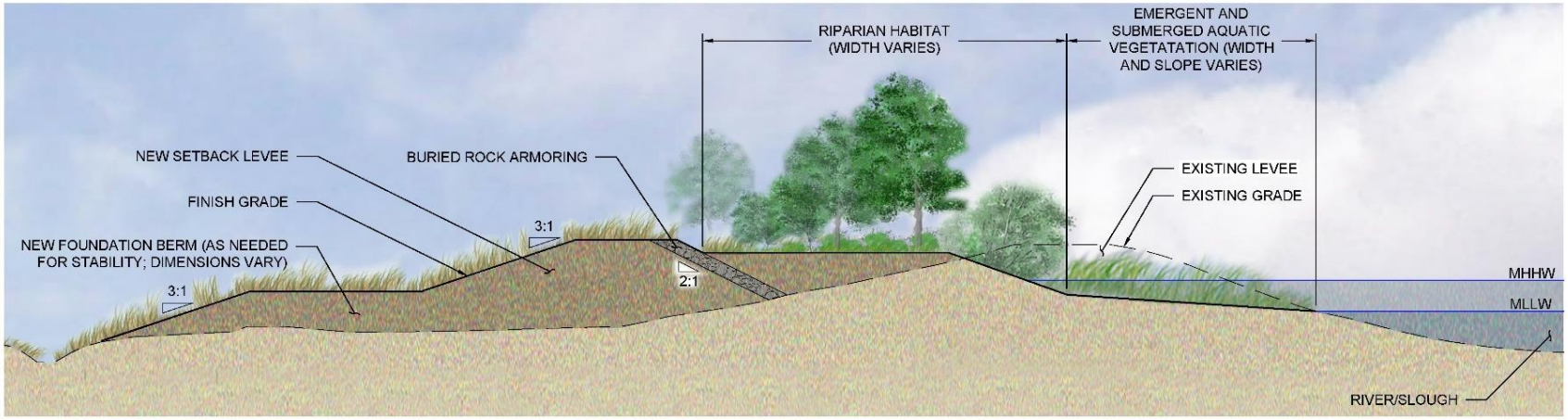
VERTICAL EXAGGERATION = 1

HORIZONTAL SCALE: 0 10 20 Feet

Delta Conveyance Mitigation Planning

**Figure 3B-13. Channel Margin No Setback Levee**

A text description of this figure is provided in Section 3B.9, *Description of Figures*




SECTION

VERTICAL EXAGGERATION = 1

HORIZONTAL SCALE: 0 10 20 Feet

Delta Conveyance Mitigation Planning

**Figure 3B-14. Channel Margin Setback Levee**

### 3B.4.3.4 Tidal Wetland Habitat Mitigation Approach

#### Purpose

The construction and operations of water conveyance facilities would potentially affect tidal perennial aquatic habitat (e.g., permanent and temporary loss of habitat due to construction) and alter hydrodynamics (e.g., reduced Sacramento River flows downstream of the north Delta intakes). Restoration of tidal wetlands is one approach to mitigate for these impacts. Tidal perennial aquatic and tidal freshwater emergent wetland habitats in the Delta play a critical role for native fish, including providing improved foraging opportunities and refuge from predators. The restoration of tidal wetlands containing dendritic channels and shallow subtidal areas is intended to mitigate impacts by providing habitat to support survival and growth (including food production) of one or more life stages of delta smelt, longfin smelt, and Chinook salmon (Sherman et al. 2017:29–30, 276–277, 316–321). Depending on the location and size, tidal wetland creation in the north Delta may also have a beneficial effect on flow reversals in Georgiana Slough (Perry et al. 2018), which would benefit migrating Chinook salmon juveniles.

#### Site Selection Criteria and Tools

Tidal wetland habitat mitigation would generally be achieved at suitable locations by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Factors to be considered when evaluating sites for potential location and design of tidal perennial habitat restoration include provision of suitable habitat features such as those suggested by the San Francisco Estuary Institute (2020:7–12) and Sommer and Mejia (2013).

- **Benefits to species**—Consider the geography and functions of targeted habitat features for affected species, population segment, and life stages where appropriate. Projects that benefit multiple species will be prioritized, to be cost-effective and efficient with restoration efforts.
- **Ownership**—Focus first on lands owned by DWR, other publicly owned lands, or land owned by project partners.
- **Mineral Rights**—Preferably, the mineral rights would be intact with the land title. In the instance where the mineral rights are severed, a remoteness opinion would be provided documenting the minimal risk of future surface disturbance for mineral purposes.
- **Geography**—Prioritize sites within the North Delta Habitat Arc, especially those areas within the lower Yolo Bypass and Cache Slough Complex. These areas would provide greater benefits for target fish species.
- **Elevation**—Prioritize existing land surfaces that have high hydrologic connectivity to adjacent lands within the tidal stage range, consistent with Delta Plan policy ER P2 *Restore Habitats at Appropriate Elevations* (23 California Code of Regulations § 5006).
- **Lateral extent/surface area**—The potential lateral extent of land surface connectivity to the tidal range is important to maximize the surface area of created wetland habitat.
- **Sea level rise accommodation**—Similar to lateral extent, sites that offer sufficient interior land area that could accommodate landward retreat in face of sea level rise should be prioritized.
- **Water quality**—Siting would consider factors such as local hydraulics, source water, drainages, and location of nearby drinking water supply intakes. Harmful algal blooms of cyanobacteria

(CHABs) have not been problematic in the Cache Slough region because water quality conditions in the North Delta Habitat Arc (Cache Slough to Suisun Marsh) are generally not conducive to *Microcystis* growth and aggregation (Environmental Science Associates 2022). The risk for increased selenium bioaccumulation would be minimized by locating new tidal habitat in the north Delta, away from selenium sources from the San Joaquin Valley. The risk of dissolved organic carbon in drainage water from oxidizing peat soils (Fleck et al. 2007) would be minimized because sites with suitable intertidal elevations would have more mineral-based soils due to geography (Cache Slough and lower Yolo Bypass areas) or design (e.g., build up elevations with RTM or dredge spoil).

- **Feasibility**—Consider factors such as type of levee (federal project or non-federal, existing condition and easements), other regulatory permitting, land ownership, geotechnical feasibility, implementation readiness, easements, and infrastructure.

## Design Criteria and Considerations

The following criteria were considered in the development of concept designs for tidal wetland habitat.

- **Tidal marsh landmasses**—Tidal marsh elevations should allow exchange between adjacent tidal marsh areas and channel habitats during high tides. Marsh plains should generally slope toward the channel for effective draining.
- **Intertidal channels**—Channel network with dendritic channels ranging in size. Channels should be sinuous and branching, similar to natural channel networks. Channels should be largest (deepest and widest) where they enter the marsh and smallest at their terminus inside the marsh.
- **Large patch size**—Where feasible, designs should favor the creation of larger patches that can be more sustainable. Large marsh patches (around 250 acres) can support well-developed channel systems and a range of physical and ecological features.
- **Minimize distance to nearest marsh "neighbor"**—This allows greater habitat connectivity and cumulative benefits.
- **Increase core habitat**—Core areas provide productivity to edge habitats, are less accessible to many predators, buffered from human disturbance.
- **Water quality**—Designs should consider hydrologic regime (sites that experience frequent wetting/drying may foster greater methylation of mercury) and channel morphology (backwater areas with low velocities and high residence time can create conditions that foster harmful algal blooms and bioaccumulation of selenium) to minimize potential effects related to methylmercury generation, selenium bioaccumulation and CHABs.

Siting, design, and performance criteria for tidal perennial habitat restoration would be developed based on assessments of topography, local hydrodynamic conditions and sediment transport. As necessary and reflecting permitting requirements, a collaborative technical team including DWR and fishery agency representatives would be formed to select the most biologically appropriate and cost-effective restoration sites, design the restoration plan, set performance criteria, and develop the restoration unit management plan for the sites.

Tidal wetland habitat mitigation would be achieved at suitable locations by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Restoration would primarily occur through breaching or setback of levees to restore tidal fluctuation to land parcels currently isolated behind those levees. Where practicable and appropriate, some areas would be raised to elevations that would support tidal marsh vegetation following levee breaching. Figure 3B-15 provides a conceptual design for tidal wetland creation at unsubsided sites while Figure 3B-16 depicts a design for subsided sites.

Typical actions required to create suitable tidal marsh habitat at these sites include grading, planting, and infrastructure modifications. Earthwork often includes breaching an existing levee or berm to reintroduce tidal action to the site. Other grading may be performed prior to breaching to create wetland features that enhance habitat function, including tidal channels, tidal pannes and tidal ponds. In addition, for certain sites, more significant earthmoving may be required to raise subsided areas to intertidal elevations or to reinforce surrounding levees. Depending on the project location, it also may be necessary to construct an entirely new flood control levee along portions of the project perimeter to protect adjacent properties. Where feasible, transitional riparian and other habitat may be graded between the marsh plain and high elevation areas. The actual extent of earthmoving required can vary significantly depending on the existing topography of the site.

Following earthwork and grading, the site would be revegetated, likely through a combination of active and passive methods. Any riparian or upland areas would be actively seeded, planted, and temporarily irrigated during the initial establishment period. Depending on site-specific conditions and monitoring results, patches of native emergent vegetation may be planted to accelerate the establishment of native marsh vegetation on restored marsh plain surfaces. Following reintroduction of tidal exchange, tidal marsh vegetation is expected to establish and maintain itself naturally at suitable elevations relative to the tidal range.

Various infrastructure modifications, such as protection, removal, or relocation of existing utilities, pumping systems, and other water management structures, would occur as needed. Typically work would be sequenced so that grading and infrastructure improvements occur first, followed by planting and finally breaching of the existing levee to reintroduce tidal action.

Levee breaching would require removing levee materials from within and adjacent to tidal and other aquatic habitats. Levee breaching would entail in-water work using construction equipment such as bulldozers, backhoes, and barges; any in-water work would be performed during an in-water work window to be approved by CDFW, the National Marine Fisheries Service (NMFS), and USFWS. Removed levee materials would be placed on the remaining levee sections, placed within the restoration area, or hauled to a disposal area previously approved by CDFW, NMFS, and USFWS.

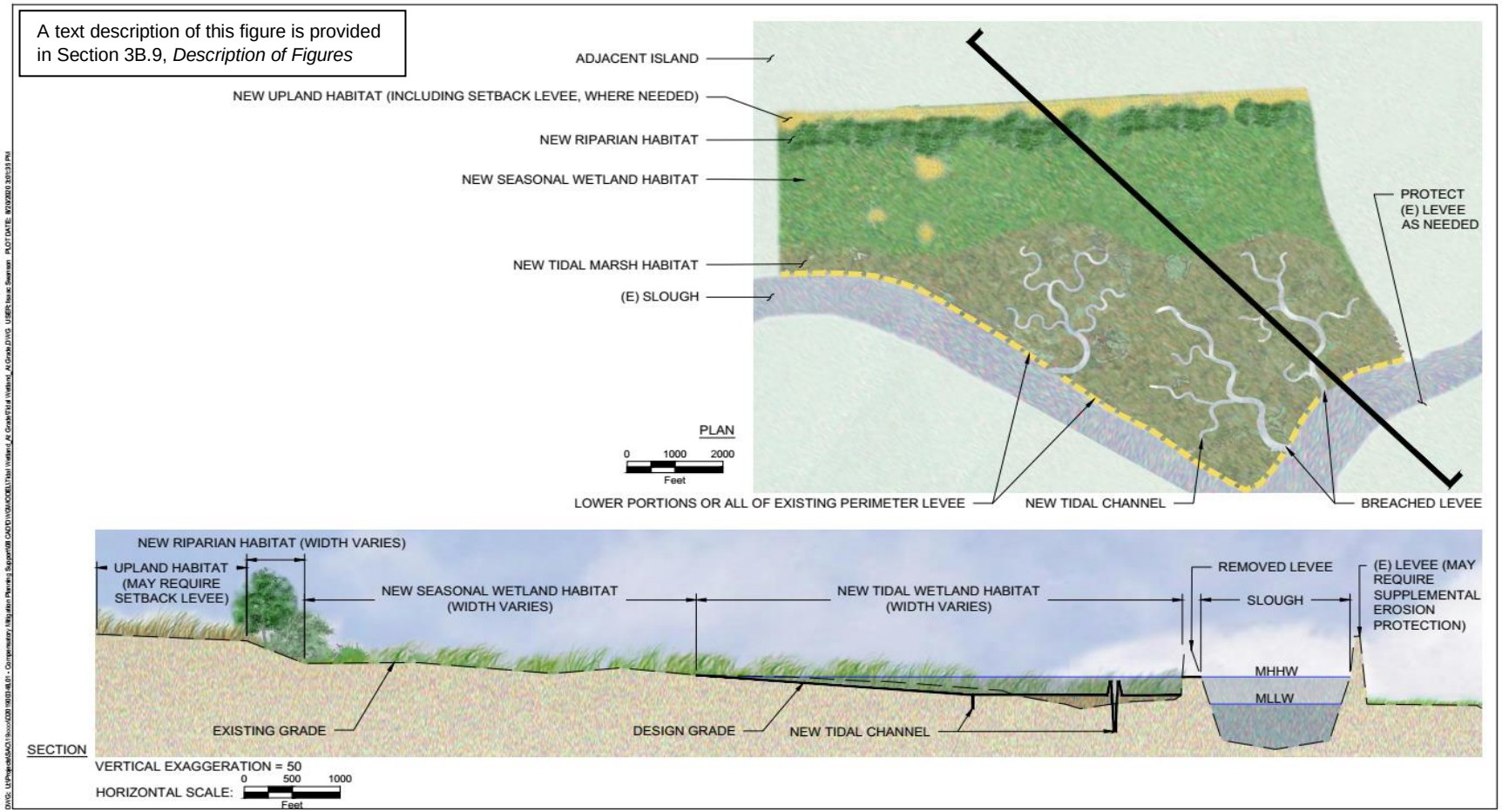



**Figure 3B-15. Tidal Wetland Unsubsided Conceptual Section**

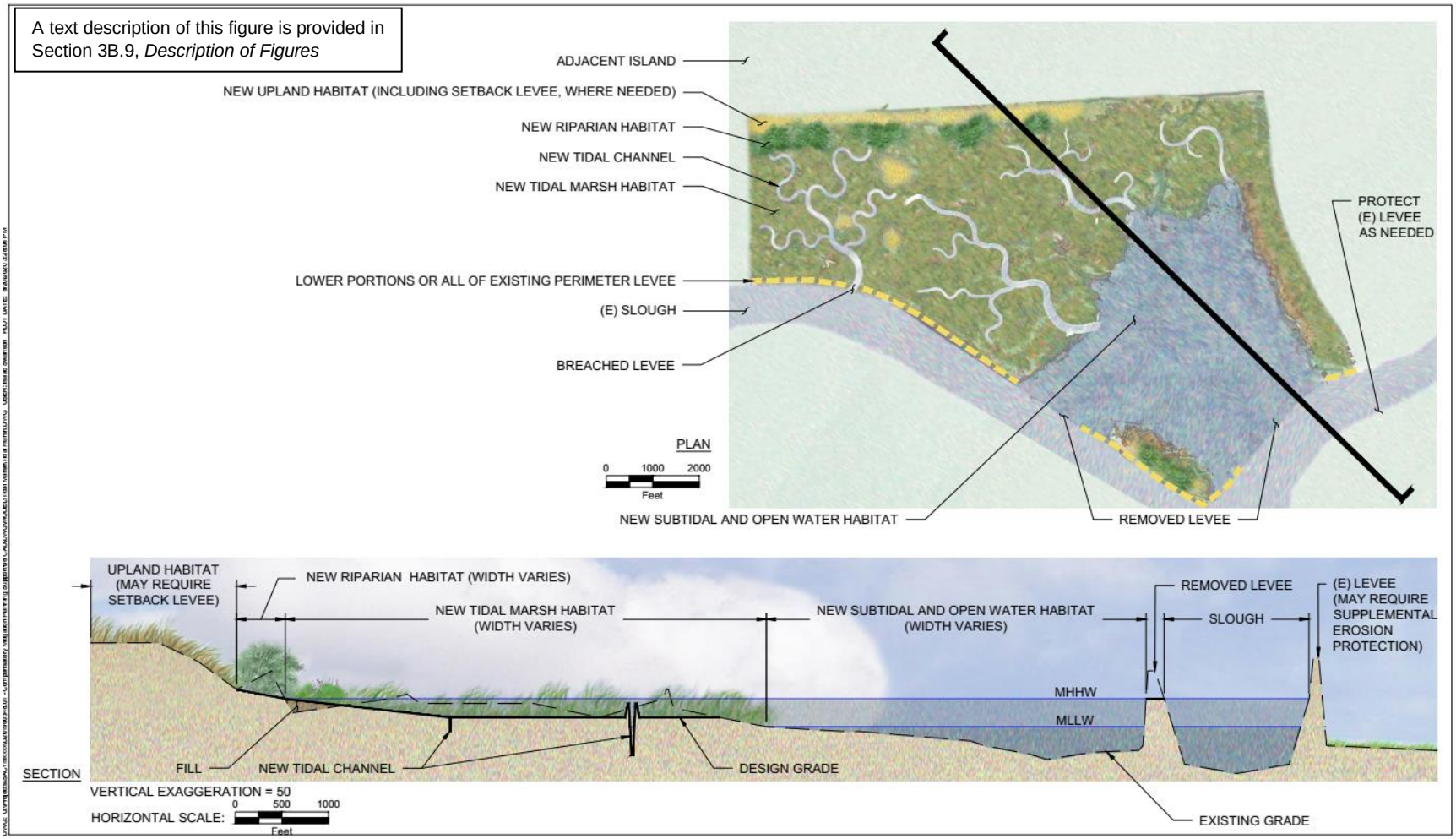



**Figure 3B-16. Tidal Wetland Subsided Conceptual Section**

### Water Quality Management

Compensatory mitigation could affect water quality in the Delta, namely levels bioaccumulation of methylmercury and, selenium, levels of dissolved organic carbon, and harmful algal blooms of cyanobacteria (CHABs) such as *Microcystis* (Appendix 6B, *Water Quality*). The creation of tidal wetland habitats, which would be hydrodynamically connected to Delta channels, could create conditions conducive to methylation of mercury, promote uptake and bioaccumulation of methylmercury and selenium in fish and aquatic-dependent birds within and adjacent to new tidal habitats, and create areas where water residence time and water temperatures could be sufficiently high to support CHABs where such blooms do not currently exist. Tidal wetland habitats would be sited in the Cache Slough region, where water quality conditions are generally not conducive for *Microcystis*.

To mitigate for these potential effects, tidal habitat siting, design, and maintenance would be guided by the design criteria stated above. DWR will implement site-specific monitoring and management plans (Section 3B.7 and AMM-23: Develop and Implement a Mercury Management and Monitoring Plan) to minimize generation of methylmercury resulting from CMP activities that could potentially promote mobilization of methylmercury into the food chain within new tidal habitats. DWR will develop a Mercury Management and Monitoring Plan (MMMP) to guide tidal habitat siting, design, monitoring, and adaptive management. The MMMP will require evaluation of site-specific conditions and include implementation design elements that minimize conditions that would be conducive to the creation or increased availability of methylmercury in tidal habitats while still achieving most or all of the restoration benefits desired. The MMMP will also require preparation of site-specific mercury management plans that will address MMMP elements for sites selected for new tidal habit, as appropriate, based on site-specific conditions.

# 3B.5 Assurances

## 3B.5.1 Financial Assurances

DWR commits to providing the funding for the initial establishment and long-term management of the mitigation sites to ensure that the mitigation sites continue to meet the established goals of the CMP and any subsequent management plans. This includes the initial 5-year establishment period for the mitigation sites and all activities associated with ongoing maintenance and long-term management. Prior to the initiation of project construction activities, DWR would acquire the necessary permits and approvals that would specify the mechanisms for financial assurances.

Payment of the costs of constructing and operating the mitigation sites is assured by DWR's long-term water supply contracts and applicable state law. DWR is a party to a long-term water supply contract with each of the SWP water contractors. These contracts are the foundation of the SWP's fiscal strength. DWR has not experienced payment delinquencies or defaults by the contractors that have had a materially adverse effect on the operation or maintenance of the SWP, or the ability of DWR to pay its obligations when due.

Construction and operation (i.e., associated management costs) of the proposed mitigation sites for the project are expected to be paid by DWR and charged to participating SWP water contractors. DWR would issue revenue bonds to fund construction costs. As part of the Delta Conveyance Project,

the long-term water supply would be amended to provide for the payment of construction and operation and maintenance costs, including all mitigation and monitoring costs incurred during and after construction.

All lands protected and restored for compensation of impacts from construction and operation of the project on aquatic resources and special-status species, as appropriate and consistent with the specific mitigation, would be protected and managed in perpetuity and with appropriate conservation easements. DWR, as project applicant, would ensure appropriate long-term funding for the compensatory mitigation and designation of the party or entity that will be responsible for long-term management of the mitigation sites.

### 3B.5.2 Site Protection Instrument

The mitigation sites on Bouldin Island and I-5 ponds would be owned and managed by the state or its designee. Long-term management plans would be developed as a part of each individual site. Conservation easements would be used to ensure long-term legal protection of these mitigation sites, with the conservation easements anticipated to be held by CDFW. Other methods of long-term legal protection could be used at other sites through deed restrictions, transfer of title, etc.

## 3B.6 Maintenance and Management

### 3B.6.1 Approach

This CMP provides the broad framework for the maintenance and management of mitigation sites. It is anticipated that more detailed, site-specific interim and long-term management plans will be prepared for each mitigation site as designs progress and (in the case of tidal and channel margin sites) additional mitigation sites are selected.

### 3B.6.2 Establishment Period Maintenance and Management

DWR would prepare an interim management plan for the establishment period for each site (generally the first 5 years following construction). This plan would address site establishment issues such as weed control and irrigation.

Weed control and vegetation maintenance would occur in all restoration areas for 5 years following restoration, as appropriate, based on performance standards described below. Approved herbicides, mowing, or grazing may be used to manage weeds, as appropriate.

Irrigation systems at mitigation sites would be maintained in working order for at least 1 year or until vegetation becomes established. Once the installed plants are established and irrigation is no longer needed, all temporary irrigation materials will be removed from the mitigation site.

### 3B.6.3 Long-Term Maintenance and Management

#### 3B.6.3.1 General Approaches

DWR would prepare and implement a long-term management plan for each mitigation site at Bouldin Island and the I-5 Ponds. These plans will address long-term maintenance needs at each

site, including vegetation management, weed control, trash management, and facilities maintenance, as well as identify the qualified staff and/or third-party entities responsible for overseeing the maintenance and management. The plans would be working documents that are updated and revised as needed to incorporate new acquisitions suitable for coverage under the same management plan and to document changes in management approach that have been agreed to by all parties, consistent with their authority.

Basic elements of long-term site maintenance may include the following.

- General site maintenance
  - Site visits
  - Checks for trespassing
  - Removal of trash
  - Maintenance and replacement of signs, fences, and gates
- Vegetation management
  - Mapping of nonnative invasive plant species
  - Control of nonnative invasive plant species
  - Mowing
  - Controlled burns
  - Grazing
  - Disking
- Levee and channel maintenance
  - Levee inspection
  - Dredging of sediment
  - Monitoring of erosion
  - Road gravel replenishment
  - Grading
  - Rodent abatement and damage repair

Annual reports would be prepared for each mitigation project site. The annual reports would include a summary of work completed to date, milestones, current status, constraints, and relative accrued benefits of the project. The report would specify remedial actions or management responses, as described in Section 3B.6.4.

### 3B.6.3.2 GGS Management at I-5 Pond Sites

In addition to the general maintenance activities described above, the I-5 pond sites would be subject to management activities designed to achieve sustainability for giant garter snake habitat. Long-term management would require access to the sites to perform ongoing vegetation and water management. Sites may need to accommodate access of large equipment and/or boats into marsh areas to chop and disc vegetation, excavate sediment, and to repair berms and water control structures. Ongoing water management and the ability to selectively isolate, de-water, and re-water separate management units are essential to maintain giant garter snake habitat at the I-5 pond sites.

Giant garter snake mitigation areas usually discourage the establishment of large stands of woody vegetation to minimize shading as well as potential predation of giant garter snake by birds of prey. Grazing, mowing, controlled burns, and/or discing can be used to minimize the growth of woody vegetation and to reduce fire risk in uplands. Grazing would require installing an exclusion fence, gates, and watering troughs to keep grazing animals out of sensitive wetland habitat and open water areas. Other fencing to dissuade trespassing may also be incorporated.

### 3B.6.4 Adaptive Management

Adaptive management is a science-based, flexible approach to resource management decision-making. The Delta Reform Act of 2009 identified adaptive management as the desired approach to reduce the ecological uncertainty associated with the management of the Delta system. An adaptive management and monitoring plan would be prepared for each mitigation site to help ensure habitat creation goals are met, consistent with the Delta Plan's adaptive framework (Delta Stewardship Council 2013:Appendix 1B).

The Adaptive Management Program for the project would outline key uncertainties for tidal wetlands, channel margin, riparian, and floodplain restoration projects intended to benefit listed terrestrial and fish species. Effectiveness monitoring and research studies would be necessary to examine the ecological function of planned restoration.

For each of the mitigation project sites, a monitoring and adaptive management plan would be prepared, as described in Section 3B.7.2, *Monitoring*). These site-specific plans would track progress toward performance standards, to improve understanding of restoration effectiveness, and to trigger remedial actions as needed to adjust management to achieve mitigation goals.

## 3B.7 Performance Standards and Monitoring

### 3B.7.1 Performance Standards

As part of the development of the site-specific maintenance and management plans, performance standards would be established for each mitigation site to provide the basis for annual monitoring parameters and help determine the need for possible remedial actions after project implementation. Development of performance standards assumes an adaptive management approach. Failure to reach one or more of the performance standards does not necessarily imply failure of the mitigation project. Rather, all monitoring results obtained during annual monitoring would be evaluated and provide the basis for discussion with the resource agencies.

Performance standards would be provided for each habitat type described herein, consistent with current USACE uniform performance standards for compensatory mitigation monitoring (33 CFR Part 332). Monitoring categories and examples of potential metrics include the following.

- **Hydrologic**—Wetland hydrology, soil saturation, inundation, hydric soils
- **Vegetation**—Survivorship of installed or transplanted plants (e.g., elderberry shrub transplants), dominance of native vegetation representative of the target natural community, percent cover of invasive nonnative vegetation, species richness, recruitment of native plants
- **Physical**—Topography, channel geomorphology, bank stability

Performance standards are not included for special-status species directly since the objective of the project mitigation is to establish compensatory suitable habitat rather than to ensure occupancy. Therefore, the successful establishment of aquatic, wetland, and upland habitats based on the floristic, physical, and hydrologic components of the habitats would be used to evaluate the success of special-status species habitat compensatory mitigation. Species-specific habitat requirements, as outlined in the design parameters (Attachment 3B.1), would also be considered as performance criteria. Examples could include the following.

- **Giant garter snake**—Amount and configuration of open water, emergent vegetation, and upland refugia.
- **Fisheries**—Amount of shaded riverine aquatic habitat, water quality (temperature, dissolved oxygen, turbidity).

Monitoring would also examine threats to habitat quality and wildlife health that could occur at mitigation sites. Examples of metrics could include the following.

- **Water quality**—concentrations of CHABs (which produce cyanotoxins) and methylmercury.
- **Invasive species**—percent cover of native or non-native invasive plant species or presence of invasive wildlife species.

See Attachment 3B.1 for more criteria for design and performance for mitigation sites.

## 3B.7.2 Monitoring

A monitoring and adaptive management plan would be prepared to guide post-construction monitoring and management during a 3- to 5-year establishment period. Compliance monitoring would be conducted to document in a GIS database the extent of natural communities and species habitats restored by measuring constructed outputs (e.g., acres restored, as-built topography and elevations, hydrology). Regulatory permits may also require specific monitoring actions. Effectiveness monitoring would be conducted to evaluate progress toward objectives and performance standards by measuring indicators of ecological status and function ("metrics") (Section 3B.7.1, *Performance Standards*). Examples of key metrics would be the establishment of native and invasive nonnative plants in restored natural communities and survivorship of transplanted plants (e.g., elderberry shrub). Species-specific habitat features, such as upland refugia, or the production of toxins, such as methylmercury or cyanotoxins would be considered as well.

The initial monitoring period would last 5 years and would evaluate establishment success of aquatic resources and special-status species habitats at the mitigation sites. The year 5 performance standards in most cases would match those identified by USACE in the Uniform Performance Standards for Compensatory Mitigation Monitoring (33 CFR Part 332). Performance standards for flora in years 1 through 4 are related to year 5 standards by assuming that each year following installation habitats should demonstrate an increase in cover of native hydrophytes, number of native recruits, species richness, and a decrease in percent cover of invasive nonnative species. Monitoring would be conducted annually.

Long-term monitoring would focus on conformance with the long-term management plan. The long-term management plan would identify remedial actions in the event that monitoring indicates performance standards may not be on track for success beyond the establishment period. Examples of remedial actions could include, but are not limited to, additional plantings, topographic

recontouring, weed control, erosion control, and further monitoring to diagnose the source of the problem. Long-term monitoring of the sites would occur every 5 years.

Tidal wetlands monitoring would be performed at the scale of the individual restoration site using consistent sampling techniques developed by the Tidal Wetland Monitoring Project Work Team of the Interagency Ecological Program (Interagency Ecological Program Tidal Wetlands Monitoring Project Work Team 2017).

Potential subsurface seepage of nuisance water would be monitored by implementing seepage monitoring studies. The studies would measure the level of shallow groundwater in the adjacent soils to evaluate the baseline conditions and continue to measure the level of groundwater for seepage. If seepage of nuisance water is detected through monitoring efforts, a seepage monitoring plan would be implemented which would include seepage control measures such as installing subsurface agricultural drainage systems to avoid raising water levels into crop root zones.

The scale and sampling frequency of monitoring (season and number of years) would dictate the source and extent of funding for postconstruction monitoring. The monitoring frequency of various metrics would likely be adjusted each year to account for changing environmental conditions (e.g., floods, drought) and current status of performance standards.

### 3B.7.3 Reporting

For the establishment period, an annual report would be prepared that includes a summary of management tasks conducted, general site conditions, and monitoring results, including status of resources and progress toward performance standards. The annual report would include description of any management problems and recommendations regarding remedial actions to resolve or reduce (e.g., weed control, security, vegetation removal, erosion control, methylmercury or CHAB production).

In the long term, it is anticipated that monitoring and reporting may be downscaled to once every 5 years based on results and recommendations to ensure that the project continues to perform as expected.

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## 3B.8.2 Personal Communications

Lee, Peggy. Ecological Solutions Manager. Resource Environmental Solutions. Sacramento, CA. April 19, 2022—email to Melissa Denena, Environmental Science Associates.

Moss, Skip. Chief Strategic Officer. Natural Resources Group. West Sacramento, CA. April 19, 2022—email to Melissa Denena, Environmental Science Associates.

# 3B.9 Description of Figures

| Figure Number | Figure Title | Description of Figure |
|---|---|---|
| 3B-1 | Mitigation Site Locations | This figure shows the locations of proposed mitigation sites for several aquatic resources. |
| 3B-2 | Watershed Boundaries | This figure shows the hydrologic unit codes 8 and 10 watersheds that the project occurs within along with the location of mitigation sites in relation to project components. |
| 3B-3 | Emergent and Forested Wetland Habitat on Bouldin Island | This figure shows a photograph of the emergent and forested wetland habitat on Boudin Island. |
| 3B-4 | Emergent, Scrub-Shrub, and Seasonal Wetland Habitat on Bouldin Island | This figure shows a photograph of the emergent, scrub shrub, and season wetland habitat on Bouldin Island. |
| 3B-5 | Bouldin Island Existing Conditions | This figure shows the existing land cover types at Bouldin Island. |
| 3B-6 | Bouldin Island Conceptual Design | This figure shows the conceptual plans, including land cover, at mitigation sites |
| 3B-7 | Bouldin Island Conceptual Section | This figure shows a cross-section of a mitigation site. |
| 3B-8 | DWR I-5 Ponds, Pond 6 Existing Land Cover | This figure shows the existing land cover at Pond 6. |
| 3B-9 | DWR I-5 Ponds, Ponds 7 and 8 Existing Land Cover | This figure shows the existing land cover at Pond 7 and 8. |
| 3B-10 | DWR I-5 Ponds, Pond 6 Conceptual Design | This figure shows the conceptual restoration plans for Pond 6. |
| 3B-11 | DWR I-5 Ponds, Ponds 7 and 8 Conceptual Design | This figure shows the conceptual restoration plan for Pond 7 and 8. |
| 3B-12 | DWR 1-5 Ponds, Pond 7 Conceptual Section | This figure shows a schematic cross-section of the Pond 7 conceptual plan. |
| 3B-13 | Channel Margin No Setback Levee | This figure provides a conceptual design for channel margin habitat creation with no setback levee. |
| 3B-14 | Channel Margin Setback Levee | This figure shows a design for sites needing a setback levee. |
| 3B-15 | Tidal Wetland Unsubsided Conceptual Section | This figure shows a conceptual design for tidal wetland creation at unsubsided sites. |
| 3B-16 | Tidal Wetland Subsided Conceptual Section | This figure shows a conceptual design for tidal wetland creation at subsided sites. |

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Attachment 3B.1

# Compensatory Mitigation Design Parameters

## 3B.1.1 Design Commitments and Guidelines

This attachment provides design commitments and guidelines for the compensatory mitigation of special-status species analyzed in the BA (Chapter 5, *Effects Analysis for Chinook Salmon, Central Valley Steelhead, Green Sturgeon, and Killer Whale*, and Chapter 6, *Effects Analysis for Delta Smelt, Longfin Smelt, and Terrestrial Species*). As descried in Section 3B.S.1, *Compensatory Mitigation Plan Permitting Supplement*, this appendix and attachment were developed originally for the 2022 *Delta Conveyance Project Draft Environmental Impact Report*[1] (EIR) and, as such, includes design commitments and guidelines for natural communities and species that are outside the purview of this Biological Assessment. Avoidance and minimization measures that would apply during construction of the project (including but not limited to construction of the compensatory mitigation sites themselves) are contained in the Appendix 3A, *General Avoidance and Minimization Measures*.

**Table 3B.1-1. Summary List of Compensatory Mitigation Design Commitments and Guidelines**

| Number | Biological Resource |
|---|---|
| CMP-0 | General Design Guidelines |
| CMP-1 | Tidal Perennial Aquatic Habitat |
| CMP-2 | Tidal Freshwater Emergent Wetlands |
| CMP-3 | Valley/Foothill Riparian Habitat |
| CMP-4 | Nontidal Perennial Aquatic Habitat |
| CMP-5 | Nontidal Freshwater Perennial Emergent Wetland |
| CMP-6 | Nontidal Brackish Emergent Wetland |
| CMP-7 | Alkaline Seasonal Wetland Complex |
| CMP-8 | Vernal Pool Complex |
| CMP-9 | Special-Status Plants |
| CMP-11 | Vernal Pool Aquatic Invertebrate Habitat |
| CMP-12 | Valley Elderberry Longhorn Beetle Habitat |
| CMP-13 | California Tiger Salamander Habitat |
| CMP-14 | California Red-Legged Frog Habitat |
| CMP-15 | Giant Garter Snake Habitat |
| CMP-16 | Western Yellow-Billed Cuckoo Habitat |
| CMP-21 | Least Bell's Vireo |
| CMP-23 | Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources |
| CMP-24 | Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources |

[1] California Department of Water Resources (DWR) published and certified the Final EIR in December 2023 (California Department of Water Resources 2023b)

| Number | Biological Resource |
|---|---|
| CMP-25 | Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles |
| CMP-26 | Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles |
| CMP-27 | Tidal Perennial Habitat Restoration for Operations Impacts on Delta Smelt |
| CMP-28 | Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt |
| CMP-30 | Northwestern Pond Turtle |
| CMP-31 | Western Spadefoot Habitat |

**Table 3B.1-2. Design Commitments and Guidelines for Compensatory Mitigation of Natural Communities, Wetlands and Other Waters**

| Number | Habitat | Detailed Description of Measure or Design Guideline |
|---|---|---|
| CMP-0 | General Design Guidelines | These design guidelines will address critical life functions for special status species. It will also include a framework to ensure that any habitat loss or conversion associated with compensatory mitigation site development are offset so that there is no net loss in habitat quantity value for special-status species. Any compensatory mitigation to offset habitat losses (associated with the implementation of compensatory mitigation projects) would be constructed prior to or concurrent with the impact. |
| CMP-1 | Tidal Perennial Aquatic Habitat | Tidal perennial aquatic habitat will be created or acquired and permanently protected to compensate for project impacts to ensure no significant loss of tidal perennial aquatic habitat functions and values. A restoration and monitoring plan will be developed and implemented concurrently with project construction. The plan will describe how tidal perennial aquatic habitat will be created and monitored, including funding mechanisms and appropriate long-term management measures, and agency reporting requirements. See Section 3B.4,3, *Tidal Habitat Mitigation Framework*, Section 3B.5, *Assurances*, Section 3B.6, *Maintenance and Management*, and Section 3B.7, *Performance Standards and Monitoring*, for additional details. |
| CMP-2 | Tidal Freshwater Emergent Wetland | Tidal freshwater emergent wetland will be created or acquired and permanently protected to compensate for project impacts to ensure no significant loss of tidal freshwater emergent wetland functions and values. A restoration and monitoring plan will be developed and implemented concurrently with project construction. The plan will describe how tidal freshwater emergent wetland will be created and monitored, including funding mechanisms and appropriate long-term management measures, and agency reporting requirements. |
| CMP-3 | Valley/Foothill Riparian Habitat | Valley/foothill riparian habitat will be created or restored and permanently protected to compensate for project impacts to ensure no significant loss of valley/foothill riparian habitat functions and values. In addition, valley/foothill riparian habitat will be acquired and permanently protected to further compensate for project impacts. A restoration and monitoring plan will be developed and implemented concurrently with project construction. The plan will describe how valley/foothill riparian habitat will be created and monitored, |

| Number | Habitat | Detailed Description of Measure or Design Guideline |
|---|---|---|
| | | including funding mechanisms and appropriate long-term management measures, and agency reporting requirements. |
| CMP-4 | Nontidal Perennial Aquatic Habitat | Nontidal perennial aquatic habitat will be created or acquired and permanently protected to compensate for project impacts to ensure no significant loss of nontidal perennial aquatic habitat functions and values. A restoration and monitoring plan will be developed and implemented concurrently with project construction. The plan will describe how nontidal perennial aquatic habitat will be created and monitored, including funding mechanisms and appropriate long-term management measures, and agency reporting requirements. |
| CMP-5 | Nontidal Freshwater Perennial Emergent Wetland | Nontidal freshwater perennial emergent wetland will be created or acquired and permanently protected to compensate for project impacts to ensure no significant loss of nontidal freshwater perennial emergent wetland functions and values. In addition, nontidal freshwater perennial emergent wetland will be acquired and permanently protected to further compensate for project impacts. A restoration and monitoring plan will be developed and implemented concurrently with project construction. The plan will describe how nontidal freshwater perennial aquatic habitat will be created and monitored, including funding mechanisms and appropriate long-term management measures, and agency reporting requirements. |
| CMP-6 | Nontidal Brackish Emergent Wetland | Nontidal brackish emergent wetland will be created or acquired and permanently protected to compensate for project impacts to ensure no significant loss of nontidal brackish emergent wetland functions and values. In addition, nontidal brackish emergent wetland will be acquired and permanently protected to further compensate for project impacts. A restoration and monitoring plan will be developed and implemented concurrently with project construction. The plan will describe how nontidal brackish emergent wetland will be created and monitored, including funding mechanisms and appropriate long-term management measures, and agency reporting requirements. |
| CMP-7 | Alkaline Seasonal Wetland Complex | Alkaline seasonal wetland complex will be created or acquired and permanently protected to compensate for project impacts to ensure no significant loss of alkaline seasonal wetland complex functions and values. In addition, alkaline seasonal wetland complex will be acquired and permanently protected to further compensate for project impacts. A restoration and monitoring plan will be developed and implemented concurrently with project construction. The plan will describe how alkaline vernal pool habitat will be created and monitored, including funding mechanisms and appropriate long-term management measures, and agency reporting requirements. |
| CMP-8 | Vernal Pool Complex | Vernal pool complex will be created or acquired and permanently protected to compensate for project impacts to ensure no significant loss of vernal pool complex wetland functions and values. In addition, vernal pool complex will be acquired and permanently protected to further compensate for project impacts. A restoration and monitoring plan will be developed and implemented concurrently with project construction. The plan will describe how vernal pool complex will be created and monitored, including funding mechanisms and appropriate long-term management measures, and agency reporting requirements. |

**Table 3B.1-3. Design Commitments and Guidelines for Compensatory Mitigation to Compensate for Loss of Special-Status Species Habitat**

| Number | Species Habitat | Detailed Description of Measure or Habitat Design Guideline |
|---|---|---|
| CMP-9 | Special-Status Plants | Impacts on special-status plants and their habitat will be offset through restoration of suitable habitat. Suitable habitat is defined as habitat that currently supports the species for which mitigation is being implemented or meets habitat requirements for the species, as identified in the species models used in the impact analysis. Habitat requirements for the species include consideration of factors such as the natural community types associated with the species, soil map units associated with the species, and whether the species is or was known to occur at the proposed mitigation site. Suitable habitat also includes habitat that historically supported the species for which mitigation is being implemented so long as a good-faith effort is made to identify and address those factors that contributed to the species' absence. In addition to addressing those factors that likely resulted in local extirpation (e.g., ranching, mowing, disking, altered hydrology, presence of invasive species). Reestablishing a plant species into suitable, historically-supported habitat may include actions such as transplanting, propagation of seed, weed abatement, restoration of microtopography, and siting near existing occurrences. If propagation seed is used, it will be selected with consideration of maintenance of genetic diversity. Any propagation material would be sourced from the population affect by the project. Mitigation habitat will consist of existing, off-site suitable habitat acquired in-fee, through conservation easements, or from a certified conservation bank. At least 2 acres of habitat will be restored and protected for every 1 acre that would be lost. A restoration and monitoring plan will be developed and implemented concurrently with project construction. The plan will include success criteria, specify the length of the monitoring period, and contain assurances of implementation, monitoring and maintenance. Restored special-status plant habitat will be carried out concurrently with sensitive natural community mitigation and sited in areas near extant populations of the affected species that could provide vegetative or seed propagules. Restored habitat will be sited in locations subject to CDFW approval. The mitigation habitat shall be monitored annually to verify that the habitat suitability is maintained. Annual monitoring reports shall be submitted to CDFW for review and determination that the project remains in compliance with the mitigation. |
| CMP-11 | Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp Habitat | Compensatory mitigation for vernal pool fairy shrimp and vernal pool tadpole shrimp habitat directly or indirectly affected will consist of the preservation of habitat and the creation of habitat at either a USFWS-approved mitigation bank or at a non-bank site approved by USFWS supporting habitat for vernal pool fairy shrimp and vernal pool tadpole shrimp. Mitigation at a non-bank location will be prioritized in the Altamont Hills recovery area, which is one of the core recovery areas identified in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service 2005). |
| CMP-12 | Valley Elderberry Longhorn Beetle Habitat | Generally following the guidance in USFWS's 2017a *Framework for Assessing Impacts on Valley Elderberry Longhorn Beetle (Desmocerus californicus dimorphus)*, the permanent loss of suitable riparian habitat will be offset with riparian creation and enhancement consistent with the restoration guidance in the Framework. All temporarily affected areas will be restored on-site and where on-site restoration is not possible the habitat will be |

| Number | Species Habitat | Detailed Description of Measure or Habitat Design Guideline |
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| | | replaced. All elderberry shrubs that are one inch or greater in diameter at ground level in riparian habitat that will be affected will be transplanted to mitigation areas identified in the CMP. All elderberry shrubs in non-riparian areas that will be affected will be transplanted to mitigation areas identified in the CMP if they contain exit holes. All transplanted shrubs will be monitored and adaptively managed for survivorship as part of the site-specific maintenance and management plan and the monitoring and adaptive management plan as described in Sections 3B.7 and Section 3B.6.4, *Adaptive Management*, respectively. |
| CMP-13 | California Tiger Salamander Habitat | To the extent possible, California tiger salamander habitat protection will be located in a mitigation bank (with a service area that overlaps with the impact area) or other site protection instrument in the geographically appropriate management unit of the Central Valley Recovery Unit, which is identified in USFWS's 2017b *Recovery Plan for the Central California Distinct Population Segment of the California Tiger Salamander (Ambystoma californiense)*. If a mitigation bank is not used, land acquisition for California tiger salamander will be prioritized based on the following characteristics.<br>• Large contiguous landscapes that consist of grasslands, vernal pool complex, and alkali seasonal wetland complex and encompass the range of vegetation, hydrologic, and soil conditions that characterize these communities.<br>• Lands that maintain connectivity with protected grassland, vernal pool complex, and alkali seasonal wetland complex landscapes near proposed construction sites, including connectivity with lands that have been protected or may be protected in the future under the East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan.<br>• Grasslands containing stock ponds and other aquatic features that provide aquatic breeding habitat for California tiger salamander.<br>• Adjacent or connected to occupied California tiger salamander upland or aquatic habitat. |
| CMP-14 | California Red-Legged Frog Habitat | To mitigate for the loss of California red-legged frog aquatic and upland habitat, DWR will protect suitable habitat. California red-legged frog aquatic breeding and upland habitat will be prioritized for protection within the East San Francisco Bay core recovery area as described in the *Recovery Plan for the California Red-Legged Frog (Rana aurora draytonii)* (U.S. Fish and Wildlife Service 2002), at a location subject to USFWS approval. All lands protected and restored for compensation of effects on California red-legged frog habitat will be protected and managed in perpetuity. Land acquisition for California red-legged frog habitat management lands will be prioritized based on the following characteristics.<br>• Lands that connect with existing protected grassland, vernal pool complex, and alkali seasonal wetland complex landscapes, including those in the East San Francisco Bay core recovery area for California red-legged frog. |
| CMP-15 | Giant Garter Snake Habitat | Where identified and delineated giant garter snake habitat cannot be avoided, compensation for the loss of the habitat will occur for aquatic and upland habitat, with in-kind habitat type compensation. The following measures will be considered when selecting mitigation sites.<br>• Giant garter snake upland mitigation will be placed and protected adjacent to aquatic habitat protected for giant garter snake. The upland habitat will not exceed 200 feet from protected aquatic habitat (unless |

| Number | Species Habitat | Detailed Description of Measure or Habitat Design Guideline |
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| | | research shows a larger distance is appropriate and USFWS and CDFW agree).<br>• Incidental injury or mortality of giant garter snakes within protected and restored habitat will be avoided and minimized by establishing 200-foot buffers between protected giant garter snake habitat and roads (other than those roads primarily used to support adjacent cultivated lands and levees).<br>• Protected and restored giant garter snake habitat will be at least 2,500 feet from urban areas or areas zoned for urban development.<br>• Characteristics of restored and protected habitat may change from the above descriptors if new information and best available science indicate greater benefits as agreed upon by USFWS and CDFW.<br>Siting and design requirements for the restoration and protection of giant garter snake nontidal wetland habitat are listed below.<br>• For in-kind mitigation sites, the aquatic and upland habitat quality, character, and location must be of equal or greater value than the habitat quality that was lost.<br>• Conservation mitigation sites will be characterized as nontidal marsh and will meet the following design criteria.<br>  ○ Restored nontidal marsh will be characterized by sufficient water during the giant garter snake's active summer season (May 1–October 1) to supply constant, reliable cover and sources of food such as small fish and amphibians.<br>  ○ Restored nontidal marsh will consist of still or slow-flowing water over a substrate composed of soil, silt, or mud characteristic of those observed in marshes, sloughs, or irrigation canals.<br>  ○ Restoration designs will not create large areas of deep, perennial open water that will support nonnative predatory fish. The restored marsh will be characterized by a heterogeneous topography providing a range of depths and vegetation profiles consisting of emergent, herbaceous aquatic vegetation that will provide suitable foraging habitat and refuge from predators.<br>  ○ Aquatic margins or shorelines will transition to uplands consisting of grassy banks, with the dense grassy understory required for sheltering. These margins will consist of approximately 200 feet of high ground or upland habitat above the annual high-water mark to provide cover and refugia from floodwaters during the dormant winter season.<br>  ○ The upland habitat will have ample exposure to sunlight to facilitate giant garter snake thermoregulation and will be characterized by low vegetation, bankside burrows, holes, and crevices providing critical shelter for snakes throughout the day. All giant garter snake upland and aquatic habitat will be established at least 2,500 feet from urban areas or areas zoned for urban development.<br>  ○ The loss of tidal aquatic habitat for giant garter snake may be mitigated through restoration of tidal habitat with a design that provides equal or greater habitat value for the species as agreed upon by USFWS and CDFW.<br>  ○ Topography of the restored wetlands will be designed to provide adjacent terrestrial refuge persisting above the highwater mark. |

| Number | Species Habitat | Detailed Description of Measure or Habitat Design Guideline |
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| | | Terrestrial features will be sited within 200 feet of aquatic foraging areas at all tide levels, with slopes and grading designed to avoid exposing largely denuded intertidal mud flats during low tide. |
| CMP-16 | Western Yellow-Billed Cuckoo Habitat | DWR will offset the loss of western yellow-billed cuckoo habitat through the creation or restoration of riparian habitat in the study area. DWR will develop a riparian restoration plan that will identify the location and methods for riparian creation or restoration, and this plan will be subject to USFWS approval. |
| CMP-21 | Least Bell's Vireo | DWR will offset the loss of least Bell's vireo habitat through the creation or restoration of riparian habitat in the study area. DWR will develop a riparian restoration plan that will identify the location and methods for riparian creation or restoration, and this plan will be subject to USFWS approval. |
| CMP-23 | Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources | Tidal perennial habitat (e.g., including consideration of shallow water habitat components consistent with agency/regulatory requirements) would be restored to mitigate for construction impacts for both temporary and permanent impacts.<br>Tidal perennial habitat restoration site selection and design will occur in coordination with CDFW, USFWS and NMFS. Restoration will primarily occur through breaching or setback of levees, thereby restoring tidal fluctuation to land parcels currently isolated behind those levees. Factors to be considered when evaluating sites for potential location and design of tidal perennial habitat restoration include provision of suitable habitat features such as those suggested by San Francisco Estuary Institute (2020) and Sommer and Mejia (2013)[2].<br>Where practicable and appropriate, portions of restoration sites will be raised to elevations that will support tidal marsh vegetation following levee breaching. Depending on the degree of subsidence and location, lands may be elevated by grading higher elevations to fill subsided areas, importing clean dredged or fill material from other locations, or planting tules or other appropriate vegetation to raise elevations in shallowly subsided areas over time through organic material accumulation. Surface grading will create a shallow elevation gradient from the marsh plain to the upland transition habitat if not already present on a restoration site. Based on assessments of local hydrodynamic conditions, sediment transport, and topography, restoration activities may be designed and implemented in a manner that accelerates the development of tidal channels within restored marsh plains. Following reintroduction of tidal exchange, tidal marsh vegetation is expected to establish and maintain itself naturally at suitable elevations relative to the tidal range. Depending on site-specific conditions and monitoring results, patches of native emergent vegetation may be planted to accelerate the establishment of native marsh vegetation on restored marsh plain surfaces.<br>Siting, design, and performance criteria for tidal perennial habitat restoration will be developed based on assessments of topography, local hydrodynamic conditions, and sediment transport. As necessary and reflecting permitting requirements, a collaborative technical team including DWR and fishery agency representatives will be formed to select the most |

[2] Examples of habitat features for consideration include shallow water for juvenile Chinook salmon (San Francisco Estuary Institute 2020:14) and low salinity and high turbidity for delta smelt (Sommer and Mejia 2013:17).

| Number | Species Habitat | Detailed Description of Measure or Habitat Design Guideline |
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| | | biologically appropriate and cost-effective restoration sites, design the restoration plan, set performance criteria, and develop the restoration unit management plan for the sites.<br>Construction may involve the following activities.<br>• Prior to breaching, recontouring the surface to maximize the extent of surface elevation suitable for establishment of tidal marsh vegetation by scalping higher elevation land to provide fill for placement on subsided lands to raise surface elevations.<br>• Prior to breaching, importing dredge or fill material and placing it in shallowly subsided areas to raise ground surface elevations to a level suitable for establishment of tidal marsh vegetation.<br>• Excavating channels to encourage the development of sinuous, high-density dendritic channel networks within restored marsh plain.<br>• Revegetation through active planting and/or passive establishment of native marsh vegetation.<br>• Modifying ditches, cuts, and levees to encourage more natural tidal circulation and better flood conveyance based on local hydrology.<br>• Removal or breaching of existing levees or embankments or creation of new structures to allow restoration to take place while protecting adjacent land.<br>• Constructing dikes, relocating water diversion infrastructure, or other activities as necessary to maintain agricultural activity in lands adjacent to tidal habitat restoration. |
| CMP-24 | Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources | Channel margin habitat would be restored to mitigate construction impacts for both temporary and permanent impacts. Channel margin restoration will be accomplished by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids in particular, similar to what is currently done by the USACE and others when implementing levee improvements. Channel margin restoration associated with federal project levees will not be implemented on the levee, but rather on benches to the waterward side of such levees, and flood conveyance will be maintained as designed. Channel margin enhancements associated with federal project levees may require permission from USACE in accordance with USACE's authority under the Rivers and Harbors Act (33 USC § 408) and USACE levee vegetation policy. Sites for channel margin restoration will be subject to approval by NMFS and CDFW. Any restoration will be designed, constructed, and maintained to ensure no reduction in performance of the federal flood project.<br>As necessary and reflecting permitting requirements, a collaborative technical team including DWR and fishery agency representatives will be formed to identify the most biologically appropriate and cost-effective restoration sites, design the restoration plan, set performance criteria, and develop the restoration unit management plan for the sites for DWR's selection.<br>Types of channel margin enhancement actions may include the following:<br>• Remove riprap from channel margins. |

| Number | Species Habitat | Detailed Description of Measure or Habitat Design Guideline |
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| | | • Modify the channel margin side of levees or setback levees to create low floodplain benches with variable surface elevations that create hydrodynamic complexity and support emergent vegetation.<br>• Install large woody material (e.g., tree trunks and stumps) into constructed low benches or into existing riprapped levees to provide physical complexity.<br>• Plant riparian and emergent wetland vegetation on created benches. |
| CMP-25 | Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | DWR will undertake tidal habitat restoration in the north Delta to mitigate for potential hydrodynamics-related effects such as a greater frequency of Sacramento River reverse flows below Georgiana Slough compared to existing conditions, as reflected in the results of the hydrodynamic analyses and through-Delta juvenile Chinook salmon survival modeling. The extent of this tidal habitat restoration will be determined in consideration of the following factors.<br>1) The extent to which required or planned restoration under other projects or programs (e.g., as summarized by CDFW [2020:127] for restoration related to SWP/CVP operations and by DWR [2023a] for restoration under the EcoRestore program and required restoration mitigation for other impacts of the alternatives minimizes hydrodynamic differences between existing conditions and the project alternatives to standards established during ESA/CESA permitting.<br>2) The efficacy of the required Georgiana Slough Salmonid Migratory Barrier under the SWP ITP (California Department of Fish and Wildlife 2020:94–95);<br>3) Sea level rise and associated changes in north Delta hydrodynamics projected to occur at the commencement of operation of the north Delta intakes.<br>Restoration opportunities for this measure will align with species recovery needs and be guided by information in the Sacramento Valley Salmon Resiliency Strategy (California Natural Resources Agency 2017).<br>The efficacy of tidal habitat restoration in affecting north Delta hydrodynamics has been demonstrated through modeling studies (Resource Management Associates 2020). This mitigation measure's effectiveness will be subject to long-term monitoring and assessed in coordination with USFWS and CDFW as part of the Adaptive Management Program. |
| CMP-26 | Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles | DWR will undertake channel margin habitat restoration to mitigate potential flow-related impacts on riparian and wetland bench habitat used by juvenile Chinook salmon for rearing. The extent of this mitigation was calculated by multiplying the largest negative deficits in bench inundation index between each alternative and existing conditions in each geographic group (Table 5.3-18) by the total length of benches in each geographic group, which gives a total length of deficit (Table 5.3-19) (Chapter 5, *Effects Analysis for Chinook Salmon, Central Valley Steelhead, Green Sturgeon, and Killer Whale* ).<br>This channel margin habitat restoration will be in addition to the channel margin habitat restoration included to mitigate construction impacts to channel margin habitat. The efficacy of channel margin habitat restoration has been demonstrated by studies in the Sacramento River documenting occurrence and abundance of juvenile Chinook salmon that is greater than at riprapped sites and similar to natural sites (Hellmair et al. 2018). |

| Number | Species Habitat | Detailed Description of Measure or Habitat Design Guideline |
|---|---|---|
| CMP-27 | Tidal Habitat Restoration for Operations Impacts on Delta Smelt | DWR will mitigate potential project-related impacts to delta smelt by restoring tidal habitat, concentrated within the north Delta Arc or other areas deemed appropriate through consultation with USFWS and CDFW. The main objective of this restoration would be to increase the extent of suitable delta smelt habitat (e.g., intertidal and subtidal habitat; California Department of Fish and Game 2011) with appropriate parameters (e.g., turbidity) providing habitat for occupancy (e.g., Sommer and Mejia 2013) or higher food availability in the vicinity (e.g., Hammock et al. 2019). This mitigation measure's effectiveness will be subject to long-term monitoring and assessed in coordination with USFWS and CDFW as part of the AMP. |
| CMP-28 | Tidal Habitat Restoration for Operations Impacts on Longfin Smelt | DWR will undertake tidal habitat restoration to mitigate potential flow-related impacts on longfin smelt. The extent of this mitigation was calculated using the method of Kratville (2010), as recently applied by DWR (2019:5-5).. With the concurrence of USFWS and CDFW, this habitat restoration mitigation requirement may be partly or fully met by tidal perennial or shallow water habitat restoration for construction effects. |
| CMP-30 | Northwestern Pond Turtle | DWR will offset the loss of northwestern pond turtle aquatic and upland habitat either through the creation or enhancement of suitable habitat at the initial mitigation sites. The habitat needs of the species include: (1) aquatic habitat such as ponds, lakes, and streams for breeding, feeding, overwintering, sheltering, and dispersal; (2) basking sites that allow for thermoregulation; and (3) upland habitat adjacent to aquatic habitat for nesting, overwintering and aestivation, and dispersal and connectivity between populations (88 FR 68373). Mitigation sites will include aquatic and upland habitat features that meet breeding, feeding, overwintering, thermoregulation, and dispersal needs of the species. DWR will create or enhance and protect suitable aquatic and upland habitat at a ratio of 1:1 for the lost suitable habitat. |
| CMP-31 | Western Spadefoot | Compensatory mitigation for loss of western spadefoot aquatic and upland habitat will consist of the preservation of habitat and the creation of habitat, through purchasing of mitigation credits, at either a USFWS-approved mitigation bank or at a non-bank site approved by USFWS supporting habitat for western spadefoot. The habitat needs of the species include: (1) aquatic breeding and rearing habitat such as vernal pools and other ephemeral wetland areas and (2) upland habitat with open grassland cover, scrub, or mixed woodland on flat or gently rolling topography for feeding, sheltering, and dispersal (88 FR 84255). Mitigation sites will include aquatic and upland habitat features that meet breeding, feeding, sheltering, and dispersal needs of the species. DWR will create or enhance and protect suitable aquatic and upland habitat at a ratio of 1:1 for the lost suitable habitat. |

CDFW = California Department of Fish and Wildlife; CMP = compensatory mitigation plan; DWR = California Department of Water Resources; EIR = Environmental Impact Report; NMFS = National Marine Fisheries Service; USACE = U.S. Army Corps of Engineers; USC = United States Code; USFWS = U.S. Fish and Wildlife Service.

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Appendix 3C

# North Delta Diversion Operations Adaptive Management and Monitoring Plan

# North Delta Diversion Operations Adaptive Management and Monitoring Plan

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# Contents

**Appendix 3C North Delta Diversion Operations Adaptive Management and Monitoring Plan ..... 3C-1**
3C.1 Introduction ..... 3C-1
3C.1.1 Background ..... 3C-1
3C.1.2 Purpose ..... 3C-1
3C.2 Scope of Adaptive Management ..... 3C-2
3C.2.1 Spatial Scope ..... 3C-2
3C.2.2 Relationship to Proposed Action Activities ..... 3C-3
3C.2.3 Relationship to Agency Programs ..... 3C-4
3C.2.4 Consistency with Consultation for the Long-Term-Operations of the State Water Project ..... 3C-8
3C.3 Adaptive Management Framework ..... 3C-8
3C.3.1 Planning Period ..... 3C-9
3C.3.2 Implementation Period ..... 3C-9
3C.3.3 Evaluate and Respond Period ..... 3C-9
3C.4 Proposed Action Effects and Biological Resources Objectives ..... 3C-10
3C.4.1 Relationship to Consultation Effects Analyses ..... 3C-10
3C.4.2 Proposed Action Effects ..... 3C-13
3C.4.3 Established Objectives ..... 3C-15
3C.5 Monitoring ..... 3C-16
3C.6 Performance Measures and Management Response ..... 3C-16
3C.6.1 Chinook Salmon and Steelhead Objectives ..... 3C-17
3C.6.2 Green Sturgeon Objectives ..... 3C-21
3C.6.3 Delta Smelt and Longfin Smelt Objectives ..... 3C-22
3C.7 Governance Framework and Decision-Making Process ..... 3C-25
3C.7.1 Governance Framework ..... 3C-25
3C-3C.7.2 Decision-Making Process ..... 3C-28
3C.8 References ..... 3C-28

# Acronyms and Other Abbreviations

This document contains capitalized acronyms of up to five characters in length.

| Acronym | Definition |
|---|---|
| Bay-Delta | San Francisco Bay/Sacramento–San Joaquin Delta |
| BA | biological assessment |
| BIOP | biological opinion |
| CAMT | Collaborative Adaptive Management Team |
| CDFW | California Department of Fish and Wildlife |
| CESA | California Endangered Species Act |
| cfs | cubic feet per second |
| CSAMP | Collaborative Science and Adaptive Management Program |
| CVP | Central Valley Project |
| Delta | Sacramento–San Joaquin Delta |
| DWR | California Department of Water Resources |
| ESA | federal Endangered Species Act |
| fps | feet per second |
| IEP | Interagency Ecological Program |
| IICG | Interagency Implementation Coordination Group |
| ITAG | Interagency Telemetry Advisory Group |
| ITP | incidental take permit |
| LTO | Long-Term Operations |
| mm | millimeter |
| NMFS | National Marine Fisheries Service |
| OAMMP | operations adaptive management and monitoring plan |
| proposed action | Delta Conveyance Project |
| Reclamation | U.S. Bureau of Reclamation |
| SaMT | Salmon Monitoring Team |
| SMT | Smelt Monitoring Team |
| State Water Board | State Water Resources Control Board |
| SWP | State Water Project |
| USFWS | U.S. Fish and Wildlife Service |
| WOMT | Water Operations Management Team |
| WYT | water year type |

Appendix 3C

# North Delta Diversion Operations Adaptive Management and Monitoring Plan

## 3C.1 Introduction

### 3C.1.1 Background

The State Water Project (SWP) water conveyance facilities in the Sacramento–San Joaquin Delta (Delta), including Clifton Court Forebay and the Harvey O. Banks Pumping Plant in the south Delta, enable the California Department of Water Resources (DWR) to divert water from the Delta into the California Aqueduct. The proposed Delta Conveyance Project (proposed action) would construct and operate new conveyance facilities in the Delta that would add to the existing SWP infrastructure. New intake facilities would be constructed in the north Delta along the Sacramento River between Freeport and the divergence with Sutter Slough. The new facilities would also include a tunnel and associated infrastructure that would convey water from the new intakes to existing SWP conveyance facilities in the south Delta. The new facilities would provide alternative locations for diverting water from the Delta and would be operated in coordination with the existing SWP south Delta pumping facilities. New facilities proposed for the proposed action may include, but are not limited to, the following:

- Intake facilities on the Sacramento River (referred to in this report as the north Delta diversion facilities, which include the north Delta intakes).
- A tunnel and tunnel shafts.
- South Delta Pumping Plant.
- Bethany Complex.

As part of the proposed action, the north Delta diversion facilities would convey water from the Sacramento River to the SWP facilities in the south Delta. DWR would operate the proposed north Delta diversion facilities and the existing south Delta facilities in compliance with state and federal regulatory requirements.

Because the proposed action proposes new water diversion facilities in the north Delta as part of the SWP and the exact environmental conditions when the project will commence initial operations are uncertain, some uncertainties exist regarding the proposed action's potential effects on fisheries resources. This Operations Adaptive Management and Monitoring Plan (OAMMP) has been developed as part of the proposed action to address these uncertainties and inform the operation and adaptive management of the future north Delta diversion facilities.

### 3C.1.2 Purpose

The purpose of this OAMMP is to describe the adaptive management process used to inform additional studies and modify select operations and design elements of the north Delta diversion facilities to minimize effects on listed fish species. Adaptive management allows the best available

science to be incorporated into management decisions and actions, and to address uncertainties associated with those actions, as well as system responses to processes like climate change. Specifically, adaptive management provides a means to evaluate the effectiveness of management actions in achieving biological resources objectives by comparing the outcomes to predicted responses and providing the scientific basis for continuing or modifying the action or implementing an alternative action. The remainder of this OAMMP is organized as follows:

- **Section 3C.2, Scope of Adaptive Management,** describes the focus of adaptive management, including species examined, the spatial scope, and the relationship of the adaptive management process to other proposed action activities and agency programs.
- **Section 3C.3, Adaptive Management Framework,** describes the high-level approach to adaptive management, including the three main adaptive management periods: Planning, Implementation, and Evaluate and Respond.
- **Section 3C.4, Proposed Action Effects and Biological Resources Objectives,** details the effects of proposed action mechanisms on listed fish species, using a series of conceptual models, and establishes associated biological resources objectives for adaptive management.
- **Section 3C.5, Monitoring,** provides a high-level description of the fisheries field monitoring conducted to assess progress toward the OAMMP objectives and improve understanding of proposed action uncertainties.
- **Section 3C.6, Performance Measures and Management Response,** describes the performance measures and associated thresholds that define successful progress toward achieving OAMMP objectives and details management responses that may be implemented if measures and thresholds are not met.
- **Section 3C.7, Governance Framework and Decision-Making Process,** details the framework for agency involvement in administering adaptive management and describes the annual decision-making process for implementing potential management responses.
- **Section 3C.8, References,** provides full reference information for the citations in this document.

# 3C.2 Scope of Adaptive Management

This OAMMP details the process for informing additional studies and for modifying select operations and design elements of the north Delta diversion facilities to help meet OAMMP objectives and better understand uncertainties concerning effects of the proposed action on listed fish species. Adaptive management focuses only on proposed action effects where uncertainties regarding the nature of the effects generally require a characterization of baseline conditions that can be compared to with-proposed action effects.

## 3C.2.1 Spatial Scope

For this effort, adaptive management focuses only on effects of the north Delta diversion facilities and does not include effects of the proposed action related to other SWP facilities. Therefore, the OAMMP only examines effects and associated performance measures associated with the north Delta, including near-field effects adjacent to the new intake facilities and far-field effects downstream in the Delta.

### 3C.2.2 Relationship to Proposed Action Activities

Adaptive management activities span all proposed action study phases (Figure 3C-1). Section 3C.3, describes the activities associated with each of the three adaptive management periods: Planning, Implementation, and Evaluate and Respond. This section describes the proposed action study phases and the relationship with each adaptive management period.

1. **Project Development and Refinement:** If the proposed action is approved after the completion of appropriate environmental review, the Project Development and Refinement study phase would occur during the first one to two years of proposed action implementation (after applicable permits have been obtained), before final design and construction activities. During this study phase, the proposed action will incorporate relevant design elements such as predator refugia features or other structural elements that can be introduced during adaptive management to improve the performance of the north Delta diversion facilities, if warranted. *The Planning period of adaptive management would occur during this proposed action study phase* (see Section 3C.3 for details).
2. **Baseline:** During the Baseline proposed action study phase, field monitoring studies of predatory fish, the survival and abundance of listed fish, and other ecological responses would be conducted, building on baseline information from existing programs and the prior environmental analyses. The field monitoring studies would be conducted before and during in-water construction (i.e., during the preconstruction and construction phases) to characterize baseline conditions and inform adaptive management during the Initial Operations phase. Field studies would be initiated prior to in-water construction (i.e., prior to intake construction) to characterize preconstruction conditions. During in-water construction, field studies would continue to monitor intake study sites under a transitional condition (i.e., during in-water construction, before intake operations). The baseline conditions (preconstruction and construction) would inform trends in study site characteristics and aid analyses in refining potential effects, including those that were initially identified through prior environmental review. *The Implementation period of adaptive management would occur during this proposed action study phase* (see Section 3C.3 for details).
3. **Initial Operations:** Proposed action operations would have two sub-phases: Initial Operations and Long-Term Operations. Field monitoring studies initiated during the Baseline proposed action study phase would continue into the Initial Operations sub-phase, to evaluate the performance of initial design and operations of the proposed action intakes and inform the adaptive management of proposed action operations. In addition to informing operations, monitoring studies would inform the adaptive management of relevant design elements previously identified during the proposed action's Project Development and Refinement study phase. The Initial Operations phase is proposed to last approximately five years. *The Evaluate and Respond period of adaptive management would occur during this proposed action study sub-phase* (see Section 3C.3 for details).
4. **Long-Term Operations:** During the Long-Term Operations sub-phase, field monitoring studies would be merged with existing interagency monitoring programs for coordinated long-term operations of the SWP and Central Valley Project (CVP), as part of broader system-wide long-term operations and associated fisheries-based real-time operation decision support processes. *The Evaluate and Respond period of adaptive management would continue through this final proposed action study sub-phase of Long-Term Operations* (see Section 3C.3 for details).

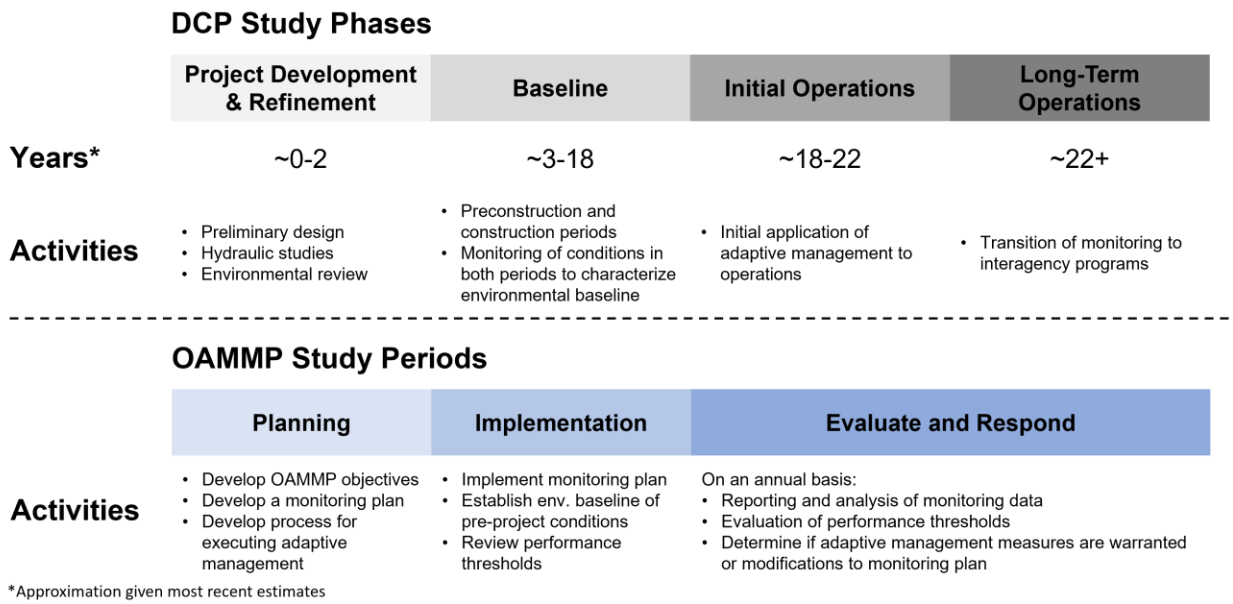


**Figure 3C-1. Relationship between the Delta Conveyance Project's Study Phases and the Adaptive Management Periods**

## 3C.2.3 Relationship to Agency Programs

The following subsections describe existing interagency programs managing the Delta's fish issues and the proposed relationship of these programs to the OAMMP.

### 3C.2.3.1 Interagency Ecological Program

#### Purpose

The Interagency Ecological Program (IEP) is a consortium of state and federal agencies that has been conducting cooperative ecological investigations since the 1970s. The IEP includes three state agencies (the California Department of Fish and Wildlife [CDFW], DWR, and the State Water Resources Control Board [State Water Board]) and six federal agencies (the U.S. Bureau of Reclamation [Reclamation], U.S. Fish and Wildlife Service [USFWS], U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, National Marine Fisheries Service [NMFS], and U.S. Geological Survey).

The mission of the IEP is to provide and integrate relevant and timely ecological information for management of the San Francisco Bay/Sacramento–San Joaquin Delta (Bay-Delta) ecosystem and the water that flows through it. The IEP relies upon multidisciplinary teams consisting of scientists from agencies, academia, and nongovernmental organizations and other scientists to conduct collaborative, scientifically sound monitoring, research, modeling, and synthesis efforts for various aspects of the aquatic ecosystem. The IEP readily shares its data, information, equipment, expertise, and resources with the Bay-Delta science community and is routinely relied upon as a partner by other scientific programs.

### Organizational Framework

The IEP is a collaborative partnership among several agencies; thus, staff roles, responsibilities, and interactions are dynamic. Scientific staff members of IEP member agencies and other scientific partners freely collaborate in interdisciplinary IEP science teams called *project work teams*.

### Program Activities

The IEP conducts scientific investigations in the Delta, its upper watershed, and out into San Francisco Bay. The habitats sampled by the IEP include open water, wetlands, flooded islands, floodplains, rivers, and sloughs.

### Relationship to the Operations Adaptive Management and Monitoring Plan

Collaboration with the IEP's extensive baseline Delta fish and food web surveys would be essential to meet the monitoring objectives of the abundance and distribution study element of the *North Delta Diversion Fisheries Field Studies Workplan* (see Section 3C.5 and Appendix 5B, *North Delta Diversion Fisheries Field Studies Workplan* for details). The IEP's ongoing trawl surveys conducted throughout the Delta would likely meet many or most of the objectives of the Fish Abundance and Distribution surveys needed to characterize the baseline status of listed fish populations in the Delta and also evaluate the effects of the proposed action, thus helping to facilitate adaptive management.

## 3C.2.3.2 Interagency Telemetry Advisory Group

### Purpose

The Interagency Telemetry Advisory Group (ITAG) was formed to serve as an advisory group to the IEP, with a focus on achieving a coordinated telemetry program that could coordinate acoustic telemetry monitoring programs in the Delta and across the Central Valley. The ITAG uses the following specific strategies to improve the efficiency and sustainability of telemetry studies in the San Joaquin and Sacramento Rivers and the Delta:

- Reduce duplication of effort by working transparently and openly together.
- Pilot and implement open data practices and tools to successfully achieve management objectives by coordinating multiple regional receiver and tagging teams.
- Standardize methods of array deployment, coordination of tag codes, and reporting procedures.
- Standardize acoustic telemetry study planning.
- Discuss and plan for potential changes to the coordinated acoustic telemetry program.
- Plan for and mitigate the potential loss of state and federal funding for the coordinated acoustic telemetry program.
- Plan and implement technology changes for the coordinated telemetry array.

### Organizational Framework

The ITAG includes up to two representatives from each IEP agency, appointed by IEP directors. The ITAG meets monthly. Meetings are planned annually by the ITAG chair(s).

### Program Activities

The ITAG conducts regular meetings for discussion, planning, and implementation of a coordinated telemetry array on the San Joaquin and Sacramento Rivers and in the Delta. The ITAG works to coordinate all acoustic telemetry studies in the Central Valley to address the following challenges, which have been observed over the last decade of acoustic telemetry studies in the Central Valley:

1. Receiver arrays are deployed for specific studies. This has limited the duration and location of deployments, which often use technology types that cannot communicate with each other. The independent completion of similar studies can also lead to duplication of receiver locations.
2. Tagging occurs independently based on projects. Without coordination of tags, accidental replication of tag codes can occur, and multiple individuals may share tag identification information, and these data cannot be used.
3. Field staff members are located far from field deployments. This makes servicing the receivers difficult, reduces the quality of the data collection system, can cause staff members to become overworked, and requires extensive travel.
4. Synthesis is difficult to undertake because receiver and tag data are not easily accessible. Data quality can be a challenge.
5. Environmental data are not often associated with receiver locations, which confounds further analyses.
6. Funding planning is difficult from year to year. This group should coordinate these annual issues to reduce the cracks between the Central Valley Project Improvement Act, the IEP, the San Joaquin River Restoration Program, and CDFW Proposition 1 when priority objectives are similar.

### Relationship to the Operations Adaptive Management and Monitoring Plan

Close coordination with the ITAG would be necessary to effectively and efficiently execute the migration and survival study element of the *North Delta Diversion Fisheries Field Studies Workplan* (see Section 3C.5 and Appendix 5B for details). The ITAG coordinates the acoustic telemetry array in the Delta and the planned releases of tagged fish; therefore, coordination with these efforts would be crucial to avoid duplication of efforts and ensure that the mutual goals of all local scientific efforts are met. This coordination would help meet the objectives of the migration and survival study element of the *North Delta Diversion Fisheries Field Studies Workplan* needed to characterize the baseline status of Delta fish populations and also evaluate the effects of the proposed action, thus helping to facilitate adaptive management.

## 3C.2.3.3 Collaborative Adaptive Management Team

### Purpose

The Collaborative Science and Adaptive Management Program (CSAMP), launched in April 2013, focuses on science and adaptive management issues related to current and future biological opinions (BiOps) for SWP and CVP operations, including the science underlying specific actions contained in the reasonable and prudent alternatives. The CSAMP has identified the need to maintain flexibility to address emerging science and information needs regarding water management and species of concern in the Delta and upriver, including actions to improve the

resiliency of delta smelt and salmonids. The Collaborative Adaptive Management Team (CAMT) is made up of managers and scientists who serve at the direction of the CSAMP Policy Group. The CAMT's goal is to develop a robust science and adaptive management program that will inform both implementation of the current BIOPSs, including interim operations, and the development of revised BIOPSs.

### Organizational Framework

The CAMT is made up of managers and scientists from state and federal agencies, local water districts, and nonprofit organizations.

### Program Activities

Given the CAMT's role in informing adaptive management of the SWP and CVP, the CAMT could provide a forum for vetting the OAMMP for the north Delta diversion facilities. The CAMT undertakes investigations to improve understanding of the effects of water operations on listed fish species and help identify potential management responses.

### Relationship to the Operations Adaptive Management and Monitoring Plan

Given the CAMT's role in informing adaptive management of the SWP and CVP, the CAMT could provide a forum for vetting the OAMMP for the north Delta diversion facilities. The CAMT could act as an independent reviewer of the OAMMP study plans and provide suggestions for improvement.

## 3C.2.3.4 Water Operations Management Team

### Purpose

The Water Operations Management Team (WOMT) comprises manager-level representatives from CDFW, USFWS, NMFS, DWR, Reclamation, and the State Water Board. The Smelt Monitoring Team (SMT) and Salmon Monitoring Team (SaMT) provide weekly updates, operations advice, and risk analyses to the WOMT. Each week the WOMT reviews and evaluates the risk assessments and operational advice and discusses potential changes to SWP and CVP operations.

The SMT consists of representatives from CDFW, USFWS, DWR, Reclamation, and the State Water Board. The SMT considers survey data, salvage data, and other pertinent biotic and abiotic factors to assess the risk of entrainment to delta smelt and longfin smelt from operation of the SWP and CVP. Based on the risk assessment, the SMT provides advice to the WOMT for real-time management of operations, consistent with the 2019 USFWS BiOp (US Fish and Wildlife Service 2019) and the 2020 SWP Incidental Take Permit (ITP, CA Department of Fish and Wildlife 2020).

The SaMT consists of representatives from CDFW, USFWS, NMFS, DWR, Reclamation, and the State Water Board. The SaMT considers the effects of hydrology, meteorology, real-time fish monitoring surveys, and other biotic and abiotic factors to assess the risk of CVP and SWP operations on listed salmonids and green sturgeon. Based on the risk assessments, the SaMT provides advice to the WOMT for real-time management of operations, consistent with the 2019 NMFS BiOp (National Marine Fisheries Service 2019) and the 2020 SWP ITP.

### Organizational Framework

The WOMT comprises manager-level representatives from multiple state and federal agencies.

### Program Activities

This management-level team meets regularly to consider management issues related to operations of the SWP and CVP.

### Relationship to the Operations Adaptive Management and Monitoring Plan

The WOMT would be expected to fulfill a similar role once the proposed action is implemented, with a focus on real-time operations, distinct from adaptive management–scale decisions.

## 3C.2.4 Consistency with Consultation for the Long-Term-Operations of the State Water Project

- The Long-Term-Operations (LTO) for the SWP is under consultation and the Proposed Action for the LTO includes a programmatic framework consultation for the operations of the Delta Conveyance Project. The Delta Conveyance Project is required to integrate with the adaptive management program included in the LTO consultation[1]. This OAMMP is in alignment with the LTO adaptive management program[2] and includes the following key actions that are consistent with the LTO.
- Cooperate with ongoing and planned monitoring programs conducted by resource agencies.
- Design studies to examine modifications of operations.
- Cooperate with resource agencies in evaluation of study findings and determine if operational changes are needed.
- Integrate Delta Conveyance Project studies with existing monitoring programs.
- Commit to a decision-making process consistent with the LTO management effort through the application of a structured-decision making framework.

# 3C.3 Adaptive Management Framework

As introduced in Section 3C.2, adaptive management encompasses three major periods: Planning, Implementation, and Evaluate and Respond. This OAMMP documents all activities associated with the Planning period of adaptive management. This OAMMP also describes the process expected to be followed during the Implementation and Evaluate and Respond periods. The following text describes the high-level activities of each period and identifies the locations of the descriptions of each activity in this OAMMP.

1. Planning Period
    a. Define the problem. (Section 3C.1)

[1] See Section 3C.7.1.2 *Interagency Implementation and Coordination Group* for additional information on coordination of the OAMMP with adaptive management under the LTO.

[2] While the DCP OAMMP includes descriptions of water operations and species technical teams included in the 2019 NMFS and USFWS BO's and 2020 CDFW ITP, the OAMMP would remain consistent with any updates to these teams and associated coordination processes identified through the consultation on LTO, where applicable.

   b. Model linkages between proposed action operations and effects on listed fish species. (Section 3C.4)
   c. Establish biological resources objectives. (Section 3C.4)
   d. Develop a monitoring plan to evaluate the biological resources objectives. (Section 3C.5)
   e. Develop performance measures and potential management response. (Section 3C.6)
2. Implementation Period
   a. Implement baseline monitoring.
   b. Implement proposed action operations.
3. Evaluate and Respond Period (Sections 3C.6 and 3C.7)
   a. Analyze, synthesize, and evaluate on an annual basis.
   b. Communicate current understanding.
   c. Adapt as needed.

## 3C.3.1 Planning Period

The Planning period of adaptive management establishes the framework to be followed during the Implementation period and the Evaluate and Respond period once the proposed action is implemented and operating. The Planning period includes the establishment of biological resources objectives, development of a monitoring plan to evaluate the objectives, and establishment of the process for executing adaptive management once the proposed action is in operation. The Planning period's activities are memorialized in this OAMMP (see the introduction to this appendix for the locations of activity descriptions). All Planning period activities would be first drafted by DWR and then reviewed and collaboratively refined with involvement by state and federal agencies.

## 3C.3.2 Implementation Period

The Implementation period of adaptive management includes the baseline monitoring activities as described in the *North Delta Diversion Fisheries Field Studies Workplan* (see Section 3C.5 and Appendix 5B) and the commencement of proposed action operations. The monitoring studies conducted during the Baseline study phase of the proposed action (see Figure 3C-1) would allow for the evaluation of proposed action effects on listed fish species by providing a baseline comparison of conditions without the proposed action in operation.

## 3C.3.3 Evaluate and Respond Period

Once the proposed action is in operation during the Initial Operations and Long-Term Operations sub-phases, the Evaluate and Respond period of adaptive management would begin. Activities during this period would include conducting an annual analysis of monitoring data, determining whether the performance thresholds for each OAMMP objective were being met, and identifying any potential need for management responses to better meet those objectives.

# 3C.4 Proposed Action Effects and Biological Resources Objectives

An adaptive management approach requires explicit, measurable objectives (Williams et al. 2009). Uncertainty about how to achieve objectives motivates adaptive management and drives the design of the monitoring system. Objectives need to be measurable for two purposes: first, to allow for an assessment of progress toward their achievement, and second, to enable performance deviating from the objectives to trigger a change in management direction. Clearly articulating measurable objectives helps to separate adaptive management from trial and error, because the use of objectives directs and justifies the exploration of management options over time. It is important to note the distinction between monitoring in support of the adaptive management plan, and the broader project compliance monitoring that will be conducted and described as part of the Mitigation Monitoring and Reporting Program and consistent with permit terms. Compliance monitoring will provide information that could ultimately be used to trigger proposed changes to the project and subsequent environmental review, but is more tailored to demonstrating that the project is implemented as described and authorized rather than targeting specific areas of uncertainty (e.g., related to complex biological interactions in response to project operations).

Proposed action effect mechanisms can be turned into adaptive management objectives, and ultimately into performance measures to measure progress toward accomplishing the objectives. The entire range of proposed action effects will be analyzed in the federal Endangered Species Act (ESA) Section 7 biological assessment (BA) and the California Endangered Species Act (CESA) ITP. Adaptive management would focus on a narrower subset of these effects with uncertainties regarding the nature of the impact on listed fish species. Section 3C.4.1 describes the relationship between the OAMMP and the ESA and CESA effects analyses, Section 3C.4.2 describes the subset of proposed action effects that would be addressed by the OAMMP, and Section 3C.4.3 describes the establishment of objectives for adaptive management.

## 3C.4.1 Relationship to Consultation Effects Analyses

Figure 3C-2 depicts the relationship between the proposed action's ESA consultation and CESA ITP and adaptive management. The effects analysis in the BA and ITP application for the ESA and CESA, respectively, will include a thorough analysis of all proposed action effects on listed fish species. While the BA and ITP application will analyze the complete range of proposed action effects, this OAMMP focuses on a narrower subset of effects with uncertainties regarding the nature of the impact on listed fish species. These uncertainties would be better understood through monitoring studies conducted before (Baseline phase) and during proposed action implementation (Initial and Long-Term Operations sub-phases), and this improved understanding of the proposed action's effects may lead to potential management responses to better achieve OAMMP objectives.

The BA and ITP will set the initial expectation for baseline conditions for fish population dynamics, as well as the range of expected impacts for each proposed action effect. The level of effect in the BA and ITP will be based primarily on model-based evaluations but will also refer to the baseline monitoring that would validate and update model-based predictions of effects. The effect bounds identified from model-based predictions and monitoring could be used to inform the performance thresholds (see Section 3C.6 for details) used to evaluate each OAMMP objective. Monitoring during the Initial and Long-Term Operations sub-phases would help to determine whether the performance threshold is being exceeded. Should a performance threshold be exceeded during the Initial or Long-

Term Operations sub-phase, the cause of the effect would be assessed to determine whether the exceedance is attributable to the proposed action. If attributable to the proposed action, then potential management responses may be enacted to achieve the OAMMP objective.

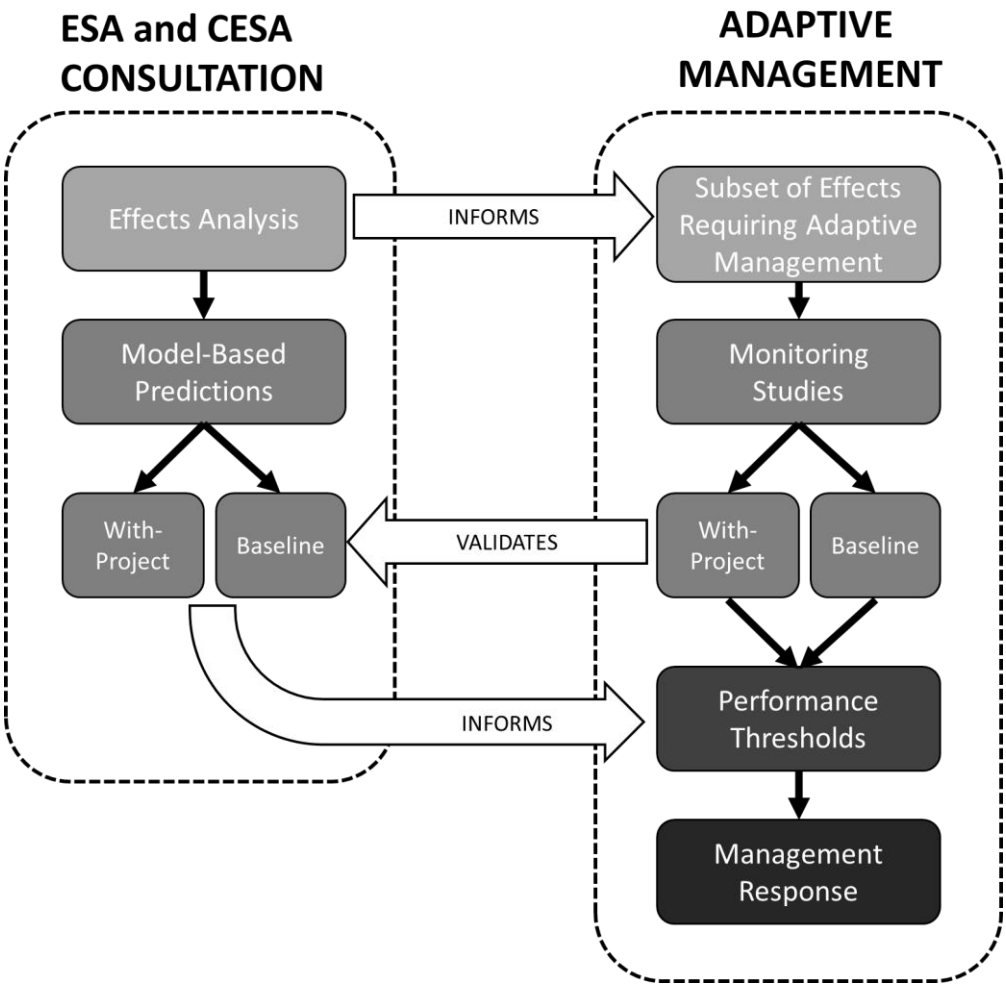


**Figure 3C-2. Relationship between the Proposed Action's Section 7 Endangered Species Act and California Endangered Species Act Consultations and Adaptive Management**

As presented in the project description in the BA, the proposed action includes multiple elements intended to reduce effects of the project to aquatic resources generally and minimize potential impacts to state and federally listed species in particular. While not exhaustive, the key minimization measures described for the proposed action are included within the adaptive management framework, below, along with biological objectives identified to guide the adaptive management process. Additionally, the minimization measures described were developed based on information available for listed species, but are also intended to function as minimization measures for non-listed species (e.g., fall-run Chinook Salmon present during pulse protection periods would experience that level of minimization). It's important to note the operational criteria included in the project description, in addition to the other mitigation commitments, are assumed to be sufficient in mitigating potential project effects based on best available science and the results of the effects analysis. The process to consider potential refinements to the key minimization measures (e.g., operational components) are described below.

This framework outlines the process for gathering appropriate information to evaluate the performance of the proposed action minimization measures relative to potential impacts identified in the effects analysis and/or baseline studies, and to assess the extent to which they are consistent with expected outcomes and guide potential adaptive management actions if the observed level of effect is greater than estimated. This approach is not intended as a substitute for re-initiation triggers but would inform decision making that could include the need to initiate formal consultation.

In addition to the rationale summarized below, the minimization measures are intended to function wholistically, and minimize potential effects of north Delta diversions beyond the specific 'regions' identified (i.e., diel operations are described for near-field but function far-field as well). Habitat restoration is proposed for the Delta Conveyance Project to further minimize (in the case of project(s) intended to offset potential hydrodynamic effects of operations) and fully mitigate potential impacts of the project, but adaptive management for the restoration projects will be addressed separately with site specific plans.

Minimization measures included to reduce potential impacts to listed fish in the intake reach, and through the Delta, include the following:

### 3C.4.1.1 Near-Field Minimization Measures

- Intake screen technology – Tee-screens with 1.75 millimeter (mm) slot openings
  - The sizing is intended to physically exclude entrainment of fish life-stages greater than approximately 22 mm in length.
- Approach and sweeping velocity at the Tee-screens – 0.2 feet per second (fps) approach/ 0.4 fps sweeping
  - These operating criteria are intended to reduce the likelihood and extent of injury/death to fish associated with screen contact.
  - These criteria are intended to reduce the likelihood of entraining/concentrating fish into the intake vicinity based on the hypothesis that it may increase the likelihood of predator encounters and predation.
- Diel north Delta diversions patterning – Operations of the north Delta diversions occur during daylight hours to the extent possible.
  - This operational pattern is designed to avoid periods when listed fish are believed to exhibit more active migration/movement in the intake reach.

Near-Field operations will be monitored to verify that criteria identified in the project description of the BA (Chapter 3, *Description of the Proposed Action*) are being implemented as described and producing flow dynamics within the ranges analyzed. Flow monitoring at Freeport and at the intakes – including instantaneous diversion rates at each screen unit – will be measured to verify consistency with approach and sweeping criteria, as well as daytime focused diversions consistent with those analyzed within the effects analysis.

#### 3C.4.1.2 Far-Field Minimization Measures

- Bypass-flow criteria – Graduated (Levels 1 – 3) diversion rates prescribed based on time of year (December – June) and Sacramento River flow measured at Freeport, determined on a 3-day running average.
    - These criteria are intended to reduce impacts to listed species associated with north Delta diversions and resulting effects on flow-related migration rates, routing, and ultimately survival.
    - The period designated for these criteria is intended to reflect the preponderance of listed fish species presence in the Delta.
- Pulse Protection criteria – Reduce north Delta diversion rates to a maximum of 900 cubic feet per second (cfs) or 6% of Sacramento River flow based on Wilkins Slough flow triggers, up to 2 times per year.
    - This measure is intended to further minimize potential far-field effects, beyond the reductions offered by the bypass flow criteria, to emigrating juvenile winter-run Chinook salmon.
    - This criteria was formulated based on historical relationships indicating large concentrations of winter-run-sized Chinook salmon juveniles movement from upstream rearing habitats, downstream toward the Delta in response to early winter storm events.
    - The timing and predictability of this storm-driven flow-pulse fish movement, as well as the endangered status of winter-run Chinook salmon, were the main drivers for the addition of this operational measure.
- Minimum Bypass-flow criteria – 5,000 cfs tidally averaged minimum flow requirement during the summer and 7,000 cfs in the fall before north Delta diversions.
    - These criteria are intended to maintain baseflows outside periods when listed species are expected to be in the intake reach.
- Far-field operations will be monitored to verify that criteria identified in the project description of the BA (Chapter 3) are being implemented as described and producing flow dynamics within the ranges analyzed. Flow monitoring at Freeport and at the intakes will be measured to verify consistency with the 3-day tidally averaged diversions prescribed by the bypass-flow criteria as well as timing and duration of pulse-protection.

These flow data will also be considered to evaluate flow-fields established in the intake reach in order to assess critical streakline location, for comparison to assumed and observed emigrating, juvenile, salmonid distribution.

## 3C.4.2 Proposed Action Effects

Adaptive management would focus on a narrower subset of the effects described in the ESA BA and CESA ITP. Adaptive management generally focuses on project effects where uncertainties exist regarding the nature of the effects, thus requiring a characterization of baseline conditions that can be compared to with-project effects. Adaptive management is also only applied to effects where multiple management choices may be available to limit the environmental impact. For example, effects defined by the facility design would not be expected to be affected by adaptive management

actions during the Initial and Long-Term Operations sub-phases. Lastly, effects that would be unlikely to occur, or that would be expected to have only a negligible impact according to the BA and ITP analyses, also would not be expected to be affected by adaptive management actions and would not be included in the OAMMP.

The following proposed action effects are drawn from the federal ESA BA and the CESA ITP. Because of the size and scope of the proposed action, its effects have been organized by spatial scale: near-field and far-field effects. Near-field effects are those that would occur in the reach immediately adjacent to the fish screens. Far-field effects are those that would occur downstream of the fish screens.

### 3C.4.2.1 Chinook Salmon and Steelhead

#### Proposed Action Effect Mechanisms

##### Near-Field Effects

- Juvenile salmonids may be exposed to the north Delta diversion fish screens, leading to the risk of mortality related to entrainment or impingement.
- The north Delta diversion facilities may concentrate predators (i.e., create a predator hotspot), leading to increased local predation of juvenile salmonids.

##### Far-Field Effects

- Changes in hydrodynamics attributable to the north Delta diversion facilities may cause changes in the routing and overall survival of juvenile salmonids migrating through the Delta.

### 3C.4.2.2 Green Sturgeon

#### Proposed Action Effect Mechanisms

##### Far-Field Effects

- Water diversions associated with the north Delta diversion facilities may cause changes in hydrodynamics and water quality parameters (e.g., turbidity) that may negatively affect the abundance and health of juvenile green sturgeon.

### 3C.4.2.3 Delta Smelt and Longfin Smelt

#### Project Effect Mechanisms

##### Near-Field Effects

- The north Delta diversion facilities may concentrate predators (i.e., create a predator hotspot), leading to increased local predation of delta smelt and longfin smelt.
- Habitat alteration at the north Delta diversion facilities may affect upstream migration by adult delta smelt and longfin smelt.

**Far-Field Effects**

- Water diversions associated with the north Delta diversion facilities may cause changes in hydrodynamics and water quality parameters (e.g., turbidity) that may negatively affect the abundance and health of delta smelt and longfin smelt.

## 3C.4.3 Established Objectives

The OAMMP objectives listed in the following subsections are tied to the proposed action effect mechanisms described in Section 3C.4.2. See Section 3C.6 for details on performance measures related to each OAMMP objective.

### 3C.4.3.1 Chinook Salmon and Steelhead

**Objective 1a:** Avoid exposure of juvenile salmonids to the screen intake at levels beyond those observed during baseline monitoring, which would result in impacts exceeding those identified in the BA/ITP effects analyses.

**Objective 1b:** Avoid densities of predators adjacent to the north Delta diversion facilities that may prey on juvenile salmonids at levels beyond those observed during baseline monitoring, which would result in impacts exceeding those identified in the BA/ITP effects analyses.

**Objective 1c:** Avoid indirect mortality of juvenile salmonids migrating through the Delta caused by changes in hydrodynamics and fish routing at levels beyond those observed during baseline monitoring, which would result in impacts exceeding those identified in the BA/ITP effects analyses.[3]

### 3C.4.3.2 Green Sturgeon

**Objective 2a:** Avoid indirect mortality and health effects of juvenile green sturgeon caused by changes in hydrodynamics (e.g., Delta outflow) and water quality parameters at levels beyond those observed during baseline monitoring, which would result in impacts exceeding those identified in the BA/ITP effects analyses.

### 3C.4.3.3 Delta Smelt and Longfin Smelt

**Objective 3a:** Avoid densities of predators adjacent to the north Delta diversion facilities that may prey on smelt at levels beyond observed during baseline monitoring, which would result in impacts exceeding those identified in the BA/ITP effects analyses.

**Objective 3b:** Avoid changes in upstream migration of adult smelt at levels beyond those observed during baseline monitoring, which would result in impacts exceeding those identified in the BA/ITP effects analyses.

**Objective 3c:** Avoid indirect mortality and health effects of smelt caused by changes in hydrodynamics (e.g., Delta outflow) and water quality parameters at levels beyond those observed

[3] Efficacy of tidal restoration to offset potential hydrodynamic changes (e.g., minimize increases in reverse flows at Georgiana Slough junction associated with north Delta diversion) due to operations of the north Delta intakes will be evaluated and considered during monitoring studies and in potential refinements to real-time operations and associated operational criteria, where applicable.

during baseline monitoring, which would result in impacts exceeding those identified in the BA/ITP effects analyses.

# 3C.5 Monitoring

Monitoring is fundamental to adaptive management, as a source of data with which to test alternative models and measure progress toward accomplishing management objectives (Williams et al. 2009). Simply put, adaptive management is not possible without effective monitoring. Not only does monitoring track progress toward achieving objectives, but it leads to a reduction in uncertainty and helps to answer the questions that need to be answered to track progress toward achieving the objectives (Williams et al. 2009).

Monitoring studies are described in Appendix 5B, *North Delta Diversion Fisheries Field Studies Workplan*. The studies are intended to address uncertainties concerning the potential effects of the proposed action on aquatic resources and inform the proposed action's operation and adaptive management. The following are the OAMMP objectives (introduced in Section 3C.4) that will be evaluated in each fisheries field study described in Appendix A.

- Migration and survival study
  - Objectives 1a, 1c, 2a, and 3a
- Predation study
  - Objectives 1b and 3b
- Abundance and distribution study
  - Objectives 3c and 3d

# 3C.6 Performance Measures and Management Response

An objective of this OAMMP is to guide monitoring and to identify the thresholds that may compose the biological objectives of the proposed action. This chapter summarizes performance measures that identify how the success of the proposed action will be measured, identify areas where unexpected outcomes may arise, and develop potential responses to those outcomes. This chapter is based on the OAMMP's objectives, listed in Section 3C.4.3. These objectives will be monitored using various methods described in Section 3C.5 and Appendix 5B. For each objective, this section details the associated monitoring study, metric, time frame to evaluate, performance threshold, and potential management responses, with definitions for each described as follows:

- **Associated Monitoring Study:** The monitoring study used to track progress toward achieving the objective (see Section 3C.5 and Appendix 5B for more information on each study).
- **Metric:** The unit of measurement/process needed to track progress toward achieving the objective.
- **Time Frame to Evaluate:** The length of time the metric would be measured to determine whether the objective is being met. Although the evaluation of performance would occur

annually, some performance thresholds would require multiple years of data to detect performance issues.

- **Performance Threshold**: The quantitative threshold for when adaptive management actions would be considered. This threshold value (or range of values) would be set to trigger if the level of effect is beyond the level of effect observed during baseline monitoring or identified in the BA/ITP effects analyses. If the threshold value is not met, then operational and monitoring activities continue as planned.
- **Potential Management Responses**: The management actions to be considered once a performance threshold is reached. These responses may include additional study, operational changes, or near-field habitat alterations. Additional study could be necessary to further examine the causation of observed effects. Should a performance threshold be exceeded, and the proposed action is believed to be the cause of the exceedance, DWR would work with state and federal agencies to determine the appropriate management response (see Section 3C.7 for details on the decision-making process).

## 3C.6.1 Chinook Salmon and Steelhead Objectives

### 3C.6.1.1 Objective 1a: Avoid exposure of juvenile salmonids to the screen intake at levels beyond those identified during Baseline monitoring.

#### Associated Monitoring Study

The Near-Field Survival Study will evaluate the exposure of juvenile salmonids to the screen intake. This near-field study would examine the movement patterns of tagged juvenile salmonids adjacent to the north Delta intakes. See Appendix 5B for details of the study.

#### Metric

Cross-stream position of tagged salmonids from the north Delta intakes. Cross-stream position is the perpendicular distance of a fish away from an intake.

#### Time Frame to Evaluate

Implementation of the study is proposed to occur annually, throughout the migratory window (e.g., October – June), for approximately 5 years (a period assumed to provide robust representation of water year types [WYT]) but subject to modification (e.g., additional years) based on observed conditions, with less intense monitoring occurring thereafter and/or greater reliance on long-term monitoring programs.

#### Performance Threshold

Observed cross-stream position of tagged salmonids from the north Delta intake, accounting for environmental conditions (in particular riverine inflow at Freeport) should not be statistically significantly less than the cross-stream position observed during Baseline studies.

### Potential Management Responses

If the ascribed threshold is not reached, existing operations would continue unchanged and monitoring would continue as planned. Deviation of observed distribution beyond the ascribed threshold would be an indicator that either 1) actual flow dynamics differ significantly from those assumed/evaluated or 2) biological/behavioral response of listed salmonids differs from baseline and/or information used in the effects analysis. Upon verification of the deviation potential management responses include:

- Triggering of additional studies to better evaluate drivers of the deviation;
- Consideration of non-operational measures (e.g., fish refugia) if there is evidence that deviations are caused by the project and deleterious to listed salmonids (e.g., resulting in greater injury/mortality);
    - Any modifications would also need to consider potential unintended impacts to other listed species, such as delta smelt.
- Consideration of operational refinement if there is evidence that deviations are caused by the project and deleterious to listed salmonids (e.g., resulting in greater injury/mortality).
    - Operational changes would be considered based on the extent to which evidence indicates deviation from survival estimates are attributable to dynamics occurring Near-Field, including:
        - Diel diversion patterning shifts to better avoid increased periods of migration – based on observed sub-daily migration behavior;
        - Tee-screen use patterns – distribution of screens used (e.g., northern-most intake screens first, individual screen diversion rates below 100 cfs) given prescribed diversion rate.

## 3C.6.1.2 Objective 1b: Avoid densities of predators adjacent to the north Delta diversion facilities that may prey on juvenile salmonids at levels beyond those observed during Baseline monitoring.

### Associated Monitoring Study

Predatory Fish Distribution and Direct Predation Rate studies will evaluate near-field predation of listed fishes. See Appendix 5B for study details.

### Metric

Densities of predatory fish and relative predation rates adjacent to the north Delta intakes.

### Time Frame to Evaluate

Implementation of the studies is proposed to occur annually, throughout the migratory window (e.g., October – June), for approximately 5 years (a period assumed to provide robust representation of WYT) but subject to modification (e.g., additional years) based on observed conditions, with less intense monitoring occurring thereafter and/or greater reliance on long-term monitoring programs.

### Performance Threshold

Observed densities of predatory fish and relative predation rates (while considering environmental covariates) adjacent to the intakes should not be statistically significantly greater than those observed during baseline studies.

### Potential Management Responses

If the ascribed threshold is not reached, existing operations would continue unchanged and monitoring would continue as planned. Deviation of observed predator densities or relative predation rate beyond the ascribed threshold would be an indicator that the biological response differs from baseline and/or information used in the effects analysis. Upon verification of the deviation potential management responses could include:

- Triggering of additional studies to better evaluate drivers of the deviation;
- Consideration of non-operational measures (e.g., fish refugia) if there is evidence that deviations are caused by the project and deleterious to listed salmonids (e.g., resulting in greater injury/mortality);
    - Any modifications would also need to consider potential unintended impacts to other listed species, such as delta smelt.
- Consideration of operational refinement if there is evidence that deviations are caused by the project and deleterious to listed salmonids (e.g., resulting in greater injury/mortality).
    - Operational changes would be considered based on the extent to which evidence indicates deviation from survival estimates are attributable to dynamics occurring Near-Field, including:
        - Diel diversion patterning shifts to better avoid increased periods of migration – based on observed sub-daily migration behavior;
        - Tee-screen use patterns – distribution of screens used (e.g., northern-most intake screens first, individual screen diversion rates below 100 cfs) given prescribed diversion rate.

## 3C.6.1.3 Objective 1c: Avoid indirect mortality of juvenile salmonids migrating through the Delta caused by changes in hydrodynamics and fish routing at levels beyond those observed during Baseline monitoring.

### Associated Monitoring Study

The Far-Field Routing and Survival Study will evaluate the migration survival and routing of juvenile salmonids within the lower Sacramento River and through the Delta. See Appendix 5B for details of the study.

### Metric

Through-Delta survival.

## Time Frame to Evaluate

Implementation of the study is proposed to occur annually, throughout the migratory window (e.g., October – June), for approximately 5 years (a period assumed to provide robust representation of WYT) but subject to modification (e.g., additional years) based on observed conditions, with less intense monitoring occurring thereafter and/or greater reliance on long-term monitoring programs.

## Performance Threshold

Differences in Through-Delta survival (while considering environmental covariates) between the project and the baseline should not be significantly more than the relative difference estimated during the effects analysis[4], as informed by the applicable monitoring studies.

## Potential Management Responses

If the ascribed threshold is not reached, existing operations would continue unchanged and monitoring would continue as planned. Deviation of observed through-Delta survival beyond the ascribed threshold would be an indicator that either 1) actual flow dynamics differ significantly from those assumed/evaluated or 2) biological/behavioral response differs from baseline and/or information used in the effects analysis. Upon verification of the deviation, potential management responses include:

- Triggering of additional studies to better evaluate drivers of the deviation, such as:
  - This would include information gathered from other studies identified, such as Near-Field Survival, operational monitoring (as noted above to verify operations within the criteria), Predatory Fish Distribution, and Direct Predation Rate;
  - Need for additional restoration based on effectiveness of prescribed tidal restoration offsetting north Delta diversion-produced increases in reverse flows.
- Consideration of non-operational measures like behavioral devices at the intakes (e.g., BAFF technology) if there is evidence that deviations are caused by the project and deleterious to listed salmonids (e.g., resulting in greater injury/mortality);
  - Any modifications would also need to consider potential unintended impacts to other listed species, such as delta smelt.
- Consideration of operational refinement if there is evidence that deviations are caused by the project and deleterious to listed salmonids (e.g., resulting in greater injury/mortality).
  - Operational changes would be considered based on the extent to which evidence indicates deviation from survival estimates are attributable to dynamics occurring Near-Field, including:
    - Diel diversion patterning shifts to better avoid increased periods of migration – based on observed sub-daily migration behavior;

[4] Relative (%) differences in through-Delta survival (while considering environmental covariates) between the project and with-out project conditions (and before implementation of hydrodynamic mitigation) should not be greater than estimated in the effects analysis. It is assumed the hydrodynamic tidal habitat restoration is sufficient in offsetting estimated differences identified in the effects analysis. Therefore, during project operations, observed differences within this range are considered mitigated (i.e., survival changes during project operations would be occurring under an improved baseline with inclusion of the hydrodynamic mitigation).

- Tee-screen use patterns – distribution of screens used (e.g., northern-most intake screens first, individual screen diversion rates below 100 cfs) given prescribed diversion rate.

- Operational changes would be considered based on the extent to which evidence indicates deviation from survival estimates are attributable to dynamics occurring Far-Field, including:
  - Bypass-flow criteria timing, and duration shifts (e.g., remaining at Level 1 longer, down-ramping from Level 3 or 2) to better align with observed listed salmonid presence;
    - This would be informed by salmonid presence and movement pattern data gathered from existing monitoring stations upstream of, and through, the Delta (e.g., Knights Landing rotary screw trap), in addition to the targeted studies identified.
  - Pulse-flow criteria timing, duration, and frequency shifts (e.g., on- and off-ramping pulse protection relative to measured upstream flows, number of pulse-protections per year) to better align with observed WRCS presence. Consideration of 'targeted' pulse-protection events based on observed SRCS, or other listed species, may also be considered.
    - This would be informed by salmonid presence and movement pattern data gathered from existing monitoring stations upstream of, and through, the Delta (e.g., KLRST), in addition to the targeted studies identified.
    - Potential use of BioSonic type technology at the intakes to further inform timing, distribution, and intake exposure of large concentrations of emigrating salmonids, would also be considered.

## 3C.6.2 Green Sturgeon Objectives

### 3C.6.2.1 Objective 2a: Avoid indirect mortality and health effects of juvenile green sturgeon caused by changes in Delta outflow at levels beyond those identified in the BA/ITP effects analyses.

#### Associated Monitoring Study

The Abundance and Distribution Study will examine densities and seasonal and geographic distribution of all life stages of listed fish species inhabiting the reaches of the lower Sacramento River likely to be affected by the proposed action. See Appendix 5B for study details.

#### Metric

The density of juvenile green sturgeon in the lower Sacramento River.

#### Time Frame to Evaluate

Implementation of surveys for juvenile green sturgeon is proposed to occur annually for approximately 5 years (a period assumed to provide robust representation of WYT) but subject to modification (e.g., additional years) based on observed conditions, with less intense monitoring occurring thereafter and/or greater reliance on long-term monitoring programs.

### Performance Threshold

Observed densities of juvenile green sturgeon (while considering environmental covariates) in the Lower Sacramento River is not statistically significantly less than densities observed during baseline studies.

### Potential Management Responses

- If the ascribed threshold is not reached, existing operations would continue unchanged and monitoring would continue as planned. Deviation of observed density beyond the ascribed threshold would be an indicator that either (1) actual flow dynamics differ significantly from those assumed/evaluated or (2) biological/behavioral response differs from baseline and/or information used in the effects analysis. Upon verification of the deviation, potential management responses include: Triggering of additional studies to better evaluate drivers of the deviation;
- Consideration of operational refinement if there is evidence that deviations are caused by the project and deleterious to green sturgeon (e.g., resulting in greater injury/mortality).
    - Operational changes would be considered based on the extent to which evidence indicates deviation from survival estimates are attributable to dynamics occurring Far-Field, including:
        - Bypass-flow criteria timing, and duration shifts (e.g., remaining at Level 1 longer, down-ramping from Level 3 or 2) to better align with observed sturgeon presence;
            - This would be informed by sturgeon presence and movement pattern data gathered from existing monitoring stations upstream of, and through, the Delta, in addition to the targeted studies identified.
        - Pulse-flow criteria timing, duration, and frequency shifts (e.g., on- and off-ramping pulse protection relative to measured upstream flows, number of pulse-protections per year) to better align with observed smelt presence.
            - This would be informed by sturgeon presence and movement pattern data gathered from existing monitoring stations upstream of, and through, the Delta, in addition to the targeted studies identified.
            - Potential use of BioSonic type technology at the intakes to further inform timing, distribution, and intake exposure of emigrating sturgeon, would also be considered.

## 3C.6.3 Delta Smelt and Longfin Smelt Objectives

### 3C.6.3.1 Objective 3a: Avoid densities of predators adjacent to the north Delta diversion facilities that may prey on smelt at levels beyond those observed during Baseline monitoring.

### Associated Monitoring Study

The Predatory Fish Distribution and Direct Predation Rate studies will evaluate predation of listed fishes. See Appendix 5B for study details,

### Metric

Densities of predatory fish and relative predation rates adjacent to the north Delta intakes

### Time Frame to Evaluate

Implementation of the studies is proposed to occur annually for approximately 5 years (a period assumed to provide robust representation of WYT) but subject to modification (e.g., additional years) based on observed conditions, with less intense monitoring occurring thereafter and/or greater reliance on long-term monitoring programs.

### Performance Threshold

Observed densities of predatory fish and relative predation rates (while considering environmental covariates) adjacent to the intakes should not be statistically significantly greater than those observed during the baseline studies.

### Potential Management Responses

If the ascribed threshold is not reached, existing operations would continue unchanged and monitoring would continue as planned. Deviation of observed predator densities or relative predation rate beyond the ascribed threshold would be an indicator that the biological response differs from baseline and/or information used in the effects analysis. Upon verification of the deviation potential management responses include:

- Triggering of additional studies to better evaluate drivers of the deviation;
- Consideration of non-operational measures (e.g., fish refugia) if there is evidence that deviations are caused by the project and deleterious to smelt (e.g., resulting in greater injury/mortality);
- Consideration of operational refinement if there is evidence that deviations are caused by the project and deleterious to smelt (e.g., resulting in greater injury/mortality).
    - Operational changes would be considered based on the extent to which evidence indicates deviation from survival estimates are attributable to dynamics occurring Near-Field, including:
        - Diel diversion patterning shifts to better avoid increased periods of migration – based on observed sub-daily migration behavior;
        - Tee-screen use patterns – distribution of screens used (e.g., northern-most intake screens first, individual screen diversion rates below 100 cfs) given prescribed diversion rate.

## 3C.6.3.2 Objective 3b: Provide upstream migration of adult smelt at levels similar to those observed during Baseline monitoring.

### Associated Monitoring Study

The Abundance and Distribution Study will examine densities and seasonal and geographic distribution of all life stages of listed fish species inhabiting the reaches of the lower Sacramento River likely to be affected by the Project. See Appendix 5B for study details.

### Metric

The proportion of the population observed upstream of the north Delta intakes during the adult migration/spawning season.

### Time Frame to Evaluate

Implementation of adult spawning surveys is proposed to occur annually, throughout the migration/spawning window (e.g., December – May), for approximately 5 years (a period assumed to provide robust representation of WYT) but subject to modification (e.g., additional years) based on observed conditions, with less intense monitoring occurring thereafter and/or greater reliance on long-term monitoring programs.

### Performance Threshold

Observed proportion of the population upstream of the north Delta intakes (while considering environmental covariates) should not be statistically significantly less than the proportion observed from baseline studies.

### Potential Management Responses

If the ascribed threshold is not reached, existing operations would continue unchanged and monitoring would continue as planned. Deviation of observed fish movement beyond the ascribed threshold would be an indicator that either 1) actual flow dynamics differ significantly from those assumed/evaluated or 2) biological/behavioral response differs from baseline and/or information used in the effects analysis. Upon verification of the deviation potential management responses include:

- Triggering of additional studies to better evaluate drivers of the deviation;
- Consideration of non-operational measures (e.g., fish refugia) if there is evidence that deviations are caused by the project and deleterious to smelt (e.g., resulting in greater injury/mortality).

## 3C.6.3.3 Objective 3c: Avoid indirect mortality and health effects of smelt caused by changes in Delta outflow at levels beyond those identified in the BA/ITP effects analyses.

### Associated Monitoring Study

The Abundance and Distribution Study will examine densities and seasonal and geographic distribution of all life stages of listed fish species inhabiting the reaches of the lower Sacramento River likely to be affected by the Project. See Appendix 5B for study details.

### Metric

The density of delta smelt in the lower Sacramento River

### Time Frame to Evaluate

Implementation of surveys for smelt is proposed to occur annually for approximately 5 years (a period assumed to provide robust representation of WYT) but subject to modification (e.g.,

additional years) based on observed conditions, with less intense monitoring occurring thereafter and/or greater reliance on long-term monitoring programs.

### Performance Threshold

Observed densities of smelt in the Lower Sacramento River (while considering environmental covariates) is not statistically significantly less than densities observed from baseline studies. While prior studies have indicated positive relationships between winter and spring outflow and juvenile abundance during the fall, exact mechanisms driving this relationship remain uncertain and will continue to be an area of study.

### Potential Management Responses

If the ascribed threshold is not reached, existing operations would continue unchanged and monitoring would continue as planned. Deviation of observed densities beyond the ascribed threshold would be an indicator that either 1) actual flow dynamics differ significantly from those assumed/evaluated or 2) biological/behavioral response differs from baseline and/or information used in the effects analysis. Upon verification of the deviation potential management responses include:

- Triggering of additional studies to better evaluate drivers of the deviation;
- Consideration of operational refinement if there is evidence that deviations are caused by the project and deleterious to smelt (e.g., resulting in greater density/abundance reductions).
    - Operational changes would be considered based on the extent to which evidence indicates deviation from density estimates are attributable to dynamics occurring Far-Field, including:
        - Bypass-flow and/or outflow criteria timing and duration shifts (e.g., remaining at Level 1), for example, to better align with observed smelt presence and/or provide downstream flow conditions conducive to positive changes on smelt abundance/density, as determined through environmental studies.
            - This would be informed by smelt presence and movement pattern data gathered from existing monitoring stations upstream of, through, and downstream of the Delta, in addition to the targeted studies identified. In addition, environmental conditions at the time of operations, relationships between abundance of specific smelt life stages and hydrological parameters (e.g., outflow) during various times of the year, and potential mechanisms driving population responses, will be considered.

# 3C.7 Governance Framework and Decision-Making Process

## 3C.7.1 Governance Framework

The implementation of the OAMMP would be a collaborative process that would be essential to the successful operation of the north Delta diversions. Under the OAMMP, new information gained

during implementation would inform operational decisions within the ranges of criteria and effects analyzed in the BIOP and CESA authorizations. The implementing agencies described below commit to working through the collaborative process to reach consensus on operational decisions and other management actions to the extent possible and to elevate any disputes over decisions to appropriate levels of officials for each agency. Each agency retains discretion to make decisions as appropriate within its authority after considering the available information. If, as part of the adaptive management process, an operational change is deemed necessary, further permitting may be required.

### 3C.7.1.1 Implementing Agencies

#### DWR

DWR is a state agency within the California Natural Resources Agency charged with responsibility for operating and maintaining the SWP's existing Delta facilities and would be responsible for constructing and operating new north Delta diversion facilities.

#### CDFW

CDFW is a state agency within the California Natural Resources Agency charged with responsibility for administering CESA and providing for the conservation of state-listed species and their habitats.

#### NMFS

NMFS is the federal agency within the United States Department of Commerce charged with responsibility for administering the ESA and providing for the conservation of federally listed anadromous and marine species and their habitats.

#### USFWS

USFWS is a federal agency within the United States Department of the Interior charged with responsibility for administering the federal ESA and providing for the conservation of federally listed fresh water and semi-anadromous aquatic and terrestrial species and their habitats.

#### SWP Contractors

The SWP contractors are public agencies that receive water under contract from the SWP. These public water agencies fund operation and maintenance of the existing SWP Delta facilities and will fund a portion of the costs to implement the proposed action, including a portion of the OAMMP. SWP contractors would also have a role on the Interagency Implementation Coordination Group (IICG), as described in Section 3C.7.1.2.

### 3C.7.1.2 Interagency Implementation and Coordination Group

The IICG would be a multi-agency group with the primary responsibility of coordinating and implementing the OAMMP. The IICG would be led by DWR and would include a representative of USFWS, NMFS, and one Designated Representative each from DWR, CDFW, and a participating SWP contractor. In the case of DWR and CDFW, a Designated Representative is an official representative designated by and authorized to act on behalf of the Governor of California. In the case of the SWP

contractors, a Designated Representative is an official representative designated by an elected board of directors to act on their behalf. These representatives on the IICG would likely be senior managers/biologists. Additional staff from any of the IICG member agencies and/or consultants may also participate to provide technical assistance or other support. The IICG would also coordinate their activities with Reclamation and CVP contractors to ensure OAMMP actions are consistent with CVP operations.

The IICG shall have primary responsibility for support, coordination, and implementation of the OAMMP and shall:

1. Be responsible for supporting those priority science needs determined necessary to carry out the OAMMP.
2. Route requests for science needs with, if necessary, appropriate funding to the appropriate entity with the capacity to complete them, or at its discretion, the IICG may initiate work to address priority science needs using staff from its member agencies, or any appropriate entity.
3. Establish mechanisms for developing and agreeing to changes to the OAMMP, such as through preparation of an annual adaptive management work plan or development of specific proposals that identify the compliance implications of the proposed change.
4. Promote and fund scientific activities/monitoring that the IICG determines are necessary to carry out the OAMMP.
5. Review scientific information and recommend changes to monitoring schema and management actions to DWR. DWR would then either implement the monitoring change or work on monitoring changes through the IEP.
6. Refer management-related actions or proposals, as appropriate, to the Delta Science Program for review by an independent science panel.
7. Assure transparency consistent with the requirements of the Delta Plan.
8. Review funding commitments and any implementation issues relative to priorities and recommendations from the Delta Science Program, CAMT, or related adaptive management fora.
9. Identify and secure needed infrastructure and resources to support scientific activities/ monitoring.
10. Review and approve the *North Delta Diversion Fisheries Field Studies Workplan* and progress reports.
11. Coordinate with the WOMT, which will consider all operational opportunities requests within 24 hours and simultaneously issue a recommendation to the IICG and the agency with authority to implement the operational opportunities.
12. Coordinate OAMMP activities[5] with the LTO Adaptive Management Steering Committee, as necessary.

[5] In the context of LTO adaptive management, it is anticipated that OAMMP activities would be Bin 3 actions, i.e., adaptive management actions for which agencies evaluate data over longer periods of implementation (on the order of 10-15 years), potentially requiring a full structured decision-making process as described in further detail in Appendix B of the LTO Adaptive Management Program.

### 3C.7.2 Decision-Making Process

Adaptive management recommendations by the IICG shall be by consensus of the representatives. In the event of a dispute within the IICG regarding different hypotheses, lines of evidence, or interpretations of science and/or data related to a proposed change to the OAMMP, any member of the IICG may initiate a non-binding process for a review concerning the matter in dispute by providing IICG members with a written notice of dispute that describes the nature of the dispute and options that may be available to help resolve the matter. In such case, to facilitate dispute resolution, the IICG would meet and confer to consider these options and to see if further collaborative work can be undertaken to determine whether agreement can be reached on the matter.

In the event that resolution of the dispute cannot be reached within the IICG, review of the issue in dispute may occur through the presentation of alternative viewpoints as part of a separate independent science review (e.g., Delta Science Program). The members of the IICG, with the assistance of the IICG Manager, would describe the nature of the dispute to be considered by the panel in consultation with the independent review panel.

Within 30 days of the completion of panel selection, the parties to the dispute shall present their views in writing. A non-binding opinion shall be issued in writing by a majority of the panel.

Within 30 days of issuance of the panel's non-binding opinion, DWR shall consider the panel opinions and provide a written response prior to final decision.

## 3C.8 References

California Department of Fish and Wildlife. 2020. *California Endangered Species Act Incidental Take Permit No. 2081-2019-066-00. Long-Term Operation of the State Water Project in the Sacramento San Joaquin Delta*. Sacramento, CA: California Department of Fish and Game, Ecosystem Conservation Division.

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Appendix 6A
# Terrestrial Effects Analysis Methods

## 6A.1 Introduction

This appendix describes the methods used to analyze the effects of the Delta Conveyance Project (proposed action) on federally listed species in the action area. Effects are analyzed using quantitative and qualitative methods. Quantitative methods are used to estimate the maximum acres of habitat loss. Qualitative methods are used to describe the relative value of the habitat lost and the potential for direct and indirect effects (e.g., injury, mortality, changes in behavior).

## 6A.2 Spatial Extent of the Terrestrial Effects Analysis

The action area for the effects analysis for listed wildlife is the entire legal Delta plus an additional area that includes the lands between Clifton Court Forebay and Bethany Reservoir. Refer to Chapter 4, *Action Area and Environmental Baseline,* for a description of the action area, the proposed action, and the environmental baseline. Chapter 4 includes an overview of environmental conditions and a description of the effects of these conditions on the species included in this biological assessment. The activities that would occur in the area between Clifton Court Forebay and Bethany Reservoir include field investigations and construction activities associated with Bethany Complex, access roads, electrical power transmission lines, and supervisory control and data acquisition (SCADA) facilities.

## 6A.3 Temporal Extent of the Terrestrial Effects Analysis

Construction of the water conveyance facility will continue for 13 years; the construction schedule includes preconstruction field investigations, habitat suitability surveys, vegetation removal and grading, facility construction, and restoration of undeveloped portions of the construction footprint. After construction is complete, this biological assessment would cover the operations and maintenance of all covered facilities for 10 years. Thus, the temporal extent of the analysis is 30 years. Construction of all habitat creation, restoration, and enhancement actions that are required by the Compensatory Mitigation Plan (CMP) is expected to be completed by the time conveyance facility construction is complete. Monitoring and maintenance of created, restored, and protected habitat will continue in perpetuity.

## 6A.4 Terrestrial Effects Analysis Organizational Background

This section describes the background necessary to understand the organizational approach taken in the terrestrial effects analysis. Chapter 6, *Effects Analysis for Delta Smelt, Longfin Smelt, and Terrestrial Species*, is organized by feature of the proposed action (e.g., north Delta intakes, tunnel shaft, Bethany Complex) and by impact category (e.g., habitat loss and fragmentation, construction-

related effects, and operations and maintenance). The sections below describe each of these features and impact categories.

## 6A.4.1 Impact Categories

Activities related to the proposed action could affect wildlife resources in the action area either directly or indirectly. Direct effects can be either permanent, long-term temporary, or temporary. These impact categories were used to assess effects on wildlife resources.

- Permanent. This is the conversion of a natural or agricultural habitat type to a feature of the proposed action. For example, a patch of grassland or riparian habitat would be converted to a concrete pad on which an intake or a tunnel shaft is constructed. The habitat is permanently lost.
- Long-term temporary. This is habitat loss or disturbance that lasts longer than 1 year, but the area would be returned to as close to pre-action conditions as possible after construction is finished (see Chapter 3, *Description of the Proposed Action*, Section 3.2.15, *Land Reclamation*). For the purposes of the effects analysis discussion, this loss is considered permanent. Any habitat created by reclamation of these areas post-construction would be considered newly created habitat that could count toward the total acres of compensatory mitigation if the reclaimed areas meet habitat suitability requirements and have not experienced irreversible changes to hydrology or soil compaction. The purpose for counting long-term temporary impacts as permanent is to recognize, and compensate for, the temporal loss of habitat.
- Temporary. Temporary, or short-term temporary impacts, include ground-disturbing activities in habitat that would be restored to pre-project conditions in less than a year after initial disturbance.

Generally, the take analysis contains an assessment of both direct and reasonably foreseeable indirect impacts of the proposed action. Direct impacts of the proposed action are caused by activities that occur during construction and implementation. Indirect effects of the proposed action are caused by activities that occur at some later time or farther removed in distance but are reasonably foreseeable. Direct effects on terrestrial species could be caused by habitat loss and fragmentation, construction-related effects, or operation and maintenance of project facilities. Indirect effects on terrestrial species could be caused by permanent alterations to light and noise levels, alterations to hydrology, damage through toxicity associated with herbicides and rodenticides, or introduction of invasive (nonnative) species.

## 6A.4.2 Features of the Proposed Action

More than 200 unique features of the proposed action (often called project features) are included in the preliminary engineering drawings for the proposed action. However, these features are bundled into complexes and, from a species impact perspective, are not unique or distinct. To inform the effects analysis in Chapter 6, project features are bundled or “rolled up” into a small number based on impact type and specific geography. For example, all activities that occur to construct the north Delta intakes and Bethany Complex would result in similar impact mechanisms—noise, light, dust, permanent habitat loss. However, the Bethany Complex would be built in a separate geography and thus has the potential to affect different species. Therefore, the north Delta intakes and Bethany Complex need to be discussed separately. Table 6A-1 shows the full suite of the proposed action's features, as labeled in the original engineering drawings, that were identified as unique from a terrestrial species impact perspective. These features were then further “rolled up” and it is the rolled up features by which the Chapter 6 analysis is organized. The primary reason for the rolled up list of project features is to provide a smaller, more workable group of project features by which the analysis is organized. The main difference between the full and rolled up list is that project features

that have long-term temporary impacts are combined with project features that have permanent impacts. Because long-term temporary impacts are assumed to last longer than one year, and because wildlife agency staff typically consider habitat loss that lasts longer than one year to be permanent; long-term temporary impacts are considered permanent. This analysis presents a record of the long-term temporary impacts so that wildlife agency staff understand the magnitude and location of areas that could be restored upon construction completion for partial compensation of habitat loss. See Section 6A.4.1, *Impact Categories*, for more details.

**Table 6A-1. Project Features Informing the Terrestrial Effect Analysis by Impact Type**

| Rolled-Up Project Features as Analyzed in Chapter 6 [a] | Impact Types [b] | | Full List of Project Features [c] |
|---|---|---|---|
| | Permanent | Temporary | |
| Field Investigations | – | x | Fault Trench Line Work Area, Geotechnical Exploration Zone |
| North Delta Intake | x | – | North Delta Intake |
| Tunnel Shaft | x | – | Tunnel Shaft |
| RTM Area | x | – | RTM Area, Other Long-Term Temporary, Twin Cities Complex Ring Levee |
| Bethany Complex | x | – | Bethany Complex |
| Access Roads | x | x | Access Roads [d]<br>Levee Improvement Area [e]<br>Other Long-Term Temporary<br>Railroad Work Area<br>Public Road [d] |
| Electrical and SCADA Facilities (Overhead and Underground) | x | x | Other Permanent, SCADA Facilities (Overhead), Electrical Facility (Overhead), Electrical Facility Transmission (Underground), SCADA Facilities (Underground) [f] |
| Other Construction Support Facilities | x | x | Other Permanent, [g] Other Long-Term Temporary [h] |
| CCWD | x | | CCWD |
| CMP | – | x [i] | CMP |

CCWD = Contra Costa Water District; CMP = Compensatory Mitigation Plan; RTM = reusable tunnel material; SCADA = supervisory control and data acquisition.

[a] These are the section headings in the terrestrial portion of the Chapter 6 effects analysis. These are the project features for which impacts on terrestrial species are evaluated.

[b] See Section 6A.4.3, *Effects Mechanisms*, for definitions of permanent, long-term temporary, and temporary impact types.

[c] This is the "full list" of project features evaluated for the purposes of the terrestrial impact analysis. The source of these project features is the original Engineering Project Reports (Delta Conveyance Design and Construction Authority 2022a, 2022b).

[d] Access road and public road activity types are temporary. All other project features in this category are permanent or long-term temporary (which is considered permanent in the roll up).

[e] The levee improvement area on Lower Roberts Island will be constructed alongside, and at the same time as, the access road. Because both impacts are permanent and have similar construction-related effects, they are treated together in the Chapter 6 terrestrial effects analysis.

[f] SCADA Facilities (underground) is the only temporary activity in the Electrical and SCADA Facilities (Overhead and Underground) impact category.

[g] The "other permanent" category includes the following project features: batch plant, metering area, park and ride, and proposed switching station. Although these features occur in various locations along the alignment, they are all very small, permanent, and discrete (i.e., occur away from larger complexes).

[h] The "other long-term temporary" project features include batch plant, water pumping plant, proposed switching station, and substation.

[i] For those species with modeled habitat that overlaps with the CMP footprint (least Bell's vireo, western yellow-billed cuckoo, giant garter snake, and valley elderberry longhorn beetle, western pond turtle, western spadefoot), implementation of the CMP would convert existing, low quality habitat to high quality habitat and thus the ground disturbance is considered temporary.

For a full description of the activities that would occur at each project feature see Chapter 6. The introduction to each project feature section includes a brief description of the activity as it relates to the terrestrial effects analysis.

## 6A.4.3 Effects Mechanisms

The effects analysis for each species is organized into three effect mechanism types: habitat loss and fragmentation, construction-related effects, and operations and maintenance. These categories are described below.

- Habitat Loss and Fragmentation.
  - Habitat loss is the conversion of habitat to non-habitat. There are two types of habitat loss discussed in Chapter 6—permanent and temporary—however, the full impact analysis identifies three types – permanent, long-term temporary, and temporary, which are described in 6A.4.1. *Impact Categories*. The project features associated with each impact type are described in Table 6A-1.
  - Fragmentation is the result of a contiguous patch of habitat being divided into two or more smaller patches by a project feature that could serve as a full or partial barrier to wildlife movement. Fragmentation lowers the value of the remaining habitat patches.
- Construction-Related Effects. These are actions that can result in species injury or mortality, or changed behavior (e.g., changing movement patterns, avoidance of the construction area, emergence from cover, etc.) that could result in injury or mortality. The impact mechanisms that are discussed in this section of the effects analysis are listed below.
  - Heavy equipment—Heavy equipment is required for grading, excavation, trenching, drilling, and placement of fill and could result in the crushing of individuals.
  - Hazardous materials—Examples include spills of fuels, oils, and cement which could result in toxicity.
  - Vehicle movement—Examples include construction personnel vehicles, haul trucks, and grading equipment movement on local roads and construction access roads, and off-road vehicle movement in portions of work areas which would result in the crushing of individuals.
  - Noise—Examples include equipment operation, pile driving, and helicopters which could result in wildlife avoiding areas or other changed behaviors that make wildlife more susceptible to increased energy expenditure or predation or that result in relocation to areas of reduced pretty abundance.
  - Light—Includes permanent lighting at project facilities, temporary lighting used for construction, and disturbances caused by the presence of construction vehicles and personnel which could result in wildlife avoiding the area or in changed circadian rhythms and increased stress and energy expenditure.

  - Vibration—Heavy equipment, vehicles, and pile driving are the primary sources of vibration which could result in avoidance, increased potential for predation or increased energy expenditure.
  - Visual disturbance—The presence of humans or construction equipment on the landscape, in particular, the movement of people or equipment which could result in avoidance, increased potential for predation or increased energy expenditure.
  - Water quality—Includes the creation and mobilization of methylmercury, selenium, pesticides, and microcystins, which could result in acute toxicity that leads to death or chronic toxicity that could lead to decreased survivability or reproductive malformations. Also includes erosion and sedimentation that could result in injury, mortality, or disruption of normal behaviors of individuals, eggs, and larvae using aquatic habitat.
  - Dewatering—Includes pumping and draining of waterbodies which could lead to mortality of early life stages or increased potential for predation for adults.
  - Dust—Results from ground disturbance and vegetation removal and could result in wildlife avoiding the area or in decreased photosynthesis/survivorship in plants.
- Operations and Maintenance. While operations and maintenance activities would be different from construction activities, many of the impact categories (e.g., noise, hazardous materials, light, dust, etc.) are the same. In addition to those listed above for construction-related effects, impacts mechanisms for operations and maintenance also include herbicide/pesticide application and vegetation removal, trimming, and mowing; all of which could result in the injury and mortality mechanisms listed above.

# 6A.5 Terrestrial Effects Analysis Methods

As described in Section 6A.4, *Terrestrial Effects Analysis Organizational Background*, Chapter 6 is organized by project feature and then by impact category. While the project feature determines what impact category will be relevant to the analysis, it is the impact categories that determine the method of analysis. The terrestrial effects analysis uses two basic methods for evaluating impacts: quantitative and qualitative. Habitat loss is evaluated quantitatively, and all other impact categories are evaluated qualitatively. The two methods are further described in the following sections.

## 6A.5.1 Habitat Loss

Habitat loss was quantified by overlapping or intersecting a project footprint represented spatially in geographic information systems (GIS) with a species model, also represented spatially in GIS. Wherever the footprint and the model overlap, it is counted as an impact measured in acres. The project footprint GIS layer includes information such as project feature type and impact type, thus, the acres of overlap with the species model can be delineated by project feature type and impact type. The output of the GIS terrestrial effects analysis intersect is a table that lists how many acres of overlap occur, or more specifically, how many acres of modeled habitat will be affected, by project feature, impact type, and species model type. See Section 6A.4.2, *Project Features*, and Section 6A.4.1 for descriptions of project features and impact types. See Chapter 4, Section 4.4, *Status of the Species/Environmental Baseline Summary* for a description of each species model.

Table 6A-2 includes the results of the intersection of the project footprint and the species models for the full suite of project features; Table 6A-3 includes the results for the rolled-up features. The modeled habitat loss results presented in Table 6A-3 are presented and analyzed in Chapter 6.

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**Table 6A-2. Maximum Loss of Modeled Habitat, Full List of Project Features (acres)**

| Species | Habitat | Permanent Habitat Loss [a] | | | | | | | | | | | | | Long-Term Temporary Habitat Loss [a, b] | | | | | | Temporary Habitat Loss [a, c] | | | | | | | | | Total Affected Modeled Habitat | Initial Mitigation Sites |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CCWD | Access Roads | Bethany Complex | North Delta Intake | Levee Improvement Area | Other Permanent [d] | SCADA Facilities (Overhead) | Electrical Facilities (Overhead) | Public Road | RTM | Tunnel Shaft | Electrical Facilities (Underground) | Permanent Surface Impact Total | CCWD | Bethany Complex | North Delta Intake | Other Long-Term Temporary [e] | Tunnel Shaft | Long-Term Temporary Surface Impact Total | CCWD | Access Roads | Fault Trench Line Work Area | Geotechnical Exploration Zone | Public Road | Other Temporary | SCADA Facilities (Underground) | Electrical Facilities (Underground) | Temporary Surface Impact Total | | |
| San Joaquin kit fox | High quality | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | **0.13** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.01 [f] | 0.01 | **0.06** | **0.19** | 0.00 |
| San Joaquin kit fox | Moderate quality | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | **0.06** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 [f] | 0.00 | **0.02** | **0.08** | 0.00 |
| San Joaquin kit fox | Low quality | 0.00 | 12.51 | 19.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.42 | 3.71 | 0.00 | 0.00 | 0.00 | **35.89** | 0.00 | 2.80 | 0.00 | 0.00 | 0.00 | **2.80** | 0.00 | 11.12 | 0.00 | 2.58 | 2.61 | 0.00 | 0.63 [f] | 0.00 | **16.94** | **55.63** | 0.00 |
| California least tern | Foraging | 0.00 | 0.42 | 0.00 | 4.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.16 | 0.00 | 0.00 | 0.29 | **5.86** | 0.00 | 0.27 | 0.83 | 0.00 [g] | 0.00 | **1.10** | 0.00 | 0.45 | 0.00 | 3.36 | 0.24 | 0.00 | 0.10 | 0.01 | **4.16** | **11.13** | 0.00 |
| Least Bell's vireo | Recolonization | 0.00 | 0.77 | 0.16 | 4.51 | 1.45 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.00 | 0.11 | **7.54** | 0.00 | 0.06 | 1.85 | 0.00 [h] | 0.23 | **2.13** | 0.00 | 1.11 | 0.00 | 0.71 | 0.93 | 0.00 | 4.05 | 0.87 | **7.67** | **17.34** | 204.79 [i] |
| Western yellow-billed cuckoo | Migratory | 0.00 | 0.77 | 0.16 | 4.51 | 1.45 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.00 | 0.11 | **7.54** | 0.00 | 0.06 | 1.85 | 0.00 [h] | 0.23 | **2.13** | 0.00 | 1.11 | 0.00 | 0.71 | 0.93 | 0.00 | 4.05 | 0.87 | **7.67** | **17.34** | 204.79 [i] |
| California red-legged frog | Aquatic | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 | **0.21** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.00 | 0.00 | 0.00 | **0.12** | **0.34** | 0.00 |
| California red-legged frog | Upland | 0.00 | 1.47 | 0.06 | 0.00 | 0.00 | 0.02 | 0.00 | 0.05 | 2.32 | 0.00 | 0.00 | 0.00 | **3.92** | 0.00 | 3.15 | 0.00 | 0.00 | 0.00 | **3.15** | 0.00 | 0.71 | 0.00 | 0.00 | 1.40 | 0.00 | 0.60 | 0.01 | **2.72** | **9.78** | 0.00 |
| California red-legged frog | Dispersal [j] | 0.00 | 17.16 | 244.75 | 0.00 | 0.00 | 0.00 | 0.00 | 0.64 | 30.13 | 0.00 | 0.00 | 0.00 | **292.68** | 0.00 | 70.80 | 0.00 | 0.00 | 0.00 | **70.80** | 0.00 | 20.05 | 15.92 | 5.11 | 5.43 | 0.00 | 1.46 | 0.01 | **47.97** | **411.45** | 0.00 |
| California tiger salamander | Aquatic [k] | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.14** | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | **0.06** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.20** | 0.00 |
| California tiger salamander | Upland | 0.00 | 9.71 | 32.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.61 | 2.84 | 0.00 | 0.00 | 0.00 | **45.18** | 0.00 | 15.02 | 0.00 | 0.00 | 0.00 | **15.02** | 0.00 | 10.37 | 1.96 | 2.97 | 2.21 | 0.00 | 1.56 | 0.02 | **19.08** | **79.29** | 0.00 |
| Giant garter snake | Aquatic | 0.00 | 1.05 | 0.08 | 1.39 | 2.89 | 0.00 | 0.00 | 0.00 [l] | 0.29 | 0.54 | 0.11 | 0.38 [l] | **6.73** | 0.25 | 0.19 | 0.63 | 0.00 [h] | 1.83 | **2.91** | 0.00 | 7.94 | 0.25 [l] | 3.03 [l] | 0.64 | 0.00 | 0.17 | 1.84 | **13.87** | **23.52** | 150.54 [m] |
| Giant garter snake | Upland | 0.02 | 10.61 | 1.92 | 8.15 | 12.60 | 0.00 | 0.00 | 0.06 [l] | 6.10 | 0.00 | 0.00 | 0.78 [l] | **40.25** | 5.88 | 5.41 | 4.01 | 0.00 [h] | 15.69 | **31.00** | 0.00 | 10.47 | 5.57 [l] | 5.77 [l] | 5.66 | 0.00 | 6.37 | 3.87 | **37.70** | **108.95** | 189.81 [m] |
| Valley elderberry longhorn beetle | Riparian | 0.00 | 0.98 | 0.88 | 4.66 | 7.57 | 0.00 | 0.00 | 0.00 | 1.51 | 0.00 | 0.00 | 0.43 | **16.03** | 0.00 | 0.15 | 2.35 | 0.00 [h] | 0.94 | **3.44** | 0.00 | 1.75 | 0.00 | 2.38 | 1.49 | 0.00 | 4.28 | 0.98 | **10.89** | **30.36** | 204.79 [n] |
| Vernal pool fairy shrimp | Modeled | 0.00 | 0.11 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | **0.36** | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | **0.06** | 0.00 | 0.00 [o] | 0.23 [o] | 0.34 [o] | 0.19 [o] | 0.00 | 0.00 | 0.00 | **0.76** [o] | **1.18** [o] | 0.42 |
| Vernal pool tadpole shrimp | Modeled | 0.00 | 0.11 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | **0.36** | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | **0.06** | 0.00 | 0.00 [o] | 0.23 [o] | 0.34 [o] | 0.19 [o] | 0.00 | 0.00 | 0.00 | **0.76** [o] | **1.18** [o] | 0.42 |
| Northwestern pond turtle | Aquatic | 0.00 | 2.03 | 1.89 | 5.82 | 0.93 | 0.03 | 0.00 | 0.6 | 1.37 | 5.12 | 0.85 | 0.55 | **18.59** | 0.33 | 1.69 | 1.87 | 0.01 | 11.18 | **15.09** | 0.00 | 8.21 | 0.44 | 6.07 | 1.31 | 0.00 | 0.42 | 2.61 | **19.05** | **52.73** | 233.94 |
| Northwestern pond turtle | Upland | 0.02 | 20.24 | 19.75 | 11.99 | 12.98 | 1.16 | 0.00 | 0.00 | 12.55 | 0.10 | 0.33 | 0.79 | **80.51** | 5.88 | 15.21 | 4.59 | 0.29 | 9.60 | **35.58** | 0.00 | 17.52 | 3.67 | 8.36 | 10.36 | 0.00 | 8.56 | 6.32 | **54.78** | **170.87** | 456.10 |
| Western spadefoot | Aquatic | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.14** | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | **0.06** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** | **0.20** | 0.00 |
| Western spadefoot | Upland | 0.00 | 5.89 | 14.93 | 0.00 | 0.00 | 0.02 | 0.00 | 0.05 | 0.01 | 0.00 | 0.00 | 0.00 | **20.90** | 0.00 | 12.00 | 0.00 | 0.00 | 0.00 | **12.00** | 0.00 | 1.86 | 1.66 | 0.30 | 0.07 | 0.00 | 0.28 | 0.17 | **4.34** | **37.24** | 0.00 |

CCWD = Contra Costa Water District; CMP = Compensatory Mitigation Plan; RTM = reusable tunnel material; SCADA = supervisory control and data acquisition.

[a] See Section 6A.4.1, *Impact Categories*, for definitions of permanent, long-term temporary, and temporary impact types.

[b] Long-term temporary impacts are those impacts that would be restored, but not within 1 year from ground disturbance (as temporary impacts will be).

[c] Temporary habitat disturbance from construction would be restored to pre-disturbance conditions within 1 year of construction completion, as described in *AMM14: Construction Best Management Practices for Biological Resources* (Appendix 3A, *General Avoidance and Minimization Measures*).

[d] The "other permanent" category includes the following project features: concrete batch plant, metering area, park-and-ride lots, proposed switching station, and overhead SCADA. These features have been grouped together because they have similar impacts/activities, are of small extent, and are discrete (i.e., occur away from larger complexes).

[e] The "other long-term temporary" project features include concrete batch plant, construction water pipeline, proposed switching station, and substation.

[f] A SCADA facility overlaps with San Joaquin kit fox modeled habitat near the Bethany Complex, however, rather than being trenched, the facility would be bored and, therefore, would not have a surface impact (so no impacts are reported). All other SCADA facilities that overlap with the model occur within a larger construction complex such as the Bethany Complex.

[g] Includes impacts from railroad work area.

[h] Includes impacts from ring levee and railroad work area.

[i] This effect analysis assumes that existing, low-quality least Bell's vireo and western yellow-billed cuckoo habitat would be temporarily disturbed from implementation of the compensatory mitigation plan enhancement and creation actions. The temporary disturbance is expected to convert existing, low-quality habitat to enhanced, high-quality habitat.

[j] Overlap between the project footprint and dispersal habitat is described here to inform the impact discussion of movement.

[k] The aquatic habitat model for California tiger salamander includes vernal pool complex, a natural community made up of pool features in a grassland matrix. As a result, the acres of modeled habitat represent mostly upland acres (rather than aquatic acres).

[l] Field investigations and electrical facilities would avoid suitable aquatic giant garter snake habitat; see Chapter 3, Section 3.6.2.7, *Giant Garter Snake Avoidance and Minimization Measure*.

[m] This effect analysis assumes that existing, low-quality giant garter snake habitat would be temporarily disturbed from implementation of the compensatory mitigation plan enhancement and creation actions. The temporary disturbance is expected to convert existing, low-quality habitat to enhanced, high-quality habitat.

[n] This effect analysis assumes that existing, low-quality valley elderberry longhorn beetle riparian habitat would be temporarily disturbed from implementation of the compensatory mitigation plan enhancement and creation actions. The temporary disturbance is expected to convert existing, low-quality habitat to enhanced, high-quality habitat.

[o] This effect analysis assumes that all temporary and indirect effects on vernal pools result in a permanent loss of the pool.

**Table 6A-3. Maximum Loss of Modeled Habitat, Project Features "Roll Up" (acres)**

| | | | Permanent Habitat Loss [a, b] | | | | | | | | | Temporary Habitat Loss [a, b] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Habitat | Total Modeled Habitat in the Action Area | CCWD | Access Roads [c] | Bethany Complex | North Delta Intake | Other Construction Support Facilities [c] | Electrical and SCADA Facilities (Overhead and Underground) [c] | RTM [c] | Tunnel Shafts | Permanent Habitat Loss Total | Field Investigation [c] | CCWD | Access Road [c] | Other Construction Support Facilities | Electrical and SCADA Facilities (Overhead and Underground) | Temporary Habitat Loss Total | Total Affected Modeled Habitat | CMP |
| San Joaquin kit fox | High quality | 78.28 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.11 | 0.00 | 0.00 | 0.13 | 0.04 | 0.00 | 0.00 | 0.01 | 0.01 | 0.06 | 0.19 | 0.00 |
| San Joaquin kit fox | Moderate quality | 11.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.06 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.08 | 0.00 |
| San Joaquin kit fox | Low quality | 1,363.62 | 0.00 | 16.22 | 22.05 | 0.00 | 0.00 | 0.42 | 0.00 | 0.00 | 38.69 | 2.58 | 0.00 | 13.73 | 0.00 | 0.63 | 16.94 | 55.63 | 0.00 |
| California least tern | Foraging | 9,021.95 | 0.00 | 0.58 | 0.27 | 5.82 | 0.00 | 0.29 | 0.00 | 0.00 | 6.96 | 3.36 | 0.00 | 0.70 | 0.00 | 0.11 | 4.16 | 11.13 | 0.00 |
| Least Bell's vireo | Recolonization | 17,386.63 | 0.00 | 2.77 | 0.22 | 6.35 | 0.00 | 0.11 | 0.00 | 0.23 | 9.68 | 0.71 | 0.00 | 2.04 | 0.00 | 4.92 | 7.67 | 17.34 | 204.79 |
| Western yellow-billed cuckoo | Migratory | 17,296.15 | 0.00 | 2.77 | 0.22 | 6.35 | 0.00 | 0.11 | 0.00 | 0.23 | 9.68 | 0.71 | 0.00 | 2.04 | 0.00 | 4.92 | 7.67 | 17.34 | 204.79 |
| California red-legged frog | Aquatic | 148 | 0.00 | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.21 | 0.00 | 0.00 | 0.12 | 0.00 | 0.00 | 0.12 | 0.34 | 0.00 |
| California red-legged frog | Upland | 668 | 0.00 | 3.79 | 3.21 | 0.00 | 0.02 | 0.05 | 0.00 | 0.00 | 7.06 | 0.00 | 0.00 | 2.11 | 0.01 | 0.60 | 2.72 | 9.78 | 0.00 |
| California red-legged frog | Dispersal | 21,580 | 0.00 | 47.29 | 315.55 | 0.00 | 0.00 | 0.64 | 0.00 | 0.00 | 363.48 | 21.03 | 0.00 | 25.47 | 0.01 | 1.46 | 47.97 | 411.45 | 0.00 |
| California tiger salamander | Aquatic | 9,326.57 | 0.00 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.00 |
| California tiger salamander | Upland | 7,402.42 | 0.00 | 12.55 | 47.03 | 0.00 | 0.02 | 0.61 | 0.00 | 0.00 | 60.20 | 4.92 | 0.00 | 12.58 | 0.02 | 1.56 | 19.08 | 79.29 | 0.00 |
| Giant garter snake | Aquatic | 55,384.97 | 0.25 | 4.24 | 0.27 | 2.03 | 0.00 | 0.38 | 0.54 | 1.94 | 9.65 | 3.28 | 0.00 | 8.58 | 0.00 | 2.01 | 13.87 | 23.52 | 150.54 |
| Giant garter snake | Upland | 51,148.80 | 5.90 | 29.31 | 7.32 | 12.17 | 0.00 | 0.85 | 0.00 | 15.69 | 71.24 | 11.34 | 0.00 | 16.12 | 0.00 | 10.24 | 37.70 | 108.95 | 189.81 |
| Valley elderberry longhorn beetle | Riparian | 20,458.28 | 0.00 | 10.06 | 1.04 | 7.01 | 0.00 | 0.43 | 0.00 | 0.94 | 19.47 | 2.38 | 0.00 | 3.25 | 0.00 | 5.26 | 10.89 | 30.36 | 204.79 |
| Vernal pool brachiopods | Vernal pools | 13,819.36 | 0.00 | 0.22 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.42 | 0.57 | 0.00 | 0.19 | 0.00 | 0.00 | 0.76 | 1.18 | 0.42 |
| Northwestern pond turtle | Aquatic | 110,519.78 | 0.33 | 4.32 | 3.58 | 7.69 | 0.04 | 0.55 | 5.12 | 12.03 | 33.67 | 6.51 | 0.00 | 9.52 | 0.00 | 3.03 | 19.05 | 52.73 | 233.94 |
| Northwestern pond turtle | Upland | 63,117.86 | 5.90 | 45.77 | 34.96 | 16.58 | 1.46 | 1.40 | 0.10 | 9.93 | 116.09 | 12.02 | 0.00 | 27.88 | 0.02 | 14.86 | 54.78 | 170.87 | 456.10 |
| Western spadefoot | Aquatic | 11,937.05 | 0.00 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.00 |
| Western spadefoot | Upland | 2,919.58 | 0.00 | 5.91 | 26.93 | 0.00 | 0.02 | 0.05 | 0.00 | 0.00 | 32.90 | 1.96 | 0.00 | 1.93 | 0.01 | 0.43 | 4.34 | 37.24 | 0.00 |

CCWD = Contra Costa Water District; CMP = Compensatory Mitigation Plan; RTM = reusable tunnel material; SCADA = supervisory control and data acquisition.

[a] These are the project features for which impacts on terrestrial species are evaluated in Chapter 6.

[b] See Section 6A.4.1, *Impact Categories*, for definitions of permanent and temporary habitat loss.

[c] See Table 6A-1 for the full list of the project features that have been rolled up to inform this table and effects analysis in Chapter 6.

[d] SCADA facilities are bored in this region and not trenched. No impact to modeled habitat.

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#### 6A.5.1.1 Suitable Habitat Models

Habitat models were developed because project design and impact analysis were developed simultaneously. As such, access to the project footprint has not been granted and on-the-ground surveys of suitable habitat are not possible. Habitat models collect a variety of information relating to habitat requirements—environmental attributes, species life history, and occurrences—to create hypotheses of species-habitat relationships rather than statements of proven cause-and-effect relationships (Schamberger et al. 1982). Habitat models for terrestrial species are formulated primarily using land cover data from existing GIS data sources as described in Chapter 4, Section 4.4 and are assumed to provide a conservative estimate of maximum habitat loss from which can inform take assessments.

The habitat models were created using existing GIS data that in some cases do not provide the necessary information to precisely identify suitable habitat characteristics for a species. For example, the riparian plant alliance data are not good predictors of the structural characteristics necessary to support nesting least Bell's vireos or western yellow-billed cuckoos. For this reason, *modeled habitat* is differentiated from *suitable habitat,* as defined for each species in Chapter 4, Section 4.4*.* Suitable habitat would be delineated prior to breaking ground to identify appropriate avoidance and minimization measures and to measure the habitat loss so that it can be tracked against the estimated habitat loss maximums presented in Tables 6.A-2 and 6.A-3.

Habitat models for species addressed in this take analysis are used to identify areas where suitable habitat, and thus, individuals are likely to occur. Although the models portray a reasonable distribution of habitat for the species, they do not necessarily indicate with certainty that species are restricted to those areas; nor do they predict whether the habitat is or will be occupied. Instead, the models indicate that nonhabitat areas have a much lower probability of species occurrence compared with areas identified as habitat.

In some cases, the models were developed using site-specific species occurrence information from the California Natural Diversity Database (CNDDB) (California Department of Fish and Wildlife 2020) and information from extensive field surveys conducted in and around water conveyance facility footprints by DWR (*2009 to 2011 Bay Delta Conservation Plan EIR/EIS Environmental Data Report*) (California Department of Water Resources 2011). DWR's survey results were used together with CNDDB occurrence data to determine whether construction footprints for the proposed action would affect known species occurrences. DWR surveys have not been performed on all lands within the alignment and the CNDDB data is limited by where previous surveys have occurred. Therefore, while the species models likely include habitat that may not be suitable or is unoccupied, they provide a conservative estimate of potentially suitable habitat. Habitat suitability will be determined, prior to ground disturbance, using field surveys. Because the models are conservative, it is assumed that the total impacted acreage would be less than what was estimated using the species models. Though the analysis discusses where CNDDB occurrences may overlap with, or occur close to the project footprint, on-the-ground suitable habitat surveys, and in some cases, species surveys, would be used to verify suitability and occupancy prior to construction.

#### 6A.5.1.2 Vernal Pool Branchiopods

There are three types of impact quantified for vernal pool branchiopods: direct permanent, direct temporary, and indirect. The direct and temporary impact categories are defined in Section 6A.4.1 and include the overlap between modeled habitat and a project feature footprint in GIS. However, vernal pool branchiopods are the only species for which indirect impacts are specifically defined and quantified. For vernal pool branchiopods, indirect effects occur when the construction footprint occurs within 250 feet of a modeled pool and pool hydrology is likely to be affected such that the pool hydroperiod is unlikely to support the species into the future. Even though there is little

property access for on-the-ground surveys, there are qualitative rationale that can be provided to support a conclusion of adverse impact avoidance for indirect effects.

For the purposes of this biological assessment, indirect effects on vernal pool branchiopod habitat was determined on a case-by-case basis based on the activity type and topographical position. Each of these factors are described below.

- Activity type. Upgrades to existing roads are assumed to not disturb any land outside the existing paved surface and therefore would not lead to habitat loss. Where an existing feature, such as a road, occurs between the modeled pool feature and the construction footprint, pool hydrology is assumed to be avoided even though the construction footprint is within 250 feet of the feature.
- Topographical position. If ground disturbance or loss occurs down slope from a modeled pool feature, the hydrology of the pool upslope would not be affected.

Where pool avoidance cannot be determined based on topography or the activity, the entire modeled pool feature was assumed lost, and the acreage of that modeled feature was counted as a permanent loss. See Table 6.12-1 for direct and indirect habitat loss acreages.

### 6A.5.1.3 Electrical Facilities

Transmission and distribution line construction for alternatives would consist of underground construction (which requires surface disturbance for trench digging), overhead construction, and overhead construction on existing lines. For the analysis of construction impacts on terrestrial biological resources, the following assumptions were applied.

- All permanent new aboveground distribution lines would be constructed within access road rights-of-ways and it is assumed that there would be no ground-disturbing impacts outside of the access road footprints.
- All permanent underground transmission lines were treated as a permanent impact within the 25-foot-wide easement that would be established above the line. No agriculture requiring cultivation would be allowed in this easement and no woody vegetation (e.g., riparian) would be allowed to reestablish. Underground transmission lines for facilities used during construction only, such as park-and-ride lots, would have long-term temporary impacts; lines would be de-energized and abandoned in-place after construction and restrictions within the easement would not be required thereafter. Lines would be installed using open-cut trenches and directional drilling to go underneath existing infrastructure (e.g., highways and railroads) and waterways.
- Some new overhead transmission line construction would take place over more than 1 year. The current level of design for new transmission lines is conceptual and final design criteria would be developed by the infrastructure owner. The conceptual design currently consists of a 150-foot-wide corridor where most construction-related disturbance is anticipated to take place. In order to estimate what permanent and temporary impacts on terrestrial biological resources would be, assumptions were developed for the amount of ground disturbance based on information obtained from other transmission line construction projects of a similar size. These assumptions include the following.
    - Towers—Towers were assumed to be lattice towers with four footings requiring 7.5 square feet of permanent impact per footing for a total permanent impact of 30 square feet. For towers in agricultural areas, no agricultural production would be possible beneath or immediately adjacent to the towers. For agricultural areas, it was assumed that 900 square feet of agricultural land would be permanently affected per tower. Towers were assumed to

be spaced 1,250 feet apart. Temporary work areas around each tower were assumed to be 40,000 square feet and in use for more than 1 year.

  - Pull sites—Sites used for stringing transmission lines on towers (pull sites) were assumed to require 30,000 square feet of temporary work area per pull site. Pull sites were assumed to be spaced every mile and at every point where a line made a turn. Pull sites were assumed to be in use for more than 1 year.
  - Temporary access roads—It was assumed a 24-foot-wide temporary access road would be needed within the 150-foot-wide corridor for the duration of transmission line construction, which would be more than 1 year.

- Overhead construction on an existing transmission line would be required to power the intakes and Twin Cities Complex. The proposed action would attach an additional power line to an existing Sacramento Municipal Utility District (SMUD) line that follows Franklin Boulevard from around Hood-Franklin Road south to Lambert Road. This new line would be a short segment (approximately 4 miles) constructed in parallel (i.e., at the same elevation) to the existing power line on these poles. All construction activity is assumed to be done from the existing roadway and shoulder and would not result in any permanent or temporary ground disturbance.

#### 6A.5.1.4 SCADA Facilities

Fiber optic cables that are part of SCADA would be installed throughout the proposed action. SCADA lines would be both underground and overhead. Construction for both types would take less than 1 year in a given location.

Underground SCADA lines are assumed to require a 25-foot-wide temporary construction area along the length of the line and there would be no permanent restrictions on activities above these lines (i.e., prohibitions on cultivation or vegetation management). In most areas SCADA lines are situated within existing or planned roads but there are some instances where they are outside of roadways. Construction would involve open-cut trenches and directional drilling to go beneath existing infrastructure (e.g., highways and railroads) and waterways. Overhead SCADA lines would be attached to existing poles but may require permanent impacts associated with pole upgrades. Where upgrades are required, each existing pole was assumed to require 50 square feet of permanent impact. SCADA lines were assumed to be hung below existing power lines and in parallel with existing communications lines.

#### 6A.5.1.5 Compensatory Mitigation Plan

To offset habitat loss from the proposed action, a CMP involving the creation and enhancement of wetlands and other waters, as well as habitat for special-status species on Bouldin Island and the I-5 ponds, would be constructed as described in Appendix 3B, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*. Preliminary designs have been created for these projects in GIS. This preliminary footprint was intersected with the species habitat suitability models and the estimated acres of overlap are presented in Tables 6A-2 and 6A-3. As described Chapter 6, the overlap between the CMP footprint and the habitat model is considered a habitat conversion where existing, low-quality habitat is converted to high-quality habitat for most species. See the *Compensatory Mitigation Plan* sections for each species in Chapter 6 for more details.

### 6A.5.2 Fragmentation

As described in Section 6A.4.1, fragmentation is the result of a contiguous patch of habitat being divided into two or more smaller patches by a project feature that could serve as a full or partial barrier to wildlife movement. The evaluation of fragmentation effects is qualitative and includes two

primary components: (1) an evaluation of the quality of the existing modeled habitat being fragmented and (2) a discussion of the position, size, and permeability of the feature being constructed.

The qualitative analysis of existing habitat includes describing the quality of habitat in general terms of low, moderate, and high quality. These categories of habitat quality are based primarily on the existing land cover, patch size, and occurrences. For example, small, isolated patches of California tiger salamander modeled upland habitat along levees and state and federal water project aqueducts near the Clifton Court Forebay is assumed to be of lower quality than the large patches of grassland habitat surrounding Bethany Reservoir.

The second part of the qualitative discussion evaluates the position of the project feature within the existing landscape. Does the feature substantially increase fragmentation in the region? Is the project feature being constructed between important breeding and foraging habitat? Does the project feature create a new, impervious barrier that would substantially increase wildlife energy expenditures to move around or over it?

## 6A.5.3 Construction-Related Effects

There is a potential for individual animals to be harmed, harassed, injured, or killed as a result of construction activities. The mechanisms by which construction activities affect species are described above in Section 6A.4.1. The construction-related effects sections in the Chapter 6 effects analyses identify those impact categories that would be present (for the given project feature).

Construction-related effects are evaluated qualitatively as to their potential to occur. If a construction-related activity or effect (e.g., heavy equipment use, noise) is mentioned within the chapter effects analysis, it has some potential to occur. In such cases, the potential effect is enough to trigger the requirement for avoidance and minimization measures (so long as suitable habitat is determined to occur during preconstruction field surveys of the action area). In some cases, rationale is provided for why a construction-related activity or effect has low potential to occur or a low potential to result in an adverse effect. In such cases, avoidance and minimization measures are not recommended.

While the qualitative assessment method for most impact categories is straightforward, a few—noise, light, and water quality—have relevant background information that is summarized in the sections below.

### 6A.5.3.1 Noise

The effects of noise may extend beyond the areas immediately adjacent to the construction footprint. For the purposes of this analysis, two species have vulnerability to noise: least Bell's vireo and western yellow-billed cuckoo. These birds have been shown to be particularly vulnerable to noise while nesting (California Department of Transportation 2016:87). During nesting, individuals are less likely to move away from an area to avoid noise; if nesting birds do leave a nest, take of eggs, nestlings, or juveniles could result. In addition, nesting and feeding young is an energy-intensive activity and any additional stress caused by noise or light could further stress an adult, making the individual more vulnerable to predation and disease.

Adverse effects on birds have been shown to occur when noise levels reach or exceed 60 decibels (dB) (California Department of Transportation 2016:87). Noise levels produced by commonly used construction equipment are summarized in Table 6A-4. In Chapter 6, noise impacts are assumed to have potential to affect nesting vireo or cuckoo if modeled habitat is present in the vicinity of the construction footprint. Avoidance and minimization measures to limit noise to below the 60 dB thresholds would be required if birds are detected during preconstruction surveys.

**Table 6A-4. Project Features and Associated Noise Emission Levels (dBA $L_{eq}$ [1 hr]) at Distance (feet) [a]**

| Distance (feet) | Roads and Park-and-Ride Lots | Electrical Facilities and SCADA Facilities | Batch Plant | Facility Construction [b] | Vibratory Pile Driving [c] | Impact Pile Driving [c] |
|---|---|---|---|---|---|---|
| 50 | 90 | 89 | 84 | 89 | 96 | 101 |
| 100 | 82 | 81 | 76 | 81 | 88 | 93 |
| 200 | 74 | 73 | 68 | 73 | 80 | 85 |
| 300 | 69 | 68 | 63 | 68 | 75 | 80 |
| 400 | 66 | 65 | 60 | 65 | 72 | 77 |
| 500 | 63 | 62 | 57 | 62 | 69 | 74 |
| 600 | 61 | 60 | 55 | 60 | 67 | 72 |
| 700 | 60 | 59 | 54 | 59 | 66 | 71 |
| 800 | 58 | 57 | 52 | 57 | 64 | 69 |
| 900 | 57 | 56 | 51 | 56 | 63 | 68 |
| 1,000 | 56 | 55 | 50 | 55 | 62 | 67 |
| 1,100 | 54 | 53 | 48 | 53 | 60 | 65 |
| 1,200 | 53 | 52 | 47 | 52 | 59 | 64 |
| 1,300 | 53 | 52 | 47 | 52 | 59 | 64 |
| 1,400 | 52 | 51 | 46 | 51 | 58 | 63 |
| 1,500 | 51 | 50 | 45 | 50 | 57 | 62 |
| 1,600 | 50 | 49 | 44 | 49 | 56 | 61 |
| 1,700 | 50 | 49 | 44 | 49 | 56 | 61 |
| 1,800 | 49 | 48 | 43 | 48 | 55 | 60 |
| 1,900 | 48 | 47 | 42 | 47 | 54 | 59 |
| 2,000 | 48 | 47 | 42 | 47 | 54 | 59 |

Notes:
dBA = A-weighted decibel; 1-hour $L_{eq}$ = equivalent sound level (over 1 hour); RTM = reusable tunnel material; SCADA = supervisory control and data acquisition.

[a] Equivalent Sound Level ($L_{eq}$) represents an average of the sound energy occurring over a specified period. In effect, $L_{eq}$ is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The duration of the measurement is commonly indicated; in this case, a 1-hour $L_{eq}$ sound level is indicated as dBA $L_{eq}$ (1 hr).

[b] Facilities include the larger construction complexes: north Delta intakes, tunnel shafts, Bethany Complex, and RTM areas.

[c] Impact pile driving would occur at the north Delta intakes and Bethany Complex.

### 6A.5.3.2 Light

Construction light has potential to extend beyond the project footprint, depending on the activity. Species most likely to be vulnerable to light include birds (California least tern, least Bell's vireo, and western yellow-billed cuckoo) (Gauthreaux and Belser 2006:67–86) and nocturnal amphibians such as California tiger salamander and California red-legged frog. The proposed action would be designed to minimize impacts from construction light. In addition, measures would be required to further minimize these effects on species. The analysis discusses the measures that would be implemented to avoid and minimize these effects and assesses any residual effects that cannot be avoided.

#### 6A.5.3.3 Water Quality

Giant garter snake, northwestern pond turtle, and the two riparian-side foraging bird species—least Bell's vireo and western yellow-billed cuckoo—are vulnerable to water quality impacts, specifically Microcystis, mercury, and selenium. Giant garter snakes and northwestern pond turtle are exposed by consuming fish, whereas the birds are exposed by consuming aquatic insects. Additional construction-related water quality effects such as erosion and sedimentation that could affect the species are discussed in Section 6A.4.3, *Effect Mechanisms*.

### 6A.5.4 Operations and Maintenance

As described in Section 6A.4.1, operations and maintenance activities, with the addition of mowing and herbicide/pesticide application, have potential to incur the same impacts on species as construction. While there may be some differences, the impact categories and the effects on the species are generally the same. As such, the methods used to evaluate impacts from construction are the same as those described in Section 6A.5.3, *Construction-Related Effects*.

### 6A.5.5 Critical Habitat

California red-legged frog and vernal pool fairy shrimp have critical habitat that overlaps with the construction footprint. For each species, the following quantitative impacts are calculated in GIS.

- Acres of designated critical habitat that overlaps with the action area.
- Acres of designated critical habitat that overlaps with the construction footprint.

In addition, impacts to the primary constituent elements for each species were evaluated. For vernal pool fairy shrimp, the primary constituent elements are the same as the modeled habitat. This allowed the primary constituent element analysis to be quantitative. For the California red-legged frog, there were several more primary constituent elements than modeled habitat types. However, overall, the primary constituent elements and the modeled habitat included the same spatial extent and thus were cross walked qualitatively.

## 6A.6 References

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# Appendix 6B
# Water Quality

This appendix includes quantitative methods and selected results for analyses used in support of Chapter 6, *Effects Analysis for Terrestrial Species*. This appendix presents information on potential changes to water quality and surface water flows as a result of project operations (as described in Chapter 3, *Project Description*) and as a result of habitat creation and enhancement action on Bouldin Island and at the I-5 ponds as described in Appendix 3B, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources* (CMP). The water quality parameters of concern include methylmercury, microcystin toxins associated with cyanobacteria harmful algal blooms (CHABs), and selenium. These water quality parameters, along with surface water flow, have the potential to adversely affect listed species, including California least tern, western yellow-billed cuckoo, least Bell's vireo, and giant garter snake. For each water quality parameter and for surface flow, this appendix details the following: existing conditions, assessment methodologies, modeling results, and effects analyses for project operations and implementation of the habitat creation and enhancement action as part of the CMP.

Portions of this appendix include discussion of analysis related to the project alternatives from the Delta Conveyance Project Draft Environmental Impact Report (Final EIR) (California Department of Water Resources 2023). The proposed action is included in the Final EIR analysis as Alternative 5.

The potential effects were assessed both qualitatively and quantitatively. The quantitative analyses relies on surface water modeling to estimate methylmercury concentrations in water and fish tissue and selenium concentrations in water, fish tissue, and bird eggs. The CHABs assessment uses modeled temperature, velocity, and residence times to estimate the frequency and magnitude of CHABs in the Delta. Surface water modeling was used to analyze whether operation of the proposed action would result in changes in water levels that could affect riparian vegetation communities that could be used by western yellow-billed cuckoo and least Bell's vireo if these species are present in the action area.

## 6B.1 Mercury

The operational impacts of the proposed action on surface water flow were evaluated to assess the potential effects on mercury and methylmercury concentration and bioavailability. Creation and enhancement of wetlands as part of the CMP have the potential to exacerbate bioaccumulation of methylmercury in covered species by creating newly inundated wetlands.

### 6B.1.1 Background and Existing Conditions

Mercury and its more biologically available methylated form (i.e., methylmercury) is an element of statewide concern. Elevated methylmercury concentrations in aquatic invertebrates and fish tissue produce subsequent exposure and risk to wildlife that consume the fish and can be transferred to adjacent terrestrial foodwebs (Cristol et al. 2008:335). Elevated methylmercury concentrations have been documented in terns, riparian songbirds, and snakes, suggesting these species could be at risk for adverse effects of mercury contamination (Ackerman et al. 2016:37; Cristol et al. 2008:335; Haskins et al. 2019:144). Consequently, covered species including California least tern, western

yellow-billed cuckoo, least Bell's vireo, and giant garter snake could be affected by increased bioaccumulation of methylmercury if operation of the proposed action or wetland habitat creation and enhancement implemented as part of the CMP result in elevated methylmercury concentrations, relative to existing conditions.

Mercury present in the Delta, its tributaries, Suisun Marsh, and San Francisco Bay today is derived both from current processes and as a result of historical deposition. The majority of the mercury present is the result of historical mining of mercury ore in the Coast Ranges (transported via Putah and Cache Creeks to the Yolo Bypass) and the extensive use of elemental mercury to aid gold extraction processes in the Sierra Nevada (transported via Sacramento, San Joaquin, Cosumnes, and Mokelumne Rivers) (U.S. Geological Survey 2008:6). Residual mercury is stored in Delta and bayland soils and continues to contribute mercury in water and sediments of the Delta and downstream waterways.

Over 80% of the total mercury flux to the Delta can be attributed to the Sacramento River and Yolo Bypass (Central Valley Regional Water Quality Control Board 2010:iv). The Sacramento River is the primary tributary source of mercury to the Delta in dry years, but the proportion of mercury loading from the Yolo Bypass increases in wet years to the extent that it is comparable to that of the Sacramento River (Central Valley Regional Water Quality Control Board 2010:134). Cache Creek is a major source of mercury to the Yolo Bypass where high mercury concentrations are transported in suspended sediment (Central Valley Regional Water Quality Control Board 2010:197). Mercury loading from the Delta primarily drives mercury concentrations in northern San Francisco Bay, Suisun Bay, and Suisun Marsh (Central Valley Regional Water Quality Control Board 2010:197; San Francisco Bay Regional Water Quality Control Board 2018:49).

The bioavailability and toxicity of elemental mercury (from whatever primary source) are greatly enhanced through the natural, bacterial conversion of mercury to methylmercury. This occurs primarily under conditions where oxygen concentrations are low (i.e., anoxic) in the sediment and shores of wetlands and to a lesser degree in the water column. Mercury methylation typically occurs to the greatest degree when associated with wetting and drying cycles and varies among wetland types. Within the Delta, flooded agricultural wetlands have been found to produce more methylmercury than seasonally flooded wetlands and permanently flooded wetlands (Alpers et al. 2014:282). The flux of methylmercury from Delta open water and wetland sediments is estimated to contribute 36% of the waterborne methylmercury load in the Delta (Central Valley Regional Water Quality Control Board 2010:88). Tributary inflow sources contribute 58% of the methylmercury load in the Delta, and wastewater, agricultural lands, atmospheric deposition, and urban runoff contribute approximately 6% of the methylmercury load (Central Valley Regional Water Quality Control Board 2010:80).

The Environmental Protection Agency (EPA) approved the Sacramento–San Joaquin Delta Estuary Total Maximum Daily Load (TMDL) for methylmercury in 2011 to protect human health, wildlife, and aquatic life. The TMDL establishes methylmercury fish tissue objectives and waste load allocations for agricultural drainage, atmospheric deposition, open water, tributary inputs, wetlands, point source dischargers (e.g., municipal wastewater dischargers), and nonpoint source dischargers (i.e., municipal separate stormwater systems) in the Delta.

## 6B.1.2 Assessment Methodology

The adverse effects of methylmercury on species from the changes in surface water flow as a result of project operations was assessed quantitatively. The potential effects of wetland creation and enhancement on methylmercury concentrations as a result of wetland restoration projects implemented as part of the CMP were assessed qualitatively. Methylmercury concentrations were calculated using a mass-balance methodology applied to the Delta Simulation Model II (DSM2)-modeled source water flow fractions at each assessment location. In addition, bioaccumulation modeling was conducted to quantify changes in biota concentrations. The bioaccumulation modeling consisted of quantifying changes in water column concentrations of mercury and methylmercury and changes in methylmercury concentrations in the tissue of largemouth bass at Delta assessment locations, relative to existing conditions.

There is little information available on the relationship between methylmercury concentrations measured in water or individual prey species (e.g., plankton, macroinvertebrates, or fish) and resulting concentrations in terrestrial wildlife species. Use of a single prey species (fish) has been documented to be a poor indicator of bird methylmercury concentrations because birds such as terns have large foraging home ranges and consume a variety of species of fish in a variety of habitats with differing methylmercury bioavailability (Ackerman et al. 2014:63). However, a proxy species such as largemouth bass can provide a reasonable way of understanding the magnitude of a potential change relative to existing conditions.

### 6B.1.2.1 Use of Surrogate Species

Largemouth bass was used as a surrogate species to measure the potential magnitude of change in methylmercury from operations because it is a good indicator of mercury contamination throughout the aquatic foodweb (Wood et al. 2011:67). The magnitude of methylmercury bioaccumulation and its toxic effects on individuals differs among species and habitats due to differences in ecological factors, such as habitat type and foodweb structure, and biological factors, such as species sensitivity and exposure to other environmental stressors (Eagles-Smith et al. 2016:1216), and use of individual fish species has been documented to be a poor indicator of methylmercury concentrations in waterbirds that have broad foraging home ranges (Ackerman et al. 2014:63), so largemouth bass tissue is not an accurate measure of actual methylmercury concentrations in terrestrial vertebrates. Largemouth bass have a relatively high level of mercury compared to other species, are piscivorous (like the California least tern), are abundantly distributed throughout the Delta, and have high site fidelity (and therefore can indicate differences in methylmercury concentrations throughout the Delta).

California least tern forage for fish in Delta waterways and giant garter snake primarily consumes small fish and amphibians (US Fish and Wildlife Service 2017), so modeled water column and largemouth bass tissue concentrations are considered appropriate indicators for potential changes in dietary methylmercury exposure for these species. Least Bell's vireo and western yellow-billed cuckoos are insectivorous and do not use aquatic habitats but could use riparian habitats adjacent to aquatic habitats if the species are present within the action area. Methylmercury can be transported from aquatic to adjacent terrestrial foodwebs through ingestion of aquatic prey items, where it can biomagnify and expose songbirds to high concentrations in large insect prey (Cristol et al. 2008:335). Therefore, modeled changes in aquatic foodweb methylmercury concentrations resulting from project operations, as modeled in water concentrations and largemouth bass, are assumed to result in similar changes in adjacent terrestrial foodwebs. Accordingly, modeled

largemouth bass methylmercury concentrations are used as a general indicator of expected changes to methylmercury bioavailability in Delta aquatic and adjacent terrestrial foodwebs, which could affect California least tern, western yellow-billed cuckoo, least Bell's vireo, and giant garter snake if they are present in these habitats.

### 6B.1.2.2 Water Column Concentrations

The quantitative assessment for the Delta utilized a mass-balance approach that applied the DSM2-modeled average monthly source water flow fractions for each Delta assessment location. The source water flow fraction output is the percentage of water at each assessment location constituted by the six primary source waters—Sacramento River (SAC), San Joaquin River (SJR), Yolo Bypass (YOL), eastside tributaries (EST), San Francisco Bay (BAY), and Delta agriculture returns (AGR). These flow fractions were used together with source water constituent concentrations to calculate a given constituent concentration at the assessment locations according to the following equation.

$$C_i = f_{SAC,i}(C_{SAC}) + f_{SJR,i}(C_{SJR}) + f_{YOL,i}(C_{YOL}) + f_{EST,i}(C_{EST}) + f_{BAY,i}(C_{BAY}) + f_{AGR,i}(C_{AGR})$$

In the above equation, $C_i$ is the concentration at Delta assessment location i, $f_{X,i}$ is the average monthly flow fraction from source water X at assessment location i, and $C_X$ is the source water X concentration. Source water concentrations input into the above equation are discussed below in Section 9H.3, *Source Water Concentrations*.

Table 6B-1 lists the Delta assessment locations for which mercury and methylmercury concentrations were calculated.

**Table 6B-1. Delta Assessment Locations and Concentration Calculation Method**

| Assessment Location | Delta Region | Concentration Calculation Method |
|---|---|---|
| Barker Slough at North Bay Aqueduct | Northern | Mass-balance |
| Sacramento River at Emmaton | Western | Mass-balance |
| San Joaquin River at Antioch | Western | Mass-balance |
| Sacramento River at Mallard Island | Western | Mass-balance |
| South Fork Mokelumne River at Terminous | Interior | Mass-balance |
| San Joaquin River at Empire Tract | Interior | Mass-balance |
| Contra Costa Water District Pumping Plant #1 | Interior | Mass-balance |
| Old River at State Route 4 | Southern | Mass-balance |
| Victoria Canal | Southern | Mass-balance |
| Banks Pumping Plant | Export area | Mass-balance |
| Jones Pumping Plant | Export area | Mass-balance |

### 6B.1.2.3 Fish Tissue Concentrations

Tissue concentrations of methylmercury in largemouth bass of 350 millimeters (mm) were calculated by applying the Central Valley Regional Water Quality Control Board (RWQCB) model used in the development of the Delta mercury total maximum daily load (TMDL) (Central Valley Regional Water Quality Control Board 2010:73). The Delta TMDL model is an empirical power curve

that uses water column concentrations of methylmercury to estimate methylmercury concentrations in the fish fillets of standard 350-mm-long largemouth bass. The model is based on largemouth bass as grouped in large regions of the Delta (rather than specific locations) compared to average methylmercury concentrations in water for those same general regions. Data were grouped by subareas of the Delta such as Sacramento River, Mokelumne River, central Delta, San Joaquin River, and west Delta. Largemouth bass are excellent indicators of mercury contamination because they have a relatively high level of mercury compared to other species, are piscivorous, are abundantly distributed throughout the Delta, are popular gamefish, and have high site fidelity. Largemouth bass are therefore representative of spatial patterns of tissue methylmercury concentrations throughout the aquatic foodweb, including exposure to humans.

The Delta TMDL model used for estimating fish tissue concentrations of methylmercury in largemouth bass is presented below (Central Valley Regional Water Quality Control Board 2010:73).

$$\textit{Fish mercury (milligrams per kilogram, wet weight)} = 20.365 \times (\textit{methylmercury in water, nanograms per liter})^{1.6374}$$

$$(r^2 = 0.91, \text{ and } P \text{ less than } 0.05)$$

The modeled methylmercury concentrations in water developed from the mass-balance calculation were input into the above equation to develop fish tissue concentrations of methylmercury at the Delta assessment locations.

## 6B.1.3 Source Water Concentrations

Another input to the mass-balance calculation of mercury and methylmercury concentrations in water at the Delta assessment locations is the concentrations in the primary source waters to the Delta: Sacramento River, San Joaquin River, San Francisco Bay, eastside tributaries (i.e., the Cosumnes, Mokelumne, and Calaveras Rivers), Delta agricultural return waters and Yolo Bypass. Tables 6B-2 and 6B-3 provide summary statistics for the primary source water concentrations of mercury and methylmercury, respectively, as well as information on the source of the data. The concentrations are expressed as total.

**Table 6B-2. Source Water Total Mercury Concentrations (in nanograms per liter)**

| Data Parameter | Sacramento River | San Joaquin River | San Francisco Bay | Eastside Tributaries | Delta Agriculture Return Waters | Yolo Bypass |
|---|---|---|---|---|---|---|
| Average | 6.82 | 7.60 | 6.91 | 7.77 | 6.5 | 27.4 |
| Minimum | 0.56 | 2.4 | 0.14 | 0.26 | – | 7.18 |
| Maximum | 89.1 | 21.7 | 21.6 | 26.2 | – | 92.2 |
| 75th percentile | 8.42 | 8.5 | 10 | 7.5 | – | 35.6 |
| 99th percentile | 30.7 | 18.6 | 18.9 | 26.2 | – | 80.5 |
| Data source | CEDEN 2020 | CEDEN 2020 | CEDEN 2020 | Central Valley Regional Water Quality Board 2010 | Central Valley Regional Water Quality Board 2010 | Central Valley Regional Water Quality Board 2010 |
| Station(s) | Sacramento River at Freeport, River Mile 44, Greene's Landing | San Joaquin River at Vernalis | Mallard Island | Mokelumne River at I-5 and Calaveras River at West Lane | Mid-Delta locations, median | Prospect Slough |
| Date range | 1994–2017 | 2000–2017 | 2008–2013 | 2000–2003 | 2008 | 1995–2003 |
| Non-detect results replaced with reporting limit for statistics | No | No | Yes | No | No | No |
| Data omitted | No | No | No | No | No | 2 outlier values excluded |
| Number of data points | 273 | 35 | 63 | 25 | 1 | 48 |

CEDEN = California Environmental Data Exchange Network; I- = Interstate.

**Table 6B-3. Source Water Total Methylmercury Concentrations (in nanograms per liter)**

| Data Parameter | Sacramento River | San Joaquin River | San Francisco Bay | Eastside Tributaries | Delta Agriculture Return Waters | Yolo Bypass |
|---|---|---|---|---|---|---|
| Average | 0.099 | 0.162 | 0.141 | 0.151 | 0.25 | 0.256 |
| Minimum | 0.02 | 0.09 | 0.025 | 0.011 | – | 0.114 |
| Maximum | 0.341 | 0.367 | 1.38 | 0.320 | – | 0.701 |
| 75th percentile | 0.118 | 0.181 | 0.114 | 0.197 | – | 0.312 |
| 99th percentile | 0.291 | 0.329 | 1.14 | 0.310 | – | 0.641 |
| Data source | CEDEN 2020 | CEDEN 2020 | CEDEN 2020 | Central Valley Regional Water Quality Board 2010 | Central Valley Regional Water Quality Board 2010 | Central Valley Regional Water Quality Board 2010 |
| Station(s) | Sacramento River at Freeport, River Mile 44, Greene's Landing | San Joaquin River at Vernalis | Mallard Island | Mokelumne River at I-5 and Calaveras River at West Lane | Mid-Delta locations, median | Prospect Slough |
| Date range | 2000–2018 | 2000–2017 | 2008–2015 | 2000–2004 | 2008 | 2000–2003 |
| Non-detect results replaced with reporting limit for statistics | Yes | No | No | No | No | No |
| Data omitted | No | No | No | No | No | No |
| Number of data points | 185 | 35 | 22 | 27 | 1 | 22 |

CEDEN = California Environmental Data Exchange Network; I- = Interstate.

Each source water dataset was evaluated to determine whether the primary source water concentration should be represented by a single value or a different value for each month. Analysis of the Sacramento River total mercury (Kruskal Wallis; $p<0.05$) and total methylmercury (Kruskal Wallis; $p<0.05$) datasets had sufficient monthly data for this analysis and indicated significant differences in concentration by month. Concentrations were higher in wetter months in both cases. Due to the presence of a distinct monthly pattern in the Sacramento River, monthly average concentrations were used for these locations in the mass-balance calculation. Although too few data were available from other source water locations to statistically determine if data vary significantly by month, given this was the case for the Sacramento River, monthly average concentrations were used to reflect concentrations of total mercury and methylmercury most accurately in the San Joaquin River and total mercury in the Yolo Bypass. Concentrations from other source waters are represented by the arithmetic mean from the entire dataset in the mass-balance calculations because data were too limited to determine monthly concentrations. Tables 6B.1-4 through 6B-6 provide the monthly average total mercury concentrations for the Sacramento River, San Joaquin

River, and Yolo Bypass. Tables 6B-7 and 6B-8 provide the monthly average total methylmercury concentrations for the Sacramento River and San Joaquin River.

**Table 6B-4. Monthly Average Source Water Total Mercury Concentrations for the Sacramento River (in nanograms per liter)**

| Data Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average concentration | 12.0 | 7.63 | 8.04 | 8.05 | 6.30 | 3.91 | 5.68 | 3.80 | 5.41 | 4.43 | 3.06 | 6.04 |
| Number of data points | 17 | 35 | 20 | 25 | 19 | 34 | 19 | 22 | 11 | 35 | 14 | 22 |

**Table 6B-5. Monthly Average Source Water Total Mercury Concentrations for the San Joaquin River (in nanograms per liter)**

| Data Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average concentration | 5.98 | 12.5 | 8.56 | 6.98 | 7.76 | 8.15 | 7.42 | 7.11 | 7.89 | 6.60 | 4.91 | 3.12 |
| Number of data points | 2 | 3 | 2 | 5 | 4 | 4 | 4 | 3 | 3 | 2 | 2 | 1 |

**Table 6B-6. Monthly Average Source Water Total Mercury Concentrations for the Yolo Bypass (in nanograms per liter)**

| Data Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average concentration | 36.56 | 23.11 | 22.69 | 28.65 | 25.14 | 29.39 | 17.65 | 26.00 | 25.67 | 16.28 | 14.00 | 9.98 |
| Number of data points | 14 | 7 | 3 | 5 | 4 | 4 | 3 | 2 | 2 | 2 | 1 | 1 |

**Table 6B-7. Monthly Average Source Water Total Methylmercury Concentrations for the Sacramento River (in nanograms per liter)**

| Data Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average concentration | 0.128 | 0.103 | 0.113 | 0.098 | 0.116 | 0.130 | 0.091 | 0.074 | 0.075 | 0.068 | 0.097 | 0.111 |
| Number of data points | 10 | 23 | 12 | 22 | 15 | 24 | 12 | 15 | 5 | 22 | 9 | 16 |

**Table 6B-8. Monthly Average Source Water Total Methylmercury Concentrations for the San Joaquin River (in nanograms per liter)**

| Data Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average concentration | 0.239 | 0.190 | 0.169 | 0.162 | 0.128 | 0.195 | 0.165 | 0.141 | 0.139 | 0.161 | 0.152 | 0.102 |
| Number of data points | 1 | 3 | 3 | 6 | 4 | 4 | 4 | 3 | 3 | 2 | 1 | 1 |

# 6B.1.4 Applicable Water Quality Criteria/Objectives

Applicable water quality objectives for mercury are included in the *Water Quality Control Plan (Basin Plan) for Sacramento River Basin and San Joaquin River Basin* (Central Valley Regional Water Quality Control Board 2018:3-8), as well as the California Toxics Rule (CTR).

The applicable CTR criterion is for fresh water and the protection of human health from drinking the water and the consumption of organisms. The criterion is 50 ng/L, expressed as total mercury.

The Central Valley RWQCB WQCP objectives for mercury include a fish tissue methylmercury concentration goal of 0.24 milligrams per kilogram (mg/kg) wet weight for trophic level 4 fish (Central Valley Regional Water Quality Control Board 2018:3-8). This concentration of concern for methylmercury in fish fillets normalized to 350-millimeter (mm) total length largemouth bass is protective of human health and wildlife. This objective for trophic level 4 fish is equivalent to a 0.08 mg/kg wet weight objective for fillets of trophic level 3 fish and the 0.03 mg/kg objective for trophic level 2 and trophic level 3 whole fish less than 50 mm in length (Central Valley Regional Water Quality Control Board 2010:37). The dietary mercury threshold for some fish-eating bird species that is associated with impaired reproduction is 0.30 mg/kg wet weight (Ackerman et al. 2014: 42)., but the more conservative Central Valley RWQCB threshold of 0.24 mg/kg is used for this analysis.

# 6B.1.5 Modeling Results

The following sections present modeling output for mercury and methylmercury water column concentrations (Section 6B.1.5.1, *Water Column Concentrations*) and methylmercury fish tissue concentrations (Section 6B.1.5.2, *Fish Tissue Concentrations*). In general, operation of the proposed action would result in negligibly small to no change in modeled mercury concentrations in water and fish tissue, relative to existing conditions.

Water diverted at the north Delta intakes would be conveyed directly to Bethany Reservoir, the upstream terminus of the California Aqueduct into which Banks Pumping Plant water is pumped. Under the proposed action, both the north Delta intakes and Banks Pumping Plant will be operated conjunctively to deliver water to the California Aqueduct, depending on environmental and regulatory conditions. The modeling results are actually for water delivered to Bethany Reservoir from both the north Delta intakes and Banks Pumping Plant, and the term “California Aqueduct” is used to label the concentrations exported to the California Aqueduct from both north Delta intakes and Banks Pumping Plant.

## 6B.1.5.1 Water Column Concentrations

### Total Mercury

Modeled concentrations of total mercury in water are presented in Tables 6B.1-9 and 6B.1-10. The tables present the average total mercury concentrations for water years 1923 to 2015 and average concentrations by water year type (i.e., wet, above normal, below normal, dry, critical) for existing conditions and the proposed action. Differences between the proposed action and existing conditions also are presented in Table 6B-11.

At most locations and most water year types, modeled total mercury concentrations in water under the proposed action did not change from existing conditions. Small modeled changes from existing conditions up to a 0.07 ng/L increase occurred at various locations in all water year types. These

changes are considered negligible considering the low total mercury concentrations under existing conditions, relative to the 50 ng/L CTR water quality criterion.

**Table 6B-9. Total Mercury Concentrations in Water (in nanograms per liter), Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 7.86 | 9.57 | 8.42 | 7.17 | 6.77 | 6.54 |
| Sacramento River at Emmaton | 7.03 | 7.80 | 7.15 | 6.69 | 6.56 | 6.52 |
| San Joaquin River at Antioch | 6.77 | 7.04 | 6.83 | 6.67 | 6.60 | 6.57 |
| Sacramento River at Mallard Island | 7.31 | 7.94 | 7.47 | 7.06 | 6.90 | 6.86 |
| South Fork Mokelumne River at Terminous | 6.19 | 6.33 | 6.22 | 6.17 | 6.09 | 6.06 |
| San Joaquin River at Empire Tract | 6.41 | 6.65 | 6.41 | 6.38 | 6.24 | 6.21 |
| Contra Costa Water District Pumping Plant #1 | 6.31 | 6.42 | 6.32 | 6.29 | 6.25 | 6.23 |
| Old River at State Route 4 | 6.31 | 6.46 | 6.32 | 6.28 | 6.22 | 6.18 |
| Victoria Canal | 6.39 | 6.61 | 6.40 | 6.37 | 6.26 | 6.20 |
| California Aqueduct | 6.37 | 6.58 | 6.37 | 6.32 | 6.23 | 6.19 |
| Jones Pumping Plant | 6.56 | 6.79 | 6.59 | 6.52 | 6.41 | 6.36 |

**Table 6B-10. Total Mercury Concentrations in Water (in nanograms per liter), Proposed Action**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 7.91 | 9.63 | 8.49 | 7.23 | 6.80 | 6.56 |
| Sacramento River at Emmaton | 7.06 | 7.85 | 7.21 | 6.72 | 6.58 | 6.53 |
| San Joaquin River at Antioch | 6.80 | 7.07 | 6.88 | 6.70 | 6.62 | 6.57 |
| Sacramento River at Mallard Island | 7.34 | 7.98 | 7.51 | 7.09 | 6.91 | 6.86 |
| South Fork Mokelumne River at Terminous | 6.19 | 6.33 | 6.21 | 6.17 | 6.09 | 6.06 |
| San Joaquin River at Empire Tract | 6.41 | 6.65 | 6.42 | 6.39 | 6.24 | 6.21 |
| Contra Costa Water District Pumping Plant #1 | 6.33 | 6.44 | 6.33 | 6.30 | 6.26 | 6.23 |
| Old River at State Route 4 | 6.32 | 6.47 | 6.32 | 6.29 | 6.22 | 6.18 |
| Victoria Canal | 6.39 | 6.62 | 6.40 | 6.37 | 6.25 | 6.19 |
| California Aqueduct | 6.39 | 6.58 | 6.43 | 6.36 | 6.27 | 6.24 |
| Jones Pumping Plant | 6.56 | 6.79 | 6.58 | 6.52 | 6.40 | 6.35 |

**Table 6B-11. Total Mercury Concentrations in Water (in nanograms per liter), Proposed Action minus Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.05 | 0.06 | 0.07 | 0.06 | 0.03 | 0.02 |
| Sacramento River at Emmaton | 0.03 | 0.05 | 0.06 | 0.03 | 0.02 | 0.01 |
| San Joaquin River at Antioch | 0.03 | 0.03 | 0.05 | 0.03 | 0.02 | 0.00 |
| Sacramento River at Mallard Island | 0.03 | 0.04 | 0.04 | 0.03 | 0.01 | 0.00 |
| South Fork Mokelumne River at Terminous | 0.00 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Empire Tract | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Contra Costa Water District Pumping Plant #1 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 |
| Old River at State Route 4 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 |
| Victoria Canal | 0.00 | 0.01 | 0.00 | 0.00 | -0.01 | -0.01 |
| California Aqueduct | 0.02 | 0.00 | 0.06 | 0.04 | 0.04 | 0.05 |
| Jones Pumping Plant | 0.00 | 0.00 | -0.01 | 0.00 | -0.01 | -0.01 |

## Total Methylmercury

Modeled concentrations of total methylmercury in water are presented in Tables 6B.1-12 and 6B.1-13. The tables present the average total methylmercury concentrations for water years 1923 to 2015 and average concentrations by water year type (i.e., wet, above normal, below normal, dry, critical) for existing conditions and the proposed action. Differences between the proposed action and existing conditions also are presented in Table 6B-14.

At most locations and most water year types, modeled total methylmercury concentrations in water under the proposed action did not change from existing conditions. Negligibly small modeled changes from existing conditions up to a 0.01 ng/L decrease occurred at California Aqueduct in all water year types but dry years and critical years, which had no change from existing conditions.

**Table 6B-12. Total Methylmercury Concentrations in Water (in nanograms per liter), Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.13 | 0.14 | 0.14 | 0.13 | 0.12 | 0.12 |
| Sacramento River at Emmaton | 0.12 | 0.12 | 0.11 | 0.11 | 0.11 | 0.11 |
| San Joaquin River at Antioch | 0.12 | 0.13 | 0.12 | 0.12 | 0.12 | 0.12 |
| Sacramento River at Mallard Island | 0.13 | 0.13 | 0.13 | 0.12 | 0.13 | 0.13 |
| South Fork Mokelumne River at Terminous | 0.13 | 0.14 | 0.13 | 0.13 | 0.13 | 0.12 |
| San Joaquin River at Empire Tract | 0.14 | 0.15 | 0.14 | 0.14 | 0.13 | 0.13 |
| Contra Costa Water District Pumping Plant #1 | 0.13 | 0.13 | 0.13 | 0.12 | 0.12 | 0.12 |
| Old River at State Route 4 | 0.13 | 0.14 | 0.13 | 0.13 | 0.13 | 0.13 |
| Victoria Canal | 0.14 | 0.15 | 0.15 | 0.14 | 0.14 | 0.14 |
| California Aqueduct | 0.14 | 0.15 | 0.14 | 0.14 | 0.13 | 0.14 |
| Jones Pumping Plant | 0.15 | 0.15 | 0.15 | 0.14 | 0.14 | 0.14 |

**Table 6B-13. Total Methylmercury Concentrations in Water (in nanograms per liter), Proposed Action**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.13 | 0.14 | 0.14 | 0.13 | 0.12 | 0.12 |
| Sacramento River at Emmaton | 0.12 | 0.12 | 0.12 | 0.11 | 0.11 | 0.11 |
| San Joaquin River at Antioch | 0.12 | 0.13 | 0.12 | 0.12 | 0.12 | 0.12 |
| Sacramento River at Mallard Island | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 |
| South Fork Mokelumne River at Terminous | 0.13 | 0.14 | 0.13 | 0.13 | 0.13 | 0.12 |
| San Joaquin River at Empire Tract | 0.14 | 0.15 | 0.14 | 0.14 | 0.13 | 0.13 |
| Contra Costa Water District Pumping Plant #1 | 0.13 | 0.13 | 0.13 | 0.12 | 0.12 | 0.12 |
| Old River at State Route 4 | 0.13 | 0.14 | 0.14 | 0.13 | 0.13 | 0.13 |
| Victoria Canal | 0.15 | 0.15 | 0.15 | 0.14 | 0.14 | 0.14 |
| California Aqueduct | 0.13 | 0.14 | 0.13 | 0.13 | 0.13 | 0.13 |
| Jones Pumping Plant | 0.15 | 0.15 | 0.15 | 0.14 | 0.14 | 0.14 |

**Table 6B-14. Total Methylmercury Concentrations in Water (in nanograms per liter), Proposed Action minus Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sacramento River at Emmaton | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Antioch | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sacramento River at Mallard Island | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| South Fork Mokelumne River at Terminous | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Empire Tract | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Contra Costa Water District Pumping Plant #1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Old River at State Route 4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Victoria Canal | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| California Aqueduct | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 |
| Jones Pumping Plant | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

### 6B.1.5.2 Fish Tissue Concentrations

Modeled concentrations of total methylmercury in fish tissue are presented in Tables 6B.1-15 and 6B.1-16. Tables present the average total methylmercury concentrations for water years 1923 to 2015 and average concentrations by water year type (i.e., wet, above normal, below normal, dry, critical) for existing conditions and the proposed action. Differences between the proposed action and existing conditions also are presented in Table 6B-17.

The modeled concentrations of total methylmercury at the Delta assessment locations were used to model fish tissue concentrations in 350-mm-long largemouth bass, based on the Delta TMDL fish tissue model. A goal of the Delta TMDL model was to establish the linkage between the 0.24 mg/kg wet weight tissue mercury TMDL target (which is now the Delta water quality objective for trophic level 4 fish) to a water column concentration goal for methylmercury of 0.066 ng/L. These model results are presented with the recognition of the imprecision of predicting fish tissue concentrations from estimates of methylmercury concentrations for specific Delta locations but with the knowledge that largemouth bass is a suitable indicator of fish tissue mercury contamination in the Delta. Results provide an average tissue concentration, as would be expected based on the input water column concentration. The modeled water column concentrations and fish tissue concentrations presented herein are not predictive in nature. Rather, they are for comparative assessment to identify the potential effect of the proposed action on fish tissue methylmercury concentrations relative to existing conditions.

At most locations and most water year types, modeled total methylmercury concentrations in fish tissue under the proposed action did not change from existing conditions. Negligibly small modeled increases of 0.01 mg/kg occurred at many locations in all water year types. Small decreases of 0.03 mg/kg to 0.10 mg/kg occurred at the California Aqueduct under all water year types. The modeled increases represent a 4% increase from the 0.24 mg/kg fish mercury TMDL target, and the decreases at the California Aqueduct represent a 13% to 40% decrease relative to the fish mercury TMDL target.

**Table 6B-15. Total Methylmercury Concentrations in Largemouth Bass (in milligrams per kilogram wet weight), Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.73 | 0.85 | 0.77 | 0.68 | 0.66 | 0.66 |
| Sacramento River at Emmaton | 0.59 | 0.63 | 0.58 | 0.56 | 0.56 | 0.58 |
| San Joaquin River at Antioch | 0.64 | 0.68 | 0.64 | 0.61 | 0.60 | 0.62 |
| Sacramento River at Mallard Island | 0.69 | 0.71 | 0.68 | 0.67 | 0.68 | 0.70 |
| South Fork Mokelumne River at Terminous | 0.73 | 0.79 | 0.74 | 0.72 | 0.69 | 0.67 |
| San Joaquin River at Empire Tract | 0.79 | 0.88 | 0.80 | 0.77 | 0.73 | 0.71 |
| Contra Costa Water District Pumping Plant #1 | 0.68 | 0.75 | 0.69 | 0.66 | 0.63 | 0.64 |
| Old River at State Route 4 | 0.75 | 0.81 | 0.76 | 0.72 | 0.70 | 0.72 |
| Victoria Canal | 0.85 | 0.94 | 0.87 | 0.83 | 0.79 | 0.80 |
| California Aqueduct | 0.79 | 0.86 | 0.80 | 0.77 | 0.74 | 0.77 |
| Jones Pumping Plant | 0.87 | 0.92 | 0.87 | 0.85 | 0.82 | 0.85 |

**Table 6B-16. Total Methylmercury Concentrations in Largemouth Bass (in milligrams per kilogram wet weight), Proposed Action**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.74 | 0.85 | 0.78 | 0.69 | 0.66 | 0.66 |
| Sacramento River at Emmaton | 0.59 | 0.63 | 0.59 | 0.57 | 0.56 | 0.58 |
| San Joaquin River at Antioch | 0.64 | 0.69 | 0.64 | 0.62 | 0.61 | 0.62 |
| Sacramento River at Mallard Island | 0.70 | 0.72 | 0.69 | 0.68 | 0.68 | 0.70 |
| South Fork Mokelumne River at Terminous | 0.74 | 0.80 | 0.75 | 0.73 | 0.70 | 0.67 |
| San Joaquin River at Empire Tract | 0.79 | 0.89 | 0.81 | 0.78 | 0.73 | 0.72 |
| Contra Costa Water District Pumping Plant #1 | 0.68 | 0.75 | 0.70 | 0.66 | 0.63 | 0.64 |
| Old River at State Route 4 | 0.75 | 0.82 | 0.77 | 0.73 | 0.70 | 0.73 |
| Victoria Canal | 0.86 | 0.94 | 0.88 | 0.84 | 0.80 | 0.80 |
| California Aqueduct | 0.73 | 0.77 | 0.70 | 0.69 | 0.70 | 0.74 |
| Jones Pumping Plant | 0.87 | 0.93 | 0.88 | 0.85 | 0.82 | 0.85 |

**Table 6B-17. Total Methylmercury Concentrations in Largemouth Bass (in milligrams per kilogram wet weight), Proposed Action minus Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Sacramento River at Emmaton | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| San Joaquin River at Antioch | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 |
| Sacramento River at Mallard Island | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| South Fork Mokelumne River at Terminous | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 |
| San Joaquin River at Empire Tract | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 |
| Contra Costa Water District Pumping Plant #1 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Old River at State Route 4 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 |
| Victoria Canal | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 |
| California Aqueduct | -0.06 | -0.09 | -0.10 | -0.08 | -0.04 | -0.03 |
| Jones Pumping Plant | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |

# 6B.1.6 Mercury Effects Analysis and Conclusions

## 6B.1.6.1 Operations

Operations under the proposed action were analyzed to assess potential effects on mercury and methylmercury concentration and bioavailability, detailed in Section 6B.1.5, *Modeling Results*. Section 6B.1.4, *Applicable Water Quality Criteria/Objectives* provides applicable objectives for mercury and methylmercury in fish tissue.

Average water column concentrations of total mercury for the full simulation period under the proposed action would differ little from existing conditions at the Delta assessment locations (Table 6B-11). Among all Delta assessment locations, modeled total mercury concentrations range from 6.19 nanograms per liter (ng/L) to 7.86 ng/L under existing conditions and from 6.19 ng/L to 7.91 ng/L under the proposed action. Thus, total mercury concentrations under the proposed action would be well below the CTR criterion for protection of human health from consumption of water and organisms (50 ng/L; 60 *Federal Register* [FR] 2228 [May 4, 1995]; 65 FR 3162 [May 18, 2000]; 66 FR 9960 [February 13, 2001]) at all locations during all water year types. Modeled changes in average total mercury concentrations for the full simulation period would range from a decrease of up to 0.01 ng/L at Jones Pumping Plant to an increase of 0.05 ng/L in Barker Slough at the North Bay Aqueduct (Table 6B-11). Similarly, average water column concentrations of total methylmercury for the full simulation period under the proposed action would differ little from existing conditions at the Delta assessment locations (Table 6B-14). Among all Delta assessment locations, modeled total methylmercury concentrations range from 0.12 ng/L to 0.15 ng/L under both existing conditions and the proposed action (Table 6B-14).

The changes in water column concentrations of total methylmercury under the proposed action would have little to no measurable effect on Delta fish tissue concentrations, relative to existing conditions. All modeled fish tissue concentrations exceed the water quality objective of 0.24 mg/kg wet weight in 350-mm largemouth bass under both existing conditions and the proposed action

(Table 6B-17). Average modeled tissue concentrations for the full simulation period range from 0.59 mg/kg to 0.87 mg/kg wet weight under both existing conditions and the proposed action. Modeled fish tissue methylmercury concentrations increased by no more than 0.01 mg/kg wet weight as averages over the full simulation period at all Delta assessment locations under the proposed action, relative to existing conditions (Table 6B-17).

The modeled effects of mercury concentrations from changes in water operations on water and largemouth bass did not differ substantially from existing conditions (Section 6B.1.5, *Modeling Results*); therefore, these results also indicate that dietary methylmercury exposure would not measurably increase for California least tern and giant garter snake as a result of project operations. The lack of substantial change in aquatic foodweb mercury concentrations indicates that methylmercury transported to adjacent riparian foodwebs would also not increase appreciably; therefore, these results indicate that bioavailability of methylmercury to western yellow-billed cuckoo and least Bell's vireo, if they were present in the action area, would also not substantially increase as a result of project operations.

## 6B.1.6.2 Compensatory Mitigation Plan

Implementation of the CMP, which includes the creation of freshwater emergent perennial wetlands, seasonal wetlands, and tidal habitats, could result in new sources of methylmercury within the Delta, relative to existing conditions. Mercury methylation occurs under anoxic conditions in sediments, flooded shoreline soils, and to a lesser degree, in the water column. Increased methylmercury is also associated with wetting and drying cycles. These new sources of methylmercury could result in higher methylmercury concentrations and uptake into the tissues of California least tern, western yellow-billed cuckoo, least Bell's vireo, and giant garter snake residing within and immediately adjacent to these wetland habitats where elevated levels of methylmercury could be created.

### Bouldin Island and I-5 Ponds

Potential for increased methylmercury exposure, relative to existing conditions, is likely low at Bouldin Island and the I-5 ponds for the following reasons.

- Both areas contain existing wetlands with conditions that allow mercury in the soil to be transformed into methylmercury.
- Perennial wetlands and seasonal wetlands would not have the frequent wetting and drying cycles associated with the highest methylmercury production.
- The I-5 ponds are in areas that were not historically connected to Delta waters; therefore, it is unlikely that little, if any, mercury was deposited in soils at these locations.

Bouldin Island was historically tidal marsh and mercury deposition likely occurred at this site; however, much of Bouldin Island consists of agricultural crops that are managed to flood seasonally, which creates existing conditions that promote mercury methylation. Monitoring and adaptive management plans for mercury and methylmercury would be required at habitat creation, enhancement, and restoration sites as part of the CMP (Appendix 3B, Section 3B.7.2, *Monitoring*). These plans would include mercury monitoring and adaptive management at Bouldin Island and the I-5 ponds to prevent increased mercury bioavailability, relative to existing conditions. Given the low potential for increases in methylmercury concentrations above existing conditions in surface water, largemouth bass tissue, and from wetland restoration sites, and the implementation of the

monitoring and adaptive management program for tidal restoration locations, methylmercury is not likely to result in adverse effects on listed terrestrial species.

## Tidal Habitat Mitigation Framework

The locations and sizes of the new tidal habitats are currently undetermined and would be selected in accordance with the tidal habitat mitigation framework in Appendix 3B. The new tidal habitats would be hydrodynamically connected with adjacent Delta waters, and conditions that are conducive to increased mercury methylation and uptake from water into adjacent aquatic and terrestrial foodwebs could potentially occur within the new tidal habitats. However, not all types of wetland habitats have the same potential for methylmercury generation, and tidal wetlands in the Delta are not necessarily significant net producers or exporters of methylmercury to adjacent waterbodies (California Department of Water Resources 2020:7).

Regularly inundated tidal wetlands that do not fully dry between wetting cycles generate less methylmercury than seasonally flooded wetlands and high-tidal marsh (Alpers 2008:10). Likewise, permanently flooded wetlands in the Delta managed for wildlife, and seasonally flooded wetlands to a lesser degree, produced far less methylmercury than do agricultural wetlands managed for rice production (Alpers et al. 2014:282). The degree to which methylmercury generation occurs in four Delta tidal wetlands, evaluated as part of methylmercury control studies for the Delta mercury TMDL, found that concentrations did not significantly increase on ebb tides over those entering the wetlands on flood tides (California Department of Water Resources 2020:7). Thus, these restored tidal wetlands are unlikely to significantly increase methylmercury concentrations in the wetlands themselves and adjacent Delta waters. Likewise, none of the four Delta tidal wetlands studied contributed significantly to net annual methylmercury loads in surrounding waters. Another study of a natural tidal marsh in the western Delta, Browns Island, found it to be a relatively small net source of methylmercury, and extrapolation of these results to all 33 square kilometers of existing Delta tidal wetlands indicated they are a minor source, contributing only 3% of the external riverine methylmercury loads (Bergamaschi et al. 2011:1368). Studies outside the Delta have also found tidal wetlands to be net sinks for total mercury and methylmercury or only a minor source of methylmercury to nearby surface waters (Mitchell et al. 2012:7; Turner et al. 2018:153). Seasonal and spatial variability in methylmercury production and export were observed in all of these studies so that site-specific planning and monitoring should inform the design and management of any tidal habitat compensatory mitigation project to understand hydrodynamic and biogeochemical interactions as part of mercury control actions (McCord and Heim 2015:738; Bergamaschi et al. 2011:1369).

The extent to which fish exposed to tidal wetlands bioaccumulate mercury has been monitored in the north San Francisco Bay where fish tissue concentrations within restored tidal wetlands were not higher than in reference tidal wetlands (Robinson et al. 2018:18). To estimate how fish tissue concentrations could be affected by aqueous methylmercury concentrations in four restored Delta tidal marshes, monthly tidal ebb and flow mercury concentration data from the California Department of Water Resources (DWR) (2020) were used to model tissue concentrations in 350-mm largemouth bass fillets using the Delta TMDL model (Central Valley Regional Water Quality Control Board 2010:73). Modeled fish tissue mercury concentrations did not differ significantly between exposures to ebb and flood flow concentrations at three of the four tidal wetlands using Wilcoxon Signed Rank test ($p>0.05$) and were significantly greater in flood water concentrations (i.e., those entering the tidal marsh) at North Lindsay Slough ($p<0.01$). These calculations suggest that fish tissue mercury concentrations would not significantly increase within CMP tidal habitat or

in the Delta waters surrounding these habitats. Accordingly, significant increases in methylmercury exposure to listed terrestrial species is also not anticipated.

While these studies suggest a low potential for increases in methylmercury in the waters and fish tissues in restored tidal wetlands, these conditions are site-specific and vary over time, and therefore may not be predictive of mercury methylation in all tidal wetlands created within the Delta. Because mercury is bioaccumulative, even slightly elevated waterborne methylmercury concentrations that could occur in new tidal habitats would bioaccumulate in aquatic organisms that could, in turn, pose increased health risks to terrestrial wildlife consuming those organisms, relative to existing conditions.

AMM23: *Develop and Implement a Mercury Management and Monitoring Plan* would be implemented with the goal to minimize generation of methylmercury within the new tidal habitats. Tidal habitat design would be guided by this mitigation measure, which requires development of a comprehensive Mercury Management and Monitoring Plan and site-specific mercury management plans that include adaptive management and reporting requirements.

# 6B.2 Cyanobacterial Harmful Algal Blooms

## 6B.2.1 Background and Existing Conditions in the Delta

Cyanobacteria (formerly called blue-green algae) are a phylum of bacteria that obtain their energy through photosynthesis. The term CHABs refers to cyanobacteria harmful algae blooms that have the potential to harm human health or aquatic biota. CHABs are a widespread problem in waterbodies worldwide. Although cyanobacteria occur naturally, cultural eutrophication from population growth and associated urban, industrial, and agricultural wastes combined with effects from global climate change have led to the global expansion of CHABs (e.g., Rastogi et al. 2015; Glibert 2020). Toxins produced by cyanobacteria (i.e., cyanotoxins) have been implicated in human and animal illness and death in over fifty countries, including at least 35 states within the US (U.S. Geological Survey 2020). Cyanotoxins can cause toxicity to phytoplankton, zooplankton, and fish, and also can affect feeding success or food quality for zooplankton and fish (Ger et al. 2018: 2384; Acuña et al. 2012a:1191; Acuña et al. 2012b:1). Poisoning of aquatic vertebrates such as fish, turtles, ducks, and waterbirds have been documented around the world, and high levels of microcystins have been identified in the tissues of mallards and double-crested cormorants, including gonads and eggs, indicating that microcystins may also affect bird reproduction (Chen et al. 2009:3317, 3320). Microcystins have also been found in terrestrial foodwebs, such as spiders and songbirds in riparian habitats, likely through consumption of emergent aquatic insects (Moy et al. 2016:A, E). While there have been no vertebrate mortality events documented in the Delta, high cyanotoxin levels in the Delta have been associated with increased zooplankton mortality and sublethal effects on fish, including Sacramento splittail and threadfin shad (Ger et al. 2018: 2384; Acuña et al. 2012a:1191; Acuña et al. 2012b:1).

CHABs in fresh and brackish water environments typically contain *Microcystis*, *Dolichospermum* and *Aphanizomenon*. To date, the most common and well-studied cyanobacteria in the Delta is *Microcystis*. As such, most of the information included in this setting is related to *Microcystis*. *Microcystis* blooms are widespread throughout the Delta and have occurred at varying concentrations and frequency throughout the Delta since it was first detected in 1999 (Figure 6B.2-

1; ESA 2022:5). California Department of Fish and Wildlife (CDFW) and DWR have collected visual observations of *Microcystis* during fish and water quality surveys at discrete stations throughout the Delta since 2007. The visual ranking gives a general idea of when and where CHABs including *Microcystis* occur in the Delta. Visual ranking is reliable on the "presence/absence" level and is performed by taking a surface water sample with a bucket and ranking the density of colonies in the bucket according to a scale from 1 to 5 where 1 is absent and 5 is relatively high (ESA 2022:1). ESA (2022:5) used the visual observation data to determine the frequency of occurrence of *Microcystis* at numerous locations throughout the Delta (Figure 6B.2-1).

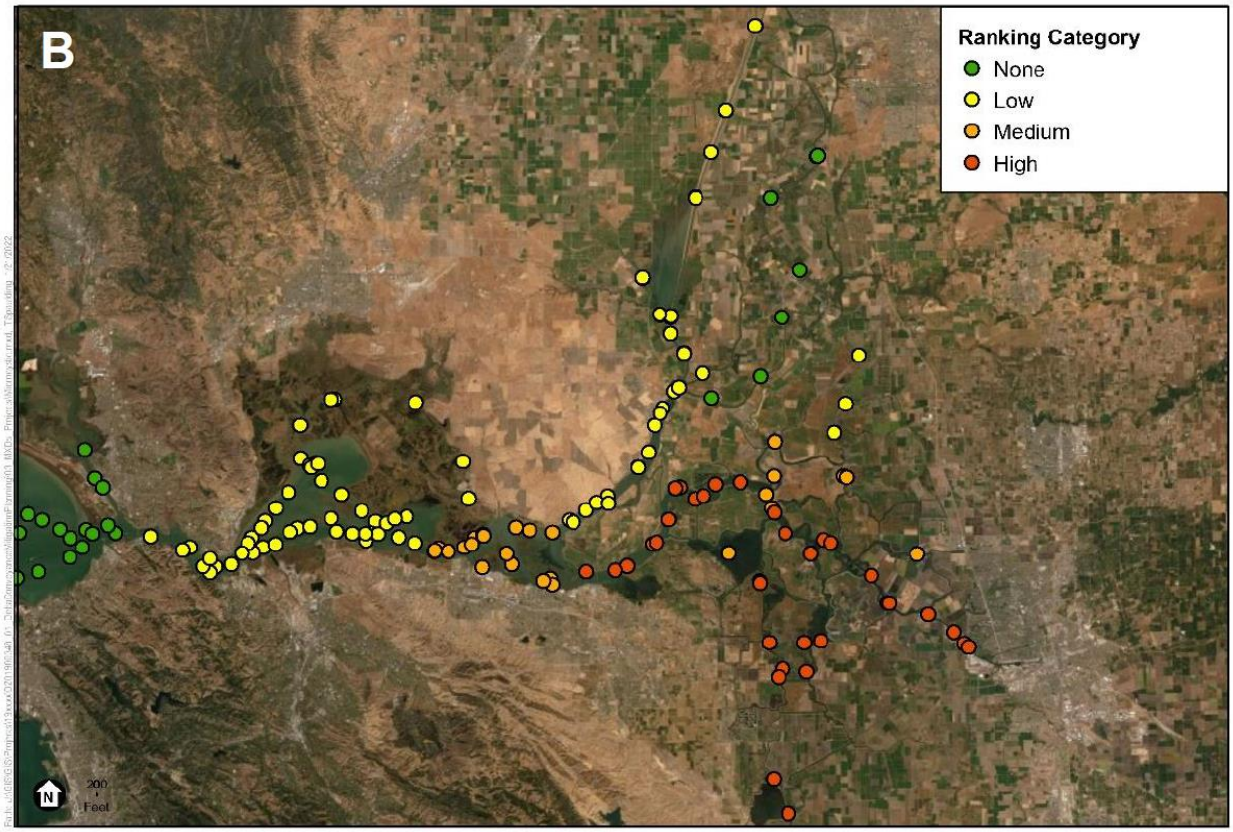


**Figure 6B.2-1. *Microcystis* Frequency of Occurrence Based on Visual Observation Data Collected Since 2007 (ESA 2022:5)**

*Microcystis* has an annual life cycle characterized by two phases. The first is a benthic phase, during which colonies overwinter in the sediment. In the second planktonic phase, which occurs during the summer and early fall months, *Microcystis* enters the water column and begins to grow. When temperatures reach 19 degrees Celsius (°C) (66.2 degrees Fahrenheit [°F]), active (i.e., sediment mixing) and passive processes (i.e., related to the physiological state of the cells) trigger *Microcystis* recruitment from the sediment, the organism is resuspended into the water column (Verspagen et al. 2004:269; Misson and Latour 2012:113; Lehman et al. 2013:141).

There are five primary environmental factors that have been related to the emergence and subsequent growth of *Microcystis* in the water column of Delta waters, which are as follows.

- Water temperatures greater than 19°C (66.2 °F)
- Low flows and channel velocities resulting in low turbulence

- Long hydraulic residence times
- Water column irradiance and clarity greater than 50 micromoles per square meter per second (μmoles/$m^2$/s)
- Sufficient nutrient availability of nitrogen and phosphorus

Further, in waterbodies influenced by saltwater salinity below 10 parts per thousand is more likely to support cyanobacteria growth than more saline waters.

The factors listed above have been related to *Microcystis* abundance throughout the Delta (Lehman et al. 2013:141; Berg and Sutula 2015:iii; Preece et al. 2017:33). Yet, the exact processes and interactions of factors that affect development of *Microcystis* blooms in the Delta are complex. There is growing evidence that blooms vary more with wet and dry water year type conditions than with nutrient availability (Lehman et al. 2020:2). However, *Microcystis* growth in the Delta was found to increase linearly when the percentage of ammonium within the total nitrogen pool increased (Lehman et al. 2015:175; Lehman et al. 2020:2). Recent research identified retention time in the Delta and water temperature as the key environmental correlates with *Microcystis* blooms in the Delta (Lehman et al. 2020:1).

In the Delta, CHABs are primarily comprised of the colonial form of *Microcystis* aeruginosa, but single cells are also present (Baxa et al. 2010:343). Other pelagic cyanobacteria including *Aphanizomenon* spp., *Dolichospermum* spp., *Planktothrix* spp., *Pseudanabaena* spp., and *Oscillatoria* have also been detected in the Delta, although generally to a lesser extent than *M. aeruginosa* (Lehman et al. 2010:229; Spier et al. 2013:8; Mioni et al. 2012:20; Berg and Sutula 2015:35; Kurobe et al. 2018:7; Lehman et al. 2020:8). From August through October 2011, *Aphanizomenon* was identified as the most common cyanobacteria genus in the Delta (Mioni et al. 2012:20); however, the species of *Aphanizomenon* that has been shown to occur in the Delta is typically not toxic (Kudela et al. 2015:196). Since it was first observed in the Delta in 1999, annual *Microcystis* blooms have occurred at varying levels throughout the Delta, with blooms typically beginning in the central and southern Delta and spreading seaward into saline environments (Lehman et al. 2008:199; Lehman et al. 2013:146; Lehman et al. 2020:1; California Water Quality Monitoring Council 2021).

Like other regions where *Microcystis* occurs, a mix of toxigenic and non-toxigenic strains occurs in the Delta and toxicity is variable (Baxa et al. 2010:342, 347). Toxigenic strains and appropriate environmental conditions must be present for cyanotoxins to occur (Marmen et al. 2016:9). A number of different secondary metabolites, designated as cyanotoxins, can be produced by cyanobacteria including liver toxins, neurotoxins, and dermatoxins. Production of cyanotoxins associated with CHABs is highly variable and not well understood. Nevertheless, *Microcystis* blooms often produce the liver toxin microcystin (Harke et al. 2016:4) and microcystin is the most frequently documented cyanotoxin in the Delta. Microcystins were first documented in the Delta in 2003 (Lehman et al. 2005:87, 97) and have been detected on numerous occasions since (Lehman et al. 2008:187; 2010:241, 245; 2013:146; 2015:169; 2017:94; Lehman et al. 2021; Spier et al. 2013:8). In addition to producing cyanotoxins, CHABs can create surface scums that interfere with recreation and cause aesthetic problems, produce taste and odor compounds, and lower oxygen levels within the water column (Sutula and Senn 2017:41). Increased microcystin concentrations are generally associated with higher *Microcystis* abundances (Lehman et al. 2013:146).

To date, monitoring for cyanotoxins has been dependent on funds that support bloom response, special projects, or opportunistically at other Delta locations when the Central Valley Water Board

or local entities respond to reports of CHAB presence. As such, Delta CHAB and cyanotoxin monitoring has generally been inconsistent and incomplete in terms of geographic coverage, which makes it difficult to assess changes over time. Nevertheless, the California Cyanobacteria and Harmful Algal Bloom Network Harmful Algal Bloom incident report portal and published studies suggest that cyanotoxins are increasing since they were first detected in the Delta.

During the 2014 drought, microcystin concentrations frequently exceeded the World Health Organization provisional drinking water guideline value of 1 microgram per liter (µg/L), the EPA 10-day Health Advisories drinking water guidelines of 0.3 µg/L for children under the age of 6 years old (Lehman et al. 2017:105), and the California Caution Action Trigger of 0.8 µg/L. Since 2014 microcystin concentrations have also exceeded EPA recreational guidelines of 8.0 µg/L and the California Danger Tier II trigger for recreational waters of 20 µg/L a number of times at different locations throughout the southern and central Delta including in Discovery Bay, at several locations along the San Joaquin River, and at locations along the Stockton Waterfront (California Water Quality Monitoring Council 2021). The neurotoxins anatoxin-a and saxitoxin have also been documented in Delta waters, but concentrations have been low (i.e., below the California Warning Tier II trigger for recreational waters of 20 µg/L) (Central Valley Regional Water Quality Control Board 2019:3; Lehman et al. 2021).

The following sections describe in detail the five environmental factors that provide favorable conditions for Delta CHABs.

#### 6B.2.1.1 Temperatures

Cyanobacteria usually bloom during the summer and early fall when water temperatures are warm. Several studies have found that 20°C (68°F) was the threshold for cyanobacterial growth (Rolland et al. 2013:746). Evidence suggests cyanobacteria growth rates double when temperatures increase from 20°C (68°F) to 27°C (80.6°F) (Berg and Sutula 2015:45). In temperate latitudes, optimal cyanobacteria growth usually occurs between temperatures of 25°C (77°F) and 35°C (95°F) (Lürling et al. 2013:554–555). Optimal growth rate for *Microcystis* in the laboratory occurs at 27.5°C (81.5°F) (You et al. 2018:26), and some *Microcystis* strains can continue to grow in temperatures of 37°C (98.6°F) or higher (Bui et al. 2018:10).

The only available regional temperature threshold information for cyanobacteria is for *Microcystis*. In the Delta, the regional temperature necessary for *Microcystis* bloom initiation is 19°C (66.2°F) (Lehman et al. 2013:141). Temperature is considered the primary factor that typically restricts *Microcystis* development to the summer and early fall months in waterbodies of the region (Lehman et al. 2013:147). Peak bloom abundance in the Delta occurs near 23°C (73.4°F) and persists to at least 25.6°C (78.1°F) (Lehman et al. 2013:147).

The specific growth rate of *Microcystis* varies based on strain, water temperature, and other environmental factors. Based on average specific growth rates, the literature reports that doubling time for *Microcystis* ranges from 0.6 to 5.2 days (Wilson et al. 2006:7386; Lürling et al. 2013:555; You et al. 2018:22). When environmental conditions are less favorable (e.g., lower water temperatures, greater turbulence and mixing, competition with other algae, grazing pressures), *Microcystis* requires more time to double its population size via growth. In a well-controlled laboratory experiment that evaluated growth of 32 *Microcystis* spp. strains at 25°C (77°F), the average growth rate across all strains resulted in cell doubling time of approximately 2.8 days (Wilson et al. 2006:7386). Lürling et al. (2013; 555) studied growth rates of cyanobacteria, including

two *Microcystis* strains at temperatures ranging from 20°C to 35°C (68°F to 95°F). Based on average growth rates for one of the *Microcystis* strains used in the study, doubling time ranged from 0.6 days (at 32°C) to 1.2 days (at 20°C). For the other *Microcystis* strain, doubling time ranged from 0.7 days (at 30°C) to 2.7 days (at 20°C). A more recent study evaluated temperatures ranging from 5°C to 35°C (41°F to 95°F) on batch cultures of *Microcystis* grown from a single strain (You et al. 2018:17). Doubling time ranged from 0.9 days (at 27.5°C) to 34.7 days (at 5°C). These studies show that as temperatures cool below 20°C, growth rates also begin to decline substantially. Although there is also an upper temperature limit to growth, collectively these studies show that *Microcystis* can grow quickly in waters with temperatures that range from 20°C to 32°C.

### 6B.2.1.2 Channel Velocities and Associated Turbulence and Mixing

Under turbulent, well-mixed flow conditions, the entire water column within the channel becomes mixed from top to bottom, thereby mixing the algae in the water column as well (O'Brien et al. 2004:143). This physical mixing disrupts *Microcystis*' ability (and *Dolichospermum's* ability) to control its location in the water column and to form mats of dense colonies/filaments at the surface of the water (O'Brien et al. 2004:143), and thus prevents *Microcystis* (and *Dolichospermum*) from shading-out and outcompeting diatoms and green algae for resources (Huisman et al. 2004:2968). Under such well-mixed conditions, diatoms and green algae typically outcompete the cyanobacteria (Li et al. 2013:70; Zhang et al. 2015:435–436; Visser et al. 2016:3).

Wind and tides can enhance the aggregation of *Microcystis* cells in slow-moving waters (Baxa et al. 2010:347), but in faster moving, turbulent waters, the ability of *Microcystis* to maintain its positive buoyancy is reduced (Visser et al. 1996:448). Therefore, higher flow rates (generally associated with higher channel velocities) make it difficult for *Microcystis* to form dense collections of colonies at the water surface. Moreover, turbulence affects metabolic processes and cell division (Li et al. 2013:65) and thus can be a negative growth factor (Visser et al. 2016:2).

It is in the calm water environments, which do not experience thorough water column mixing daily during the summer months, that allow cyanobacteria to outcompete other algae species present for light and nutrients and thus form large, problematic blooms. *Microcystis* cells can move to the water surface through the control of their buoyancy via gas vesicles within the cells (Reynolds 2006:58–59). Cells come together to form colonies and then colonies join together to form mats or scum layers at the water's surface. Here, dense mats of *Microcystis* can shade out the other algal species and thus outcompete the other algae for light and nutrients that fuel their bloom. This ecological concept explains why Li et al. (2013:70) and Zhang et al. (2015:435–436) observed the dominant phytoplankton species to shift from cyanobacteria to green algae and diatoms when flow velocities reached 0.2 to 1.0 feet per second. This is also why we see *Microcystis* blooms predominantly in lakes and in slow-moving calm water environments and not in vertically mixed, deep riverine channels (Lehman et al. 2013:155).

Turbulent mixing puts cyanobacteria at a disadvantage in its competition with other faster-growing algal species, including diatoms and green algae (Huisman et al. 2004:2968; Visser et al. 2016:3). Higher-velocity, turbulent water mixes all algae throughout the photic zone of the water column and reduces light through turbidity, which allows faster-growing chlorophytes (green algae) and diatoms to outcompete the slower-growing cyanobacteria, including *Microcystis* (Huisman et al. 2004:2968; Li et al. 2013:70). Because all algae present are mixed from the channel surface to bottom in turbulent, flowing water, *Microcystis* cells cannot control their location in the water

column and thus cannot as readily, if at all, form the dense collection of cells and colonies at the water's surface, as in calm waters.

The channel velocity required to disrupt *Microcystis* blooms varies by system, with studies reporting critical velocity rates of 0.1 to 1.3 feet per second (Mitrovic et al. 2003:164; Zhang et al. 2015:435; Mitrovic et al. 2011:238; Li et al. 2013:70). For example, in the lower Darling River, Australia, velocities above 1.0 feet per second were shown to quickly disrupt an established cyanobacteria bloom (Mitrovic et al. 2011:238). In the Zhongxin Lake system China, flow velocities of 0.2 to 1.0 feet per second disrupted *Microcystis* blooms and shifted the dominant phytoplankton species to green algae and diatoms (Li et al. 2013:70; Zhang et al. 2015:435). This information from the scientific literature is consistent with what is observed in the Central Valley regarding where *Microcystis* blooms often occur (i.e., in calm, low-velocity, non-turbulent aquatic environments) (Lehman et al. 2008:200; Lehman et al. 2013:155; Berg and Sutula 2015:21) and where they typically do not occur (i.e., in riverine channels having turbulent flow) (Lehman et al. 2013:155).

Lehman et al. (2017:106) reported that relatively small *Microcystis* blooms occurred in the 2004 and 2005 wet years when San Joaquin River flow was 28.32 to 35.40 meters cubed per second ($m^3s^{-1}$). A San Joaquin River flow of 9.1 $m^3s^{-1}$, a factor of three lower compared to 2004 and 2005 flows, produced the large 2014 *Microcystis* bloom.

### 6B.2.1.3 Hydraulic Residence Time

Hydraulic residence time refers to how long water remains at a given location before most of the water is flushed from the area, in the net downstream direction. Microcystis is relatively slow growing compared to other algal species. Therefore, sufficient hydraulic residence time is needed to enable a bloom to become established. Areas with high flushing rates (i.e., short residence times) are characterized by relatively high velocities that result in turbulent, well-mixed channels where cyanobacteria generally cannot outcompete green algae or diatoms. Hence, increasing residence times beyond the minimum required for bloom initiation primarily affects how much biomass a bloom can accumulate in an area after a bloom has initiated.

Areas with short residence times typically cannot produce high biomass blooms because the cells that are produced quickly get flushed downstream. Conversely, areas of bloom formation having low channel velocities and high hydraulic residence times can accumulate cells for a longer time, ultimately resulting in high biomass blooms.

Accumulation of *Microcystis* cells and colonies (via longer residence times) is an important mechanism affecting the magnitude of *Microcystis* blooms. Colony formation provides Microcystis with many ecological advantages, including adaption to varying light, sustained growth with poor nutrients supply, and protection from stressors including grazing (Xiao et al. 2018:1399). Large colony size allows Microcystis to attain floating velocities that allow them to maintain biomass near the surface of a waterbody and shade out other algal species (Xiao et al. 2018:1399). As Microcystis colonies increase in size, it is possible that they may produce more toxins (Wood et al. 2012:21).

Lehman et al. (2017:94) states that high residence time was a factor that contributed to the magnitude of the 2014 *Microcystis* bloom in the Delta. The high residence time allows *Microcystis* colonies to accumulate in areas of the Delta, without getting flushed from the area. There is no evidence in the scientific literature to indicate that higher residence time results in higher algal growth rates. Algal species, availability of nutrients, and temperature primarily control algal growth rates, not residence time per se.

Residence time throughout the Delta is highly variable, and unpredictable, because of fluvial and tidal hydrology, tidal wetlands, engineered floodplains, and the creation of trapezoidal channels (Kimmerer et al. 2019:13). Long residence time does not always translate into large *Microcystis* blooms. This was exemplified in the Stockton Deep Water Ship Channel, where long summer residence times occur annually. Here, a 3-year study documented a large persistent *Microcystis* bloom in 2012 but not in 2009 or 2011 (Spier et al. 2013:10). Environmental conditions were similar in 2012 and 2009 and Microcystis cells were present in 2009, yet no large bloom occurred in 2009. No specific environmental factor could be attributed to the 2012 bloom (Spier et al. 2013:10).

In another Delta study, researchers investigated how the rock barrier installed across False River during the 2015 drought would affect water quality in Franks Tract (Kimmerer et al. 2019:1). The researchers hypothesized that the rock barrier would increase residence time in Franks Tract and form conditions that would allow *Microcystis* cells to accumulate. Instead, the authors found the barrier did not cause *Microcystis* to become more abundant in Franks Tract during 2015 than it was in other dry years (Kimmerer et al. 2019:1). However, submerged aquatic vegetation was found in areas of Franks Tract that had previously been clear of vegetation (Kimmerer et al. 2019:1). These two Delta studies support the findings that Microcystis ecology and competition with other algae and macrophytes is complex, and longer residence times at small or intermediate scales do not necessarily indicate that a substantial bloom will form.

#### 6B.2.1.4 Nutrients

Nutrients (nitrogen and phosphorus) within the Delta are available annually at levels that are non-limiting to the growth of *Microcystis* (Lehman et al. 2005:91). With optimal temperatures, low turbulence and mixing, long residence time, and high irradiance, *Microcystis* (and other cyanobacteria) biomass is proportional to nutrient (i.e., nitrogen and phosphorus) availability in the water column (Berg and Sutula 2015:22) Literature suggests, however, that levels of nitrogen, phosphorus, or their N:P ratio do not control the seasonal or inter-annual bloom variation within the Delta (Lehman et al. 2013:154–155; Lehman et al. 2017:106).

Both phosphorus and nitrogen are important in promoting cyanobacteria growth and subsequent blooms (Schindler et al. 2008:11254; Levine and Whalen 2001:189). In general, nutrients typically become limiting to phytoplankton when concentrations fall below 0.07 milligram per liter (mg/L) dissolved inorganic nitrogen (nitrite, nitrate, and ammonia) and 30 µg/L dissolved phosphorus (orthophosphate or soluble reactive phosphorus) (Jassby 2005:10). The amount of total phosphorus in a waterbody is a fundamental basis for cyanobacteria growth, but concentrations below 100 µg/L are unlikely to cause mass cyanobacteria blooms (Chorus and Cavalieri 2000:5; World Health Organization 2015:5). In reviews of stream ecosystems, lakes, and reservoirs, total nitrogen concentrations of 0.7 to 1.5 mg/L were found to support cyanobacteria growth (Dodds et al. 1998:1459).

#### 6B.2.1.5 Water Column Irradiance and Clarity

Irradiance plays a critical role in cyanobacteria buoyancy control (Walsby et al. 2004:119–120), growth rates, and triggering vertical migration of over-wintering cyanobacteria cells from the sediment. Relatively high irradiances (>50 µmol photons meters squared per second [$m^{-2}$ $s^{-1}$]) have been found to promote maximal cyanobacteria growth rates in the Delta (Berg and Sutula 2015:48) and are considered a prerequisite for *Microcystis* and *Dolichospermum* bloom formation (Lehman et al. 2013:154).

Cyanobacteria generally grow ineffectively in well-mixed, low-light waters, although certain genera (i.e., *Dolichospermum* and *Cylindrospermopsis*), can grow well in constant low-light conditions (Litchman 1998:253). Other genera, such as *Microcystis*, have high light requirements and, thus cannot become dominant in light-limited conditions (Huisman et al. 1999:219–220). Diatoms are generally more adapted to low-light conditions and dominate phytoplankton communities during periods of low average irradiance with high light fluctuations (Litchman 1998:253). For example, diatoms keep near maximal growth rates in irradiances less than 50 µmol photons $m^{-2}$ $s^{-1}$ (Berg and Sutula 2015:48).

Since cyanobacteria have poor light absorption efficiency in well-mixed environments (Reynolds 2006:192–195; Visser et al. 2016:3), fluctuating light levels in turbulent waters, conditions often present in spring months, favor diatoms (Litchman 1998:253; Reynolds 2006:1994; Visser et al. 2016:3). Green algae and cyanobacteria can both dominate in high light conditions; however, *Microcystis* and *Dolichospermum* can use their buoyancy to migrate to the water surface where light is available and utilize high irradiance levels that inhibit other phytoplankton species Lehman et al. 2013:154).

### 6B.2.1.6 Cyanotoxins

Cyanobacteria produce a number of cyanotoxins. In central California, toxins other than microcystins are not frequently detected (Berg and Sutula 2015:83). However, over the past few years low concentrations of the neurotoxins anatoxin-a and saxitoxin have been detected throughout the Delta (Lehman et al. 2021:8).

The cyanobacteria toxin, microcystin, was first documented in the Delta in 2003 (Lehman et al. 2005:87) and has been detected on numerous occasions since (Lehman et al. 2008:187; Lehman et al. 2010:239; Lehman et al. 2013:141; Lehman et al. 2015:165; Lehman et al. 2017:94; Spier et al. 2013:10), with increased toxin concentrations generally associated with higher *Microcystis* abundances (Lehman et al. 2013:153). During the 2014 drought, microcystin concentrations were the highest on record for the Delta, frequently exceeding both the World Health Organization (1 µg/L) and EPA (0.3 µg/L for children under the age of 6) drinking water guidelines (Lehman et al. 2017:104–105). Microcystin concentrations continue to increase in extent and severity in the Delta and in 2020 the toxin was detected at 1,239.4 µg/L in scum in the Stockton Deep Water Ship Channel and at 138.6 µg/L in a water sample taken from Mormon Slough (State Water Resources Control Board 2021).

Like other regions where *Microcystis* occurs, the Delta has a mix of toxigenic and nontoxigenic strains (Baxa et al. 2010:347). Toxigenic strains and appropriate environmental conditions must be present for microcystin to occur (Ibelings et al. 2021:261). Even in intensively studied waterbodies it is not possible to accurately predict microcystin concentrations or correlate toxin to biomass ratios (Ibelings et al. 2021:270). As such, a larger bloom does not always correlate to greater toxin concentrations because a bloom could potentially contain more nontoxic than toxic strains. In fact, because blooms continuously evolve and can contain any mixture or ratio of toxic and nontoxic strains, bloom presence does not guarantee toxin production (Turner et al. 2018:3). Nevertheless, *Microcystis* blooms usually produce microcystin and studies often see greater toxin levels when large blooms occur, as was the case in the Delta between the 2014 and 2017 water years (Ibelings et al. 2021:261; Lehman et al. 2020:4).

## 6B.2.2 CHAB Assessment Methodology

The assessment of effects of facility operations on CHABs utilized DSM2-modeled temperature, velocity, and residence time, as well as qualitative changes in nutrients and water clarity to make determinations regarding whether the operation of the proposed action could result in substantial changes to these environmental factors in Delta waters.

### 6B.2.2.1 Delta Assessment Locations

CHABs typically form in the Delta from July through November (Lehman et al. 2020:4; ESA 2022). In some years, however, CHABs can form as early as May or June if temperatures are sufficiently warm (Lehman et al. 2017:103). This CHAB analysis focused on the period of June through November at nine Delta locations that have been part of routine Delta monitoring programs and identified as primary bloom areas (Lehman et al. 2017:95; Lehman et al. 2020:3). These nine locations are listed below.

- Sacramento River at Brannon Island
- San Joaquin River at Jersey Point
- Franks Tract
- Old River at Rock Slough
- Victoria Canal
- Stockton Deep Water Ship Channel
- Mildred Island
- San Joaquin River near Venice Island
- Mokelumne River near Bouldin Island

The residence time analysis conducted as part of the Delta CHABs analysis was expanded to include several other locations (beyond the nine listed above) to more accurately capture how the proposed action could potentially affect water residence times across the Delta. These locations included Discovery Bay, the channels adjacent to Discovery Bay, Middle River, and Old River south of Clifton Court Forebay.

In addition to the nine locations listed above, temperature and velocity data were compiled for the Sacramento River at I Street Bridge and the Sacramento River at Freeport. Although these two Sacramento River locations are within the Delta, these two locations were used to evaluate CHABs in the lower Sacramento River in the reach downstream of the American River, but upstream of much of the primary Delta region.

The proposed action's effects on CHABs were assessed both quantitatively and qualitatively based on how the proposed action would affect the five primary environmental factors that provide favorable conditions for CHABs described in Section 6B.2.1, *Background and Existing Conditions in the Delta*. Environmental factors for which adequate modeling tools were available were assessed quantitatively: water temperatures, channel velocities, and residence times. Water column irradiance and nutrient availability (based on the nutrient and total suspended solids qualitative assessments) were assessed qualitatively. The interaction of all these factors was also assessed qualitatively.

#### 6B.2.2.2 Temperature

DSM2 temperature modeling was used to evaluate how the proposed action could affect temperatures at the nine Delta assessment locations. This analysis focused on the potential for the proposed action to increase the frequency at which temperatures greater than 19°C (66.2°F) would occur in the Delta, relative to existing conditions.

#### 6B.2.2.3 Velocity

Flow (measured in cubic feet per second [cfs]) is a measure of the volume of water passing a specified location within a channel, whereas velocity (measured in feet per second [ft/s]) is the measure of how rapidly the water is moving within a channel. Channel velocity is the primary driver of channel turbulence and mixing, in-channel generated turbidity, and hydraulic residence time—all of which can affect CHABs. If a channel is large and has substantial cross-sectional area, the channel may have a relatively high flow (cfs) despite having a relatively low velocity (ft/s). Conversely, if a channel has a small cross-sectional area, it may have a relatively low flow (cfs), but a relatively high velocity (ft/s). The distinction between flow and velocity is important when evaluating cyanobacteria because it is not the volume of water moving through a channel, but rather the velocity (and associated turbulence and mixing within the channel) with which the water moves that most affects the ability of cyanobacteria to outcompete other algae, as discussed further below.

DSM2 was used to model channel velocities at various Delta locations. This analysis focused on how the proposed action would affect 15-minute absolute velocity (regardless of direction) in channels of the Delta. Mathematical daily average velocity may approach zero when flows on the tidal cycle move in opposite directions, and thus is not very useful for determining how channel velocity affects cyanobacteria. In such tidally influences channels, 15-minute absolute velocity (regardless of direction) is the parameter that best characterize the degree of channel mixing that occurs daily. Hence, this analysis determines how the proposed action would affect 15-minute absolute velocity, relative to velocities for existing conditions at the assessment locations.

#### 6B.2.2.4 Residence Time

Hydraulic residence time at various locations within the Delta was assessed directly using the QUAL module of the DSM2 model. As described above, the nine Delta assessment locations and several other locations were assessed for residence time to understand how the proposed action could potentially affect water residence time in approximately 3- to 9-mile channel reaches across the Delta. The exception to this was the channels surrounding Mildred Island where an approximately 1-mile reach was modeled and the vicinity of Venice Island where an approximately 12-mile channel reach was modeled. Hydraulic residence time was also modeled for the open water bodies of Discovery Bay, Franks Tract, and Mildred Island. To assess the incremental increases in residence times modeled for various locations in the Delta for the proposed action relative to existing conditions, both the residence time of the site itself (defined as the modeled number of hours required to flush 90% of the water from the modeled reach) and the incremental increase in residence time due to the proposed action were considered.

Residence time modeling by DSM2 has inherent limitations in simulating the hydrodynamics in the open water areas, including the flooded islands, of the Delta. For open waterbodies, DSM2 assumes uniform and instantaneous mixing over the entire open water area. Thus, it does not account for any variations in localized hydrodynamic conditions (e.g., circulation patterns) that likely exist within

the open waterbodies. The residence times within portions of an open waterbody can vary based on such site-specific conditions, which DSM2 cannot model. Hence, the output from DSM2 for the open water areas can only provide a rough estimate of residence time for the entire waterbody and a general indication of whether the proposed action would be expected to increase or decrease residence times for the entire open waterbody and does not provide any information about site-specific conditions in the open waterbodies that may be important for CHABs. Hence, DSM2 cannot provide definitive residence time estimates for open waterbodies or definitive estimates for changes in residence time due to the proposed action for open waterbodies. These limitations of the model were considered when interpreting modeled residence times for the open waterbodies.

Additionally, reported effects of residence time increases in closed bodies of waters such as lakes and reservoirs on *Microcystis* growth cannot be used to identify potential effects of the proposed action on CHABs in the Delta. Residence time-associated temperature increases in the upper portion of the water column in lakes and reservoirs are associated with reduced vertical mixing and prolonged stratification, which favor increased *Microcystis* growth (You et al. 2018 [and references within]:17). The relatively shallow and tidal nature of the Delta prevents much of the area from experiencing thermal stratification.

The following assessment focuses on median modeled residence times. However, residence times at the 25$^{th}$, 75$^{th}$, 90$^{th}$, and other percentiles also were considered (refer to Attachment 6B.1, Tables 6B.1-14 through 6B.1-19). For the purposes of this assessment, increases in modeled median residence times under the proposed action that were 24 hours (1 day) or greater, or 10% greater, relative to existing conditions, received additional analysis as described in detail below. These same parameters also were used in assessing changes in residence time at other percentiles of occurrence. As discussed above, based on the growth studies cited, increased residence time of a 24 hours (i.e., 1 day) or more could potentially provide sufficient additional time to allow additional growth (i.e., cell production), accumulation, and aggregation of cells at a site. However, there is a great deal of uncertainty that exists regarding interpretation of this residence time modeling because no scientific studies have been performed or published that specifically correlate area-specific residence times within the Delta (as modeled) to cyanobacteria bloom size, or changes in bloom size over time, in specific areas of the Delta.

### 6B.2.2.5 Nutrients

Effects of facility operations on nutrients in the Delta were assessed qualitatively, utilizing modeled changes in factors that could affect the constituent level (e.g., channel velocity, temperature, changes in relative contribution of source waters). This assessment considered the sources of nutrients to surface waters, transport and cycling mechanisms, the relative contributions of the primary Delta inflows (i.e., Sacramento River, San Joaquin River, San Francisco Bay), and the degree to which the proposed action would alter these factors and cause substantial concentration changes in Delta waters.

### 6B.2.2.6 Water Column Irradiance and Clarity

Effects of facility operations on water column irradiance and clarity in the Delta were assessed qualitatively, utilizing modeled changes in factors that could affect the constituent level (e.g., channel velocity, temperature, changes in relative contribution of source waters). This assessment considered the relative source water contributions of suspended sediment to the Delta and environmental factors within the Delta that affect turbidity and total suspended solids (TSS) levels,

and the degree to which the projects would affect these factors and result in adverse effects to beneficial uses.

## 6B.2.3 Operations Modeling Results and Qualitative Analysis

### 6B.2.3.1 Temperature

Under the proposed action, monthly average temperatures for all assessment locations would be negligibly different from those under existing conditions (refer to Attachment 6B.1, Tables 6B.1-1 through 6B.1-12). Modeling shows that the frequency with which any given temperature above 19°C (66.2°F) would occur for the proposed action would be nearly identical to that of existing conditions (refer to Attachment 6B.1, Figure 6B.1-1 through Figure 6B.1-72). From a thermal perspective, any minor differences in water temperatures at the Delta assessment location under the proposed action, relative to existing conditions, would not affect the frequency or magnitude of cyanobacteria blooms at the Delta assessment locations, relative to that which could occur under existing conditions. This result is to be expected based on the fact that atmospheric exchange processes primarily drive Delta water temperatures on both short and long timescales (Kimmerer 2004:19; Wagner et al. 2011:12; Vroom et al. 2017:9919–9920).

Based on the above findings, the proposed action would not result in increases in water temperatures that would increase the frequency or magnitude of CHABs in the Delta, relative to existing conditions. Table 6B-18 shows the percent change of temperature from existing conditions of the proposed action for the nine Delta assessment locations. (Refer to Attachment 6B.1, Tables 6B.1-1 through 6B.1-12 for modeled average temperature under existing conditions and the proposed action for the nine Delta assessment locations).

**Table 6B-18. Monthly Average Temperature (in degrees Fahrenheit), Percent Change Proposed Action from Existing Conditions, Full Simulation Period**

| Alternative(s) | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Brannan Island | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| San Joaquin River at Jersey Point | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.2% |
| Old River at Rock Slough | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Franks Tract Averaged | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Franks Tract | 0.0% | 0.0% | 0.0% | 0.2% | 0.0% | 0.0% |
| Victoria Canal | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Stockton Deep Water Ship Channel | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Mildred Island | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| San Joaquin Near Venice Cut | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.2% |
| Mokelumne River | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% | 0.2% |
| Sacramento River at I Street Bridge | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Sacramento River at Freeport | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |

### 6B.2.3.2 Velocity

The proposed action would have negligible, if any, effect on the probability with which any given 15-minute absolute velocity would occur at the assessment locations during the June through November period, relative to existing conditions (refer to Attachment 6B.1,Figures 6B.1-73 through 6B.2-138). Therefore, the proposed action would not cause lower velocities, or reduce the frequency with which any given velocity would occur when velocities are low during the months of June through November, relative to the existing conditions. Consequently, the proposed action would not alter turbulence and mixing within Delta channels sufficiently to substantially affect, or even measurably affect, the frequency or size of *Microcystis* or other cyanobacteria blooms at any Delta assessment location, relative to existing conditions.

### 6B.2.3.3 Residence Time

Depending on location and month, the proposed action would result in increases, decreases, or no change in modeled median residence time at specific locations for the full simulation period, relative to existing conditions. The proposed action would have little to no effect on median residence time for all locations with short residence time. At each of these locations, the median residence time was shown to increase by 2 hours or less (Table 6B-19; refer to Attachment 6B.1, Table 6B.1-13, Figures 6B.1-139 through 6B.1-144b, Figure 6B.1-149, and Figures 6B.1-152 through 6B.1-153). In areas where median residence times are relatively short (i.e., 72 hours or less), an increase of up to 2 hours would not provide enough additional time to allow substantial additional growth and accumulation and aggregation of cells, relative to existing conditions. Any negligible changes on growth and accumulation and aggregation of cells at these locations that may occur from such small increases in residence times would not be sufficiently large to cause effects on beneficial uses that would differ from those that would occur for existing conditions. This is true even if there is a 10% increase in residence time (e.g., an increase in median residence time from 8 to 9 hours at Victoria Canal in July) because the absolute magnitude of increase in residence time would not result in conditions substantially more conducive to CHABs, relative to existing conditions.

**Table 6B-19. Change in Median Residence Time in Hours Modeled Using DSM2 of the Proposed Action from Existing Conditions for Locations with Short Residence Time (i.e., ≤ 72 hours [3 days]).**

| Location | Month | | | | | |
|---|---|---|---|---|---|---|
| | June | July | August | September | October | November |
| Brannan Island | 0 | 0 | 0 | 0 | 0 | 0 |
| Discovery Bay Channels | 1 | 1 | 0 | 2 | 0 | 2 |
| Franks Tract Channels | 0 | 0 | 0 | 0 | 0 | 0 |
| Middle River from Woodward Island to Mildred Island | 0 | 1 | 0 | 1 | 1 | 1 |
| Mildred Island Channels | 0 | 0 | 0 | 0 | 0 | 0 |
| Mokelumne River | 0 | 0 | 0 | 0 | -1 | 1 |
| Old River at Rock Slough | -1 | 1 | 1 | 1 | 0 | 0 |
| San Joaquin River at Jersey Point | 0 | 0 | 0 | 0 | 0 | 0 |
| Victoria Canal | 0 | 1 | 0 | 1 | 1 | 0 |

The following assessment focuses on median modeled residence times. However, residence times at the 25th, 75th, 90th, and other percentiles also were considered (refer to Attachment 6B.1, Tables 6B.1-14 through 6B.1-19). For the purposes of this assessment, increases in modeled median residence times under the proposed action that were 24 hours (1 day) or greater, or 10% greater, relative to existing conditions, received additional analysis as described in detail below. These same parameters also were used in assessing changes in residence time at other percentiles of occurrence. As discussed above, based on the growth studies cited, increased residence time of a 24 hours (i.e., 1 day) or more could potentially provide sufficient additional time to allow additional growth (i.e., cell production), accumulation, and aggregation of cells at a site. However, there is a great deal of uncertainty that exists regarding interpretation of this residence time modeling because no scientific studies have been performed or published that specifically correlate area-specific residence times within the Delta (as modeled) to cyanobacteria bloom size, or changes in bloom size over time, in specific areas of the Delta.

Depending on location and month, the proposed action would result in increases, decreases, or no change in modeled median residence time at specific locations for the full simulation period, relative to existing conditions. The proposed action would have little to no effect on median residence time for all locations with short residence time (Table 6B-19). At each of these locations, the median residence time was shown to increase by 2 hours or less. In areas where median residence times are relatively short (i.e., 72 hours or less), an increase of up to 2 hours would not provide enough additional time to allow substantial additional growth and accumulation and aggregation of cells, relative to existing conditions. Any negligible changes on growth and accumulation and aggregation of cells at these locations that may occur from such small increases in residence times would not be sufficiently large to cause effects on beneficial uses that would differ from those that would occur for existing conditions. This is true even if there is a 10% increase in residence time (e.g., an increase in median residence time from 8 to 9 hours at Victoria Canal in July) because the absolute magnitude of increase in residence time would not result in conditions substantially more conducive to CHABs, relative to existing conditions.

Modeling showed larger changes in median residence time under the proposed action (both positive and negative) at locations with median residence times greater than 72 hours (3 days) (Tables 6B-20 through 6B-25, Figures 6B.1-145 through 6B.1-148, and Figures 6B.1-150 through 6B.1-151). These locations and changes in residence time under the proposed action, relative to existing conditions, are discussed in detail below.

*Stockton Waterfront*

Modeled residence times for the 25th percentile, median, 75th percentile, and 90th percentile at the Stockton Waterfront for the full simulation period for the proposed action, relative to existing conditions, generally show a decrease, or no change in the months June through November (Table 6B-20; refer to Attachment 6B.1, Table 6B.1-14 and Figure 6B.1-145). Occasionally there would be a small increase in residence time, up to 1 hour, but never an increase of 10% or greater.

**Table 6B-20. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, Stockton Deep Water Ship Channel**

| Month | 25th Percentile | | 50th (Median) Percentile | | 75th Percentile | | 90th Percentile | |
|---|---|---|---|---|---|---|---|---|
| | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action |
| June | 370 | 370 (0) | 414 | 412 (-2) | 465 | 465 (0) | 544 | 524 (-20) |
| July | 407 | 405 (-2) | 496 | 480 (-16) | 624 | 610 (-14) | 844 | 805 (-39) |
| August | 455 | 455 (0) | 541 | 530 (-11) | 616 | 613 (-3) | 731 | 731 (0) |
| September | 436 | 435 (-1) | 477 | 471 (-6) | 530 | 512 (-18) | 568 | 554 (-14) |
| October | 393 | 394 (1) | 419 | 420 (1) | 441 | 441 (0) | 463 | 458 (-5) |
| November | 452 | 448 (-4) | 487 | 479 (-8) | 555 | 528 (-27) | 604 | 583 (-21) |

Note: Change in residence time in hours for the proposed action, relative to existing conditions, are in parentheses.

The largest decreases in median residence times would occur from July to September (i.e., during the peak bloom season). The maximum modeled decrease in median residence time at the Stockton Waterfront (i.e., 16-hour decrease) would occur in July. Thus, when the greatest decreases in median residence time were to occur, the median residence times would decrease from 496 hours (20.6 days) to 480 hours (20 days). Similarly, when the greatest modeled decrease would occur (i.e., decrease of 39 hours in July for the 90th percentile), residence time would decrease from 844 hours (35.2 days) to 805 hours (33.5 days).

Although decreases in residence time were modeled to occur at the Stockton Waterfront, there is unlikely to be any change in the density or extent of *Microcystis* and other cyanobacteria at this location relative to existing conditions. Decreases in residence time under the proposed action would not be sufficient to change *Microcystis* dynamics (i.e., growth rates, accumulation, or aggregation) as residence times would continue to be long and conditions would remain favorable to support *Microcystis* growth, accumulation, and aggregation similar to existing conditions.

*Old River at Clifton Court Forebay*

In Old River at Clifton Court Forebay median modeled residence time are generally lower for the proposed action, relative to existing conditions, from June through September (Table 6B-21; refer to Attachment 6B.1, Table 6B.1-15 and Figure 6B.1-152). Median residence time in October and November under the proposed action would be nearly identical to median residence time under existing conditions. Changes in residence time at the other percentiles would be variable with decreases in some months and increases in other months. Changes in residence time at the 25th percentile would range from a decrease of 38 hours in September to an increase of 7 hours in July. Changes in residence time in the 75th percentile would range from a decrease of 40 hours in July to an increase of 23 hours in November. Changes in residence time for the 90th percentile would range from a decrease of 49 hours in November to an increase of 11 hours in June.

**Table 6B-21. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, Old River South of Clifton Court Forebay**

| Month | 25th Percentile | | 50th (Median) Percentile | | 75th Percentile | | 90th Percentile | |
|---|---|---|---|---|---|---|---|---|
| | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action |
| June | 68 (-3) | 68 (-3) | 184 | 180 (-4) | 417 | 392 (-25) | 643 | 654 (11) |
| July | 115 (7) | 115 (7) | 368 | 333 (-35) | 593 | 553 (-40) | 693 | 676 (-17) |
| August | 135 (-1) | 135 (-1) | 342 | 340 (-2) | 654 | 641 (-13) | 718 | 716 (-2) |
| September | 189 (-38) | 189 (-38) | 318 | 310 (-8) | 332 | 337 (5) | 344 | 349 (5) |
| October | 50 (0) | 50 (0) | 74 | 74 (0) | 88 | 88 (0) | 118 | 112 (-6) |
| November | 65 (0) | 65 (0) | 83 | 84 (1) | 170 | 193 (23) | 368 | 319 (-49) |

Note: Change in residence time in hours for the proposed action, relative to existing conditions, are in parentheses. Increases of 24 hours or greater are bolded.

Modeled median residence time under existing conditions during the July through September period range from 318 to 368 hours (13.3 to 15.3 days). The maximum modeled decrease in median residence time at Old River at Clifton Court Forebay (up to 40-hour decrease) would occur in July. It is possible that these decreases in median residence time under the proposed action in July and a 38 hour (16.8%) decrease in 25th percentile residence time in September could cause some decreases in the density and extent of *Microcystis* or other cyanobacteria in Old River at Clifton Court Forebay, relative to existing conditions. This is because cyanobacteria cells would have substantially less time to grow, aggregate, and accumulate at this location than under existing conditions. Although decreases in residence time would also occur in other months, these smaller decreases in residence time would not be sufficient to change *Microcystis* dynamics (i.e., growth rates, accumulation, or aggregation) as residence times would continue to be long and conditions would remain favorable to support *Microcystis* growth, accumulation, and aggregation similar to existing conditions.

The largest increase in residence time would occur in November at the 75th percentile when residence times would increase by up to 23 hours (i.e., increase by approximately 14%). Residence times corresponding to the other percentiles in November either decrease or remain identical to those that occur under existing conditions. It is possible for cyanobacteria to be present and continue to grow in November; however, after the peak growing season (i.e., July through September) there are rarely, if ever, any substantial blooms. This is due largely to the decrease in water temperatures and slower corresponding growth rates. Based on relatively cool water temperatures, the tidal nature of the waterbody, water column mixing, other environmental factors, and absolute residence times, the proposed action's effects on residence time would not be sufficient to allow for substantial increases in cell density or the formation of surface scums, relative to existing conditions. As such, increases in residence times in November that could occur under the proposed action would not cause CHAB frequency or magnitude to change sufficiently enough to negatively affect any beneficial use in Old River at Clifton Court Forebay, relative to existing conditions.

*San Joaquin River near Venice Island*

In the San Joaquin River near Venice Island, model results show median residence time would generally increase under the proposed action for the full simulation period for the months of July

through November (Table 6B-22; refer to Attachment 6B.1, Table 6B.1-16 and Figure 6B.1-148). Median residence time in June under the proposed action would be nearly identical to median residence time under existing conditions. The largest increases in modeled median residence time occur in September when median residence times increase by 14 hours under the proposed action, relative to existing conditions (Table 6B-22). Residence times for the 25th and 90th percentiles would show similar changes in residence time as those for the median. Residence times in the 75th percentile would increase by 6 hours or less in June, August, September, and October. However, in July and November residence times in the 75th percentile would increase by 17 hours and by 16 hours, respectively.

**Table 6B-22. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, San Joaquin River near Venice Island**

| Month | 25th Percentile | | 50th (Median) Percentile | | 75th Percentile | | 90th Percentile | |
|---|---|---|---|---|---|---|---|---|
| | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action |
| June | 90 | 88 (-2) | 130 | 129 (-1) | 154 | 157 (3) | 187 | 187 (0) |
| July | 71 | 79 (8) | 87 | 98 (11) | 104 | 121 (17) | 170 | 166 (-4) |
| August | 81 | 81 (0) | 94 | 99 (5) | 131 | 131 (0) | 197 | 205 (8) |
| September | 92 | 96 (4) | 115 | 129 (14) | 159 | 160 (1) | 181 | 187 (6) |
| October | 104 | 106 (2) | 143 | 147 (4) | 188 | 194 (6) | 234 | 226 (-8) |
| November | 82 | 82 (0) | 105 | 104 (-1) | 165 | 181 (16) | 225 | 229 (4) |

Note: Change in residence time in hours for the proposed action, relative to existing conditions, are in parentheses. Increases of 24 hours or greater are bolded.

In July and September there would be a 10% or greater increase in median residence time and in July a 15% increase in residence times in the 75th percentile, relative to existing conditions. Although modeled residence time in the 75th percentile would increase by up to approximately 17 hours at this location in July and by a median residence time of up to approximately 14 hours in September, these increases are not sufficient time to increase the magnitude or severity of CHABs, for several reasons. First, the other four drivers (i.e., temperature, velocity, nutrients, and irradiance) would not change under the proposed action, relative to existing conditions. Second, although it is possible for some additional growth, accumulation, and aggregation to occur in July and September, there would continue to be competition with other algae, grazing losses, virus losses, and net downstream movement of water that are co-occurring during periods of increased residence time. Third, this area would continue to be tidally influenced and experience both tidal and wind-induced velocity that would interfere with *Microcystis* life history strategy. Finally, although *Microcystis* and other cyanobacteria have been observed at this location, it is not recognized as a primary cyanobacteria producer in the Delta like backwater slough areas and channel margins where residence time is on the order of 2 weeks or more.

The greatest increase in residence time in the San Joaquin River near Venice Island was modeled to occur in July at the 75th percentile. Residence times in the 75th percentile would increase by 17 hours under the proposed action. Thus, in November residence times in the 75th percentile would increase from 165 hours (6.9 days) under existing conditions to 181 hours (7.5 days). Although it is possible for cyanobacteria to be present, and continue to grow in November, after the peak growing

season (i.e., July through September) there are rarely, if ever, any substantial blooms in November. Importantly, no substantial cyanobacteria presence has ever been observed in the San Joaquin River near Venice Island in November. This is because water temperatures are substantially cooler in November than earlier in the season, causing growth rates to substantially decline and cells to settle out of the water column into the benthos. Due to the cooler water temperatures and lower overall cyanobacteria biomass in November, the modeled increase in residence time of up to 16 hours would not substantially increase growth or presence of *Microcystis* or other cyanobacteria relative to existing conditions. Further, as described above, there would continue to be competition with other algae, grazing losses, virus losses, and net downstream movement of water that co-occur during periods of increased residence time. Although it is possible for some additional growth and cell aggregation to occur, this would not be expected to result in substantially larger blooms than would occur under existing conditions. As such, modeled increases in the 75th percentile residence time of up to 16 hours would not lead to conditions that would negatively affect beneficial uses, relative to existing conditions in the San Joaquin River near Venice Island.

*Mildred Island*

At Mildred Island, the modeled median residence time for the full simulation period under the proposed action, relative to existing conditions, show little to no change in residence time for June and November (Table 6B-23; refer to Attachment 6B.1, Table6B.1-17 and Figure 6B.1-146). Under the proposed action there are increases in median residence time in July, August, September, and October. Under the proposed action, median residence time in October would increase by 17 hours, relative to existing conditions. Modeled residence times corresponding to the 25th, 75th, and 90th percentiles show that the proposed action would have varying levels of effect on residence time with similar ranges to those reported for the median residence times. Changes in residence time at the 25th percentile would range from a decrease of 2 hours in June to an increase of 13 hours in July. Changes in residence time in the 75th percentile range from a decrease of 10 hours in October to an increase of 15 hours in November. Finally, changes in residence time in the 90th percentile range from a decrease of 22 hours in August to an increase of 13 hours in June. All modeled increases in residence time under the proposed action would be less than 10%, relative existing conditions.

**Table 6B-23. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, Mildred Island**

| Month | 25th Percentile | | 50th (Median) Percentile | | 75th Percentile | | 90th Percentile | |
|---|---|---|---|---|---|---|---|---|
| | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action |
| June | 283 | 281 (-2) | 289 | 287 (-2) | 320 | 322 (2) | 408 | 421 (13) |
| July | 196 | 209 (13) | 210 | 218 (8) | 232 | 241 (9) | 361 | 370 (9) |
| August | 204 | 207 (3) | 210 | 219 (9) | 278 | 264 (-14) | 420 | 398 (-22) |
| September | 219 | 230 (11) | 245 | 256 (11) | 296 | 303 (7) | 335 | 339 (4) |
| October | 240 | 245 (5) | 279 | 296 (17) | 349 | 339 (-10) | 427 | 421 (-6) |
| November | 202 | 203 (1) | 226 | 228 (2) | 312 | 327 (15) | 421 | 420 (-1) |

Note: Change in residence time in hours for proposed action, relative to existing conditions, are in parentheses.

Under the proposed action, Mildred Island median October residence time was modeled to increase by 17 hours, from 279 hours (11.6 days) to 296 hours (12.3 days). During October, water temperatures are substantially cooler than during the peak CHAB season of July through early September (refer to Attachment 6B.1, Figures 6B.1-1 through 6B.1-6). As such, the growth rates of cyanobacteria are lower and there is substantially less biomass in the water column relative to the peak growth period. Further, modeling showed that both the 75$^{th}$ and 90$^{th}$ percentiles residence times decrease in October rather than increase for the proposed action. Considering these factors, along with continued competition with other algae, grazing losses, virus losses, and net downstream movement of water, an increase of up to about 17 hours in residence time at Mildred Island in October, when residence time is on the order of 11 to 12 days, would not be expected to substantially increase growth, accumulation, and aggregation of cyanobacteria, relative to that which would occur for existing conditions. Although it is possible for some additional growth and cell aggregation to occur, this would not be expected to result in substantially larger blooms for the proposed action than would occur at this location under existing conditions. The same findings are also applicable to the increased residence times for the 75$^{th}$ percentile of 15 hours under the proposed action in November. In November water temperatures are even cooler than October and *Microcystis* growth rates slow considerably. As such, increases of 15 hours in residence time in November would not result in substantially larger blooms than those that would occur under existing conditions.

Based on the discussion above, it can be concluded that for the proposed action during the July through September period there may be a small increase in the number of *Microcystis* flakes (from an aggregation of cells) floating within the water column. However, based on growth rates, the tidal nature of the waterbody, water column mixing, other environmental factors, and absolute residence times, the proposed action' effects on residence time would not be sufficient to allow for substantial increases in cell density or the formation of surface scums, relative to existing conditions. As such, the relatively small increases in residence times that could occur for the proposed action would not cause CHAB frequency or magnitude to change sufficiently enough to negatively affect any beneficial use at Mildred Island, relative to existing conditions.

*Franks Tract*

Changes in modeled median residence time for the proposed action, relative to existing conditions, were variable with no change in some months to a small increase in other months (Table 6B-24; refer to Attachment 6B.1, Table 6B.1-18 and Figure 6B.1-142). The maximum increase in median residence time would be up to 5 hours in August. Modeled 25$^{th}$ percentile and 90$^{th}$ percentile changes in residence times are similar to those reported for the median. The greatest change in residence times would occur in the 75$^{th}$ percentile when residence times would increase by 13 hours in September and by 18 hours in November. All modeled increases in residence time under the proposed action would be less than 10%, relative existing conditions.

**Table 6B-24. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, Franks Tract**

| Month | 25th Percentile | | 50th (Median) Percentile | | 75th Percentile | | 90th Percentile | |
|---|---|---|---|---|---|---|---|---|
| | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action |
| June | 289 | 288 (-1) | 311 | 311 (0) | 322 | 320 (-2) | 352 | 352 (0) |
| July | 273 | 280 (7) | 283 | 287 (4) | 297 | 303 (6) | 351 | 355 (4) |
| August | 278 | 281 (3) | 292 | 297 (5) | 332 | 338 (6) | 381 | 378 (-3) |
| September | 283 | 289 (6) | 303 | 305 (2) | 335 | 348 (13) | 377 | 382 (5) |
| October | 296 | 297 (1) | 315 | 317 (2) | 362 | 362 (0) | 409 | 410 (1) |
| November | 268 | 268 (0) | 290 | 293 (3) | 325 | 343 (18) | 391 | 391 (0) |

Note: Change in residence time in hours for proposed action, relative to existing conditions, are in parentheses.

Modeled median and 75th percentile residence times in Franks Tract under existing conditions are relatively long (i.e., from 283 to 315 hours [11.8–13.1 days] and 297 to 362 hours [12.4–15.0 days], respectively). These long residence times are conducive to cyanobacteria aggregation, and *Microcystis* flakes are routinely observed at this location (ESA 2022:5). Modeled increases in residence time for the 75th percentile in residence time in September and November could allow for some additional growth, cell accumulation, and aggregation of cells at the site. However, in November, when the largest increase in residence time could occur (i.e., up to 18 hours), water temperatures are cool and growth rates are slow compared to the peak growing season of July through September.

Although it is possible for cyanobacteria to be present and continue to grow in November, after the peak growing season there are rarely, if ever, any substantial blooms in November. Importantly, no substantial cyanobacteria bloom has been observed in Franks Tract in November. Thus, modeled increases in residence time would not be sufficient to substantially increase *Microcystis* growth, accumulation, or aggregation at this location. This is particularly true when the other four drivers of *Microcystis* and other cyanobacteria blooms (including water temperature) are changing negligibly. Based on growth rates, the tidal nature of the waterbody, water column mixing, other environmental factors, and absolute residence times, the proposed action' effects on residence time would not be sufficient to allow for substantial increases in cell density or the formation of surface scums, relative to existing conditions. As such, the relatively small increases in residence times that could occur for the proposed action would not cause CHAB frequency or magnitude to change sufficiently that it would negatively affect terrestrial species at Franks Tract, relative to existing conditions.

*Discovery Bay*

In Discovery Bay, model results show median residence time would generally increase under proposed action for the full simulation period for the months July through November (Table 6B-25; refer to Attachment 6B.1, Table6B.1-19 and Figures 6B.1-150 through 6B.1-151). There would be little to no change in median residence time in June. The greatest increase in median residence time would occur in July, September, and October when median modeled residence time would increase by 25 to 31 hours. Modeled residence times corresponding to the 25th, 75th, and 90th percentiles show that the proposed action would have varying levels of effect on residence time, with decreases

in some months and increases in other months. Modeled residence times in the 25th percentile for the proposed action would range from a decrease of up to 4 hours in June to an increase of 26 hours in July and September. Changes in residence time in the 75th percentile range from a decrease of up to 19 hours in October to an increase of 44 hours in July and November, respectively. Residence times in the 90th percentile would generally decrease, except in September when residence times could increase by up to 11 hours. All modeled increases in residence time under the proposed action would be less than 10%, relative existing conditions.

**Table 6B-25. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, Discovery Bay**

| Month | 25th Percentile | | 50th (Median) Percentile | | 75th Percentile | | 90th Percentile | |
|---|---|---|---|---|---|---|---|---|
| | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action | Existing Conditions | Proposed Action |
| June | 619 | 615 (-4) | 629 | 628 (-1) | 685 | 687 (2) | 779 | 773 (-6) |
| July | 456 | **482 (26)** | 482 | **513 (31)** | 533 | **570 (37)** | 763 | 761 (-2) |
| August | 472 | 478 (6) | 498 | 510 (12) | 639 | 620 (-19) | 832 | 815 (-17) |
| September | 520 | **544 (24)** | 575 | **605 (30)** | 687 | 696 (9) | 764 | 775 (11) |
| October | 568 | 574 (6) | 662 | **687 (25)** | 759 | 760 (1) | 857 | 850 (-7) |
| November | 470 | 474 (4) | 539 | 551 (12) | 689 | **733 (44)** | 847 | 850 (3) |

Note: Change in residence time in hours for the proposed action, relative to existing conditions, are in parentheses. Increases of 24 hours or greater are bolded.

Under existing conditions, residence times in Discovery Bay are long with residence times ranging from a minimum of 456 hours (19 days) in June at the 25th percentile to a maximum of 857 hours (35.7 days) in October for the 90th percentile. These long residence times are conducive to *Microcystis* growth, accumulation, and aggregation and is one of the reasons Discovery Bay is conducive to CHABs. Under the proposed action, the largest increase in residence time would occur in July and November at the 75th percentile when residence times would increase by 37 and 44 hours, respectively. Large increases in residence time would also occur at the median in July and September when residence times could increase by 30 to 31 hours. In November, at the 75th percentile, when the largest increase in residence time could occur (up to 44 hours), water temperatures are cool and growth rates are slow compared to the peak growing season of July through September. As such, there is unlikely to be much additional growth, aggregation, or accumulation in November, relative to existing conditions.

In July when optimal temperature conditions occur, there would likely be some additional growth, aggregation, and accumulation under the proposed action relative to existing conditions. However, there would also continue to be competition with other algae, grazing losses, and virus losses that are co-occurring during periods of increased residence time. In a location like Discovery Bay that has very long residence times (i.e., on the order of 2 to 5 weeks) a day or two of additional residence time under the proposed action is not enough time to cause significantly more cyanobacteria biomass or to cause a substantially larger bloom, relative to existing conditions.

As described above, there are inherent limitations in simulating the hydrodynamics in the open water areas of the Delta, and DSM2 can only provide a rough estimate of residence time for the entire waterbody. The modeling does not account for any variations in localized hydrodynamic

conditions (e.g., circulation patterns) that likely exist within the open waterbodies, and the modeling cannot account for residence times in portions of the open waterbody that vary based on site-specific conditions. Although it is reasonably certain that the proposed action would increase residence times under a few circumstances for Discovery Bay, insufficient information is available to definitively determine the relative magnitude of change in residence time that would occur annually. Nevertheless, due to the long residence times that occur under existing conditions, even if residence time were to increase slightly more than those modeled, the proposed action would not alter cyanobacteria dynamics such that they would negatively affect any beneficial use at Discovery Bay, relative to existing conditions.

#### 6B.2.3.4 Nutrients

The two main mechanisms by which the proposed action could change total phosphorus and total nitrogen concentrations in the Delta are: (1) changing total phosphorus and total nitrogen concentrations in the source water inflows to the Delta; and (2) changing the proportions of source waters fractions at specific Delta locations.

The proposed action would result in some seasonal differences in Delta inflow rates from the Sacramento River, relative to existing conditions. However, for many months, there would be little to no change in flow under the proposed action, relative to existing conditions, and for those months when there are changes in flow the flow rates would be within the range occurring under existing conditions. Winter flows would continue to remain higher than summer flows, and storm events would continue to be the primary cause of higher nitrogen and phosphorus concentrations in the winter months relative to the summer months under the proposed action. Consequently, there would be negligible, if any, flow-related changes to nitrogen and phosphorus concentrations in rivers upstream of the Delta.

As such, total phosphorus and total nitrogen concentrations in Delta inflows would differ negligibly, if at all, from existing conditions. Therefore, the remaining assessment focuses on the changing proportions of source water fractions at specific Delta locations and how any project alternative-related changes would affect nutrient concentrations relative to existing conditions.

The San Joaquin River has considerably less discharge to the Delta than the Sacramento River and overall delivers less phosphorus to the Delta. Modeling estimates the total annual phosphorus load entering the Delta is 1,944 tons from the Sacramento River and 732 tons from the San Joaquin River watershed (Domagalski and Saleh 2015:1479). However, total phosphorus concentrations within the San Joaquin River are substantially higher than those in the Sacramento River (Table 6B-26).

**Table 6B-26. Summary of Delta Source Water Concentrations for Total Phosphorus (in micrograms per liter)**

| Source Water | Sacramento River | San Joaquin River | San Francisco Bay | Eastside Tributaries | Agriculture Drains |
|---|---|---|---|---|---|
| Mean | 100 | 204 | 136 | 50 | 503 |
| Minimum | 20 | 10 | 35 | 7 | 100 |
| Maximum | 371 | 970 | 1,400 | 470 | 810 |
| 75th percentile | 120 | 260 | 155 | 67 | 678 |
| 99th percentile | 249 | 610 | 390 | 324 | 805 |
| Data source | CEDEN 2020 | CEDEN 2020 | CEDEN 2020 | CEDEN 2020 | DWR 2020 |

| Source Water | Sacramento River | San Joaquin River | San Francisco Bay | Eastside Tributaries | Agriculture Drains |
|---|---|---|---|---|---|
| Station(s) | Sacramento River at Greene's Landing, Sacramento River at Hood | San Joaquin River at Vernalis | Sacramento River at Chipps Island and Mallard Island, Suisun Bay at Bulls Head near Martinez | Cosumnes River at Twin Cities Road, Mokelumne River at Bruella Road, New Hope Road, Georgiana Slough | Staten Island |
| Date range | 1975–2000 | 1975–2000 | 1975–2019 | 2000–2018 | 2004 |
| Data omitted | No | No | No | No | No |
| Detected | 915 | 780 | 981 | 133 | 6 |
| Number of data points | 915 | 780 | 981 | 169 | 6 |

Note: Non-detects replaced with reporting limit for these calculations.
CEDEN = California Environmental Data Exchange Network; DWR = California Department of Water Resources.

Nitrogen loads from the Sacramento River are substantially higher than from the San Joaquin River because of the higher annual average discharge of the Sacramento River to the Delta (Saleh and Domagalski 2015:1502). However, like phosphorus, nitrogen concentrations in the San Joaquin River are higher than those from the Sacramento River (Table 6B-27).

**Table 6B-27. Summary of Source Water Concentrations for Total Nitrogen (in milligrams per liter)**

| Source Water | Sacramento River | San Joaquin River | San Francisco Bay | Eastside Tributaries | Agriculture Drains |
|---|---|---|---|---|---|
| Mean | 0.664 | 2.03 | 0.779 | 0.780 | 3.29 |
| Minimum | 0.100 | 0.280 | 0.130 | 0.330 | 2.47 |
| Maximum | 2.44 | 5.80 | 2.90 | 1.19 | 4.31 |
| 75th percentile | 0.800 | 2.61 | 0.930 | 0.980 | 3.76 |
| 99th percentile | 1.56 | 4.30 | 1.44 | 1.18 | 4.29 |
| Data source | CEDEN 2020 | CEDEN 2020 | CEDEN 2020 | CEDEN 2020 | DWR 2020 |
| Station(s) | Sacramento River at Greene's Landing, Sacramento River at Hood | San Joaquin River at Vernalis | Sacramento River at Chipps Island and Mallard Island, Suisun Bay at Bulls Head near Martinez | Cosumnes River at Twin Cities Road, Mokelumne River at Bruella Road, New Hope Road, Georgiana Slough | Staten Island |
| Date range | 1975–2020 | 1975–2020 | 1975–2020 | 2009–2010 | 2004 |
| Data omitted | Yes | Yes | Yes | Yes | Yes |
| Detected | 969 | 803 | 759 | 16 | 6 |
| No. of data points | 969 | 803 | 759 | 16 | 6 |

Notes: Data omitted where concentrations of all fractions were not detected to calculate total N. Non-detects replaced with reporting limit for these calculations.
CEDEN = California Environmental Data Exchange Network; DWR = California Department of Water Resources.

As shown in EIR Appendix 9B, *Source Water Fingerprinting,* the Sacramento River is the dominant water source throughout all Delta subregions except the south Delta, where various locations can be seasonally dominated by San Joaquin River water (California Department of Water Resources 2022). Water quality in the south Delta is also strongly influenced by agricultural drains. Based on a limited data set (n = 6) these agricultural drains have the highest nutrient concentrations of all the source waters to the Delta (Tables 6B.2-9 and 6B.2-10). At the south Delta assessment locations of Victoria Canal, Old River, Banks Pumping Plant, and Jones Pumping Plant, the modeled percentage of agricultural drainage is 9% to 17% during some months of the year. In addition to high fractions of Sacramento River water, the South Fork Mokelumne River at Terminous has substantial influence from the eastside tributaries with modeled percentages ranging from 27% to 36% of the river water from January to May. The eastside tributaries have the lowest nutrient concentrations of all Delta source waters. The Sacramento River at Mallard Island, located in the western Delta, is highly influenced by tidal exchange, where the modeled percentage of San Francisco Bay water ranges from 42% to 51% of the river water from July through November.

Under the proposed action, there would generally be very small changes in source water fractions, relative to existing conditions (refer to Final EIR Appendix 9B; California Department of Water Resources 2022). At all assessment locations, except Banks Pumping Plant and Jones Pumping Plant, the proposed action would cause long-term average decreases of Sacramento River water and increases in San Joaquin River water and/or other source waters. With the exception of the Banks and Jones Pumping Plants, the modeled major source water fractions (i.e., Sacramento River, San Joaquin River, San Francisco Bay) under the proposed action differ by no more than 2%, on a long-term average, relative to existing conditions. Modeled differences for the other source waters (i.e., eastside tributaries, agricultural drainage, and Yolo Bypass) are even smaller (refer to Final EIR Appendix 9B: California Department of Water Resources 2023).

Since changes in source water fractions are larger at Banks and Jones Pumping Plants relative to the other nine assessment locations, these two locations are described separately below. To determine how these changes in source water fractions would affect nutrient concentrations, the differences in individual source water fractions between existing conditions and the proposed action were applied to the total nitrogen and total phosphorus concentrations in Tables 6B-26 and 6B-27.

The largest decreases in Sacramento River flows (i.e., 2.3% decrease) would occur under the proposed action in January in the Sacramento River at Mallard Island where the proportion of Bay water would comparably increase. This would result in an increase of 0.9 µg/L of total phosphorus under the proposed action. There would be no measurable change in total nitrogen under the proposed action relative to existing conditions. Consequently, small changes in source water fractions during some months of the year would have negligible effects on nutrient concentrations in the Delta because the relative difference in source water fractions is so small that it would not lead to substantial changes in nutrient concentrations, relative to existing conditions.

At Jones Pumping Plant, changes in source water fractions under the proposed action would be very small, with up to a 2% increase or decrease in major (i.e., Sacramento River and San Joaquin River) source water fractions, as a long-term average, relative to existing conditions. Changes in other source water fractions would be even smaller (i.e., ≤ 0.3% increases in some months).

At Banks Pumping Plant, there would be substantial seasonal increases in the fraction of Sacramento River water. Although Sacramento River water inputs would generally increase in all months, the greatest changes would occur in March, with the Sacramento River long-term average water fraction

increases ranging from 16.5% to 18.8% for the project relative to existing conditions. All other source waters would decrease, but the greatest decreases would be in San Joaquin River inputs in March and May (i.e., 7.4% to 10.8% decrease), relative to existing conditions (refer to EIR Appendix 9B). Based on the lower concentrations of nutrients in the Sacramento River, relative to the San Joaquin River and other source waters, there could be small decreases in nutrients concentrations during some months of the year at Banks Pumping Plant, relative to existing conditions.

Although the proposed action would create differences in the proportion of source water fractions at various Delta locations, for the reasons described above there would be no substantial differences in nutrient distributions from these changes in source water inputs relative to existing conditions. At Banks Pumping Plant there would be small decreases in nutrient concentrations during November through June because fractions of Sacramento River water were modeled to increase substantially while other source waters that have higher concentrations of nutrients were modeled to decrease. There would also be some small decrease in nutrient concentrations during some months at Jones Pumping Plant when Sacramento River waters were modeled to increase. Nevertheless, under the proposed action total phosphorus and total nitrogen would be present in excess (i.e., non-limiting amounts for aquatic plant and algae growth) throughout the Delta, as they are under existing conditions.

In summary, the proposed action would not cause exceedances of any state or federal objectives/criteria for nutrients because there are none. Algal and macrophyte growth rates are not phosphorus- or nitrogen-limited in the Delta because these nutrients are available in excess. Thus, potential minor increases or decreases in these nutrient concentrations that may occur at some locations and times within the Delta would have negligible, if any, effects on macrophyte and algae growth in the Delta. Hence, any potential small changes in nutrient concentrations would be of magnitude that would not adversely affect any beneficial uses or substantially degrade Delta water quality with regard to nutrients.

### 6B.2.3.5 Water Column Irradiance and Clarity

Sediment retention in upstream reservoirs has decreased the long-term sediment supply upstream of the Delta (Schoellhamer et al. 2007:7). Turbidity, which has a direct linear relationship with TSS concentrations and is often used as a surrogate for suspended sediment, has decreased along with this reduction in suspended sediment transport. Conversely, the relative sediment supply upstream of the Delta from agriculture and urbanization has increased over time as these land uses have increased downstream of major dams (Schoellhamer et al. 2007:8). However, contributions to TSS and turbidity from urban and agricultural are small in comparison with the sediment retention in reservoirs.

Schoellhamer et al. (2007:6) noted that suspended sediment concentration was more affected by season than flow, with the higher concentrations for a given flow rate occurring during “first flush events” and lower concentrations occurring during spring snowmelt events. These first flush events can comprise up to half of the annual sediment load to the Delta (Morgan-King and Wright 2016:8). As described in EIR Appendix 9M, *Upstream of Delta Water Quality Analysis*, the TSS concentrations and turbidity levels of Delta inflows under the proposed action are not expected to be substantially different from those occurring under existing conditions, including during first flush events. However, the proposed action would change the quantity of Sacramento River inflows due to diversions at the north Delta intakes, resulting in reduced suspended sediment loading to the Delta.

Reductions in annual average sediment load in the Sacramento River that would otherwise move downstream to the Delta would be 5% (EIR Chapter 12, Table 12-97). Under existing conditions, the Sacramento River transports five times more sediment to the Delta than the San Joaquin River and accounts for approximately 66% of the annual Delta sediment budget (Wright and Schoellhamer 2005:7). Thus, an annual average 5% reduction in Sacramento River load is equivalent to an annual average 3% reduction in the total external sediment load to the Delta.

Although there could be an annual average reduction in sediment load due to the diversions the TSS concentrations and turbidity levels within the Sacramento River water that flows into the Delta would not differ from existing conditions under the project for several reasons. First, sediment concentrations in the river would not change when a portion of the water is entrained. Second, the diversions would not substantially affect flows associated with storm events or the "first flush" events important for sediment transport to the Delta or the TSS concentrations or turbidity levels in those flows. Finally, Delta channel erosion processes that are driven by tidal flow velocity changes and lead to sediment suspension and deposition would continue to occur under the proposed action, similar to existing conditions.

## 6B.2.4 CHABs Effects Analysis and Conclusions

### 6B.2.4.1 Operations

The potential operational effects of the proposed action on the occurrence of CHABs were assessed using DSM2-modeled water temperature, velocity, and residence time at various locations in the Delta, as well as qualitative changes in nutrients and water clarity to make determinations regarding whether the proposed action could result in substantial changes to these environmental factors in Delta waters (Section 6B.2.3).

The modeling results presented in Section 6B.2.3 indicate that operation of the proposed action would not cause the key factors potentially associated with CHABs (i.e., temperature, residence time, nutrients, water velocities and associated turbulence and mixing, and water clarity and associated irradiance) to change in the Delta in a manner that would increase the frequency or magnitude of CHABs in the Delta region. Therefore, the proposed action is not expected to increase levels of microcystins or other cyanotoxins within the study area by frequency, magnitude, and geographic extent that would cause measurably higher body burdens of microcystins or other CHAB toxins in aquatic organisms, thereby increasing the health risks to wildlife. Because Delta waterways would not be affected by potentially increased CHABs associated with operation of the proposed action, operations are not anticipated to increase the availability of microcystin toxins that could cause substantial adverse effects on California least tern, least Bell's vireo, western yellow-billed cuckoo, or giant garter snake.

### 6B.2.4.2 Compensatory Mitigation Plan

#### Bouldin Island and I-5 Ponds

The likelihood of CHABs is low at the I-5 ponds because they are not tidally connected and would use ambient and ground water that would not contain *Microystis* (Appendix 3B, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*, Section 3B.4.1.4, *DWR I-5 Ponds*, under *Site Design and Development*). Implementation of habitat creation and enhancement at Bouldin Island as part of the CMP has the potential to result in conditions that promote CHABs,

which could result in impacts on terrestrial species using habitat adjacent to created and/or enhanced wetland and aquatic habitats. Microcystins have been found in terrestrial foodwebs, such as spiders and songbirds in riparian habitats, likely through consumption of emergent aquatic insects (Moy et al. 2016:A, E) and can affect terrestrial species if they forage in or near habitats with conditions that promote *Microcystis* blooms. Monitoring and adaptive management plans described in the CMP (Appendix 3B, Section 3B.7.2) would include CHAB monitoring and adaptive management at Bouldin Island and the I-5 ponds to prevent increased CHAB formation, relative to existing conditions.

## Tidal Habitat Mitigation Framework

Implementation of the CMP, namely, the creation of tidal habitats in the North Delta Habitat Arc (i.e., Cache Slough region) that would be hydrodynamically connected to Delta channels could create new areas that are conducive to CHABs.

It should be noted that cyanobacteria are ubiquitous within the Delta as part of the overall phytoplankton community. As such, cyanobacteria would be present within any newly created tidal habitat. The issue is not one of presence or absence of cyanobacteria at these new tidal habitats but rather whether the new tidal habitat sites provide highly suitable conditions for CHABs. This is important because high amounts of cyanobacteria biomass (i.e., blooms) are often accompanied by sufficiently high cyanotoxin levels to pose risks of adverse effects—even mortality—on aquatic life and wildlife using or feeding in these habitats or immediately adjacent Delta waters that receive flushing from these habitats. As described above in Section 6B.2.1, there are five environmental factors (i.e., water temperature, channel velocities and associated turbulence/mixing, residence time, nutrients, and water clarity and its effects on irradiance) that provide favorable conditions for CHAB development. These environmental factors are considered in the discussion below to assess if the new tidal habitat sites would provide highly suitable conditions for CHABs, relative to existing conditions.

The new tidal habitats would be located within the North Delta Habitat Arc, which was chosen, in part, because it is a region that is less likely to support CHABs (ESA 2022:5). The waterways in the North Delta Habitat Arc range from freshwater in the Cache Slough region to more saline waters in the Suisun Marsh region. CHABs are not problematic in Suisun Marsh because water quality conditions are generally not conducive to *Microcystis* growth and aggregation in this location (Sommer et al. 2020:18). Salinity is an important factor in controlling the seaward extent of Delta CHABs (Berg and Sutula 2015:iii), and salinity in Suisun Marsh that ranges from 1.9 parts per thousand (ppt) to 12.6 ppt may limit cyanobacteria growth and aggregation (Schacter et al. 2021:15). Indeed, an analysis of *Microcystis* visual observations throughout the Delta shows that areas with fresh water are more likely to support *Microcystis* than areas more influenced by salt water such as Suisun Marsh (ESA 2022:7).

CHABs are also not problematic in the Cache Slough region even though it is characterized as a freshwater habitat (i.e., ~0 ppt). Depending on the specific location within Cache Slough, residence times range from 0 to 20 days (Downing et al. 2016:13,387) while median summer temperatures are above 20°C (68°F) (ESA 2022:7). Similarly, just upstream of Cache Slough in the Sacramento Deep Water Ship Channel, median water temperatures exceed 23°C (73.4°F) and residence times range from 20 to 50 days (Downing et al. 2016:13387; ESA 2022:7). Although both of these locations have water temperatures and residence times that are sufficient to support CHABs, neither location has a history of CHABs. In fact, visual observations of *Microcystis* occurrence collected by DWR and

CDFW during their fish and water quality surveys at discrete stations throughout the Delta from 2007 to 2019 show little to no *Microcystis* in the water column of the Deep Water Ship Channel (ESA 2022:5). Similarly, just downstream in Cache Slough, visual observations of *Microcystis* are generally low (ESA 2022:5). The only times visual observations (i.e., ranked 4 on a scale of 0 to 5 with 5 being the highest) of *Microcystis* were high in Cache Slough was in the drought years of 2015 and 2016. Further analysis of the visual observation data in the Cache Slough region shows that the frequency of *Microcystis* occurrence is low (ESA 2022:5). Although the exact reasons why CHABs are not problematic in the Cache Slough region remain unknown, water residence time and gradients in mixing likely control the phytoplankton community within Cache Slough (Stumpner et al. 2020:1, 13).

There is some uncertainty related to the design of the wetlands (e.g., depth, amount of aquatic vegetation, and exact location). However, design of the tidal habitat would consider hydrologic regime and channel morphology (e.g., backwater areas with low velocities and high residence time can create conditions that foster CHABs) to help ensure potential effects related to CHABs are minimized. As such, newly created tidal habitats would have daily tidal flushing to ensure no substantial increase in residence time, relative to existing conditions. Although tidal habitats would be designed to reduce potential for CHAB formation, it is possible that along the edges of the new tidal habitat there could be small areas of increased residence time, elevated water temperatures, decreased water column turbulence and mixing, and turbidity (which affects irradiance). Depending on the vegetation in the tidal habitat, there could be some increased nutrient concentrations (from decomposing vegetation). However, the presence of vegetation would generally decrease the potential for CHAB formation as plants would likely outcompete cyanobacteria for nutrients and sunlight.

Although there are some characteristics of the newly created tidal habitats that could increase residence time and water temperatures along the margins, implementation of the CMP is not expected to cause substantial additional *Microcystis* or other cyanobacteria production for the following reasons.

- First, tidal restoration sites would be sited in the North Delta Habitat Arc where conditions are not conducive to CHAB formation.
- Second, the design of the tidal habitats is such that there would be daily hydrologic exchange that would ensure that there would not be substantially increased residence times compared to adjacent habitats.
- Third, if the tidal habitat were to be located in the Suisun Marsh region, salinities would continue to be high enough to prevent substantial growth and aggregation of cyanobacteria. Similarly, if the tidal habitats were to be located in Cache Slough, the mixing gradients and residence time would continue to prevent substantial cyanobacteria production.

Based on the above findings, the new tidal habitats created in accordance with the CMP would not result in adverse effects on California least tern, western yellow-billed cuckoo, least Bell's vireo, or giant garter snake due to CHABs.

# 6B.3 Selenium

## 6B.3.1 Background and Existing Conditions

Selenium is an essential trace element for human and other animal nutrition that occurs naturally in the environment. Substantial point sources of selenium do not exist upstream in the Sacramento River watershed or in the watersheds of the eastside tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Nonpoint sources of selenium within the watersheds of the Sacramento River and the eastside tributaries also are relatively low, resulting in generally low selenium concentrations in the reservoirs and rivers of those watersheds. The San Joaquin River watershed is the major source of selenium to the Delta, and the Sacramento River watershed has generally low selenium concentrations (Central Valley Regional Water Quality Control Board 1988:14). Selenium occurs naturally throughout the lower San Joaquin River watershed, with elevated concentrations of selenium occurring in the shallow groundwater within the Grassland watershed, which is a valley floor sub-basin of the San Joaquin River watershed. Subsurface agricultural drainage discharges from these areas are the major source of selenium to the San Joaquin River and Delta.

Selenium is a constituent of concern in the lower San Joaquin River, the Delta, and San Francisco Bay because it can cause chronic toxicity (especially impaired reproduction) in fish and aquatic birds (Ohlendorf and Heinz 2011:670). Selenium concentration in species differs by the trophic level at which they feed, increasing with trophic level, therefore, birds that consume prey with high levels of selenium have a higher risk of selenium toxicity (Ackerman and Eagles-Smith 2009:2139). Dietary uptake is the principal route of toxic exposure to selenium in wildlife, including California least tern, western yellow-billed cuckoo, least Bell's vireo, and giant garter snake (Beckon et al. 2003: 69; Ackerman and Eagles-Smith 2009:2134; Ohlendorf and Heinz 2011:669).

Toxicity thresholds are established by identifying concentrations of selenium that result in an observable effect on an organism (e.g., altered metabolism, mortality, deformity, reproductive failure). Elevated selenium exposure has been found primarily to cause reproductive effects such as developmental abnormalities and increased embryo mortality. Although adult mortality has occurred in wild aquatic birds that use agricultural drainage water storage areas with high selenium concentrations in the San Joaquin Valley, mortality is rare. Sublethal effects on adults include emaciation and feather loss (Ackerman and Eagles-Smith 2009:2134; Ohlendorf and Heinz. 2011:670). Reduced hatchability and embryo deformities have been documented in bird eggs with selenium concentrations over 6 micrograms per gram (µg/g) (dry weight) and adult physiological harm and mortality are associated with liver selenium concentrations above 20 µg/g (dry weight) (Beckon 2017:133; Ohlendorf and Heinz 2011: Table 21.1). Because reproductive effects are the primary concern for birds, bird eggs are good indicators of selenium effects on birds.

No information is available on the toxicity thresholds or indirect effects of selenium for giant garter snake or other snakes. However, information on the risk of selenium exposure on other species may be useful in predicting general effects on giant garter snakes. Laboratory and field study on giant garter snake and terrestrial snakes have documented selenium bioaccumulation from prey consumption.

A single laboratory study dosed female terrestrial brown house snakes (*Lamprophis falginosus*) with selenium, as selenomethionine, injected into their food items at approximately 1 (control), 10, and 20 µg/g (dry weight) doses. The investigators selected these dosages because they represented the range of exposures used in prior avian and mammalian studies. No significant effects on survival or

reproduction were observed at any dose (Hopkins et al. 2004). However, in the two treatment groups, selenium was transferred to eggs in concentrations that exceeded all suggested reproduction thresholds for birds and fish (24.25 ±0.49 µg/g dry weight in the 20 µg/g treatment group) (Hopkins et al. 2004). No information was available on the consequences of the egg selenium burdens for post-hatch survival.

Wylie et al. (2009) measured selenium and other trace elements in 23 dead giant garter snakes collected from 1995 to 2004 at sites in Colusa National Wildlife Refuge, the Natomas Basin, and other sites in Northern California. Giant garter snake liver selenium concentrations ranged from 1.24 to 6.98 µg/g (dry weight) with a geometric mean of 3.06 µg/g. Current science does not provide information about the consequences of these selenium body burdens to the health or survival of individuals or populations of giant garter snake.

Scaled reptiles, such as giant garter snake, generally do not secrete an albumin layer in eggs (Unrine et al. 2006). As a result, selenium may be transported through serum to the egg from the liver as vitellogenin, whereas in birds, crocodilians, and turtles additional oviductal contributions of selenium occur post-ovulation (Unrine et al. 2006; Janz et al. 2010). Therefore, a dietary selenium toxicity threshold, rather than an egg concentration threshold, appears appropriate for assessing selenium effects to giant garter snake. There are currently no predictive modeling tools, nor is there an understanding of effects thresholds, that would enable predicting direct effects of dietary selenium exposure on giant garter snakes. However, inferences about the effects of selenium exposure are possible using modeled fish selenium concentrations as a surrogate for giant garter snakes' prey.

## 6B.3.2 Assessment Methodology

Selenium was assessed quantitatively for the Delta. Concentrations were calculated using a mass-balance methodology applied to the DSM2-modeled source water flow fractions at each assessment location. In addition, bioaccumulation modeling was conducted to quantify changes in biota concentrations, which consisted of quantifying changes in water column concentrations of selenium and changes in selenium concentrations in whole-body fish tissue. These modeled selenium concentrations represent dietary exposure to California least tern and giant garter snake, and bird eggs (invertebrate diet and fish diet). In turn, selenium exposure in bird eggs represents potential effects on California least tern, western yellow-billed cuckoo, and least Bell's vireo. Modeled selenium concentrations were compared to recommended ecological risk guidelines, which recommend No Effect thresholds for selenium in whole-body fish tissue (4 mg/kg dry weight) and bird eggs (6 mg/kg dry weight) (Beckon 2017:133).

### 6B.3.2.1 Water Column Concentrations

The quantitative assessment for the Delta utilized a mass-balance approach that applied the DSM2-modeled average monthly source water flow fractions for each Delta assessment location. The source water flow fraction output is the percentage of water at each assessment location constituted by the six primary source waters—Sacramento River (SAC), San Joaquin River (SJR), Yolo Bypass (YOL), eastside tributaries (EST), San Francisco Bay (BAY), and Delta agriculture returns (AGR). These flow fractions were used together with source water concentrations to calculate a given concentration at the assessment locations according to the following equation.

$$C_i = f_{SAC,i}(C_{SAC}) + f_{SJR,i}(C_{SJR}) + f_{YOL,i}(C_{YOL}) + f_{EST,i}(C_{EST}) + f_{BAY,i}(C_{BAY}) + f_{AGR,i}(C_{AGR})$$

In the above equation, $C_i$ is the concentration at Delta assessment location i, $f_{X,i}$ is the average monthly flow fraction from source water X at assessment location i, and $C_X$ is the source water X concentration. Source water concentrations input into the above equation are discussed below in Section 9J.3, *Source Water Concentrations*.

Table 6B-28 lists the Delta assessment locations for which selenium concentrations were calculated.

**Table 6B-28. Delta Assessment Locations and Concentration Calculation Method**

| Assessment Location | Delta Region | Concentration Calculation Method |
|---|---|---|
| Barker Slough at North Bay Aqueduct | Northern | Mass-balance |
| Sacramento River at Emmaton | Western | Mass-balance |
| San Joaquin River at Antioch | Western | Mass-balance |
| Sacramento River at Mallard Island | Western | Mass-balance |
| South Fork Mokelumne River at Terminous | Interior | Mass-balance |
| San Joaquin River at Empire Tract | Interior | Mass-balance |
| Contra Costa Water District Pumping Plant #1 | Interior | Mass-balance |
| Old River at State Route 4 | Southern | Mass-balance |
| Victoria Canal | Southern | Mass-balance |
| Banks Pumping Plant | Export area | Mass-balance |
| Jones Pumping Plant | Export area | Mass-balance |

### 6B.3.2.2 Biota Concentrations

Selenium concentrations in fish tissues and in bird eggs were calculated using calibrated Delta-wide selenium bioaccumulation models, based on ecosystem-scale models developed by Presser and Luoma (2010a:703, 2010b:18, 2013:5). These models used biogeochemical and physiological factors from laboratory and field studies; loading rates, chemical speciation, and transformation to particulate material; bioavailability; bioaccumulation in invertebrates; and trophic transfer to predators. Important components of the methodology included: (1) empirically determined environmental partitioning factors between water and particulate material ($K_d$) that quantify the effects of dissolved speciation and phase transformation; (2) concentrations of selenium in living and non-living particulates at the base of the foodweb that determine selenium bioavailability to invertebrates; and (3) selenium biodynamic foodweb transfer factors that quantify the physiological potential for bioaccumulation from particulate matter to consumer organisms and from prey to their predators. The modeled water column concentrations and tissue concentrations presented herein are not intended to be predictive in nature. Rather, they are for comparative assessment to identify the potential effect of the proposed action on biota concentrations of selenium relative to existing conditions.

The following sections describe the bioaccumulation models and calibration of $K_d$ to reflect Delta-specific conditions.

## Bioaccumulation Model Descriptions

The sections below provide descriptions of bioaccumulation models that were employed to calculate selenium concentrations in fish tissues and in bird eggs. These consist of models for calculating selenium concentrations in particulates, invertebrates, whole-body fish, and bird eggs.

## Selenium Concentrations in Particulates

Phase transformation reactions from dissolved to particulate selenium are the primary form by which selenium enters the foodweb. Presser and Luoma (2010a:687, 2010b:19, 2013:5) used field observations to quantify the relationship between selenium concentrations in particulate material and dissolved selenium concentrations in the water column as indicated in the following equation.

$$C_{particulate} = K_d * C_{water\ column}$$

Where:

$C_{particulate}$ = *selenium concentration in particulate material (micrograms/kilogram [µg/kg], dry weight [dw])*

$K_d$ = *particulate/water ratio*

$C_{water\ column}$ = *selenium concentration in water column (micrograms per liter [µg/L])*

The $K_d$, also called an "enrichment factor," describes the particulate/water ratio at the moment the sample was taken and should not be interpreted as an equilibrium constant, as it sometimes is mistaken to be. The $K_d$ can vary widely among hydrologic environments and potentially among seasons (Presser and Luoma 2010a:690, 2010b:20, 2013:14; Young et al. 2010:20). In addition, other factors such as selenium speciation, water residence time, and particle type affect $K_d$. Selenium typically enters a stream primarily as selenate. If the stream flows into a wetland and the water is retained there with sufficient residence time, recycling of selenium may occur (Presser and Luoma 2010b:2, 2013:14; Stewart et al. 2013:5). This results in generation of particulate selenium and conversion to more bioaccumulative selenite and organo-selenium from the less-bioaccumulative dissolved selenate.

Residence time of water containing selenium is usually the most influential factor on the conditions in the receiving aquatic environment. Short water residence times, such as in streams and rivers, limit partitioning of selenium into particulate material. Conversely, longer residence times, such as in sloughs, lakes, and estuaries, allow greater uptake by plants, algae, and microorganisms. Furthermore, environments in downstream portions of a watershed can receive cumulative contributions of upstream recycling in a hydrologic system. Greater selenium uptake associated with increases in residence time are reflected by higher $K_d$ (Presser and Luoma 2010b:2, 2013:14). Because of its high variability, $K_d$ is a large source of uncertainty in any selenium model where extrapolations from selenium concentrations in the water column to those in aquatic organism tissues, or from tissue to water column concentrations, are necessary. While $K_d$ can vary among locations and over time, this uncertainty was minimized in Delta tissue bioaccumulation models calibrated with site-specific data. Additional discussion of Delta-specific $K_d$ values used in the bioaccumulation models is provided in Section 9J.2.2.2, *Delta-Wide Bioaccumulation Model Calibration*.

## Selenium Concentrations in Invertebrates

Trophic transfer factors (TTFs) describing the transfer of selenium from particulates to prey and from prey to predators were developed using data from laboratory experiments and field studies (Presser and Luoma 2010a:693, 2010b:23, 2013:15). TTFs are species-specific, but the range of TTFs for freshwater invertebrates was similar to TTFs for marine invertebrates determined in laboratory experiments.

TTFs for estimating selenium concentrations in invertebrates were calculated using the following equation.

$$TTF_{invertebrate} = (C_{invertebrate})/(C_{particulate})$$

Where:

$TTF_{invertebrate}$ = *trophic transfer factor from particulate material to invertebrate*

$C_{invertebrate}$ = *concentration of selenium in invertebrate (micrograms per gram [µg/g] dw)*

$C_{particulate}$ = *concentration of selenium in particulate material (µg/g dw)*

An average aquatic insect TTF was calculated from TTFs for aquatic insect species with similar bioaccumulative potential, including mayfly (*Baetidae*, *Heptageniidae*, *Ephemerellidae*), caddisfly (*Rhyacophilidae*, *Hydropsychidae*), crane fly (*Tipulidae*), stonefly (*Perlodidae*/*Perlidae*, *Chloroperlidae*), damselfly (*Coenagrionidae*), corixid (*Cenocorixa* spp.), and chironomid (*Chironomus* spp.) aquatic life stages. Species-specific TTFs ranged from 2.1 to 3.2. The average TTF of 2.8 was used in the Delta-wide model.

## Selenium Concentrations in Whole-Body Fish

The mechanistic equation for modeling selenium bioaccumulation in fish tissue is similar to that for invertebrates if whole-body concentrations are the endpoint (Presser and Luoma 2010a:695, 2010b:16, 2013:15), as shown in the following equation for a trophic level 2 fish eating invertebrates.

$$TTF_{fish} = C_{fish}/ C_{invertebrate}$$

where:

$$C_{invertebrate} = C_{particulate} * TTF_{invertebrate}$$

therefore:

$$C_{fish} = C_{particulate} * TTF_{invertebrate} * TTF_{fish}$$

Where:

$C_{fish}$ = *concentration of selenium in fish (µg/g dw)*

$C_{particulate}$ = *concentration of selenium in particulate material (µg/g dw)*

$C_{invertebrate}$ = *concentration of selenium in invertebrate (µg/g dw)*

$TTF_{invertebrate}$ = *trophic transfer factor from particulate material to invertebrates*

$TTF_{fish}$ = *trophic transfer factor from invertebrates to fish*

Selenium bioaccumulation into a particular fish species depends on organism physiology and its preferred foods. Variability in fish tissue selenium concentrations for the present modeling is driven more by dietary choices and their respective levels of bioaccumulation (that is, $TTF_{invertebrate}$) than by differences in fish physiology or the dietary transfer to the fish ($TTF_{fish}$). Higher trophic level 4 fish (e.g., predator fish such as bass consuming forage fish) can be completed by incorporating additional TTFs, as shown in the following equation.

$$C_{predatorfish} = C_{particulate} * TTF_{invertebrate} * TTF_{foragefish} * TTF_{predatorfish}$$

Where:

$$C_{predatorfish} = \text{concentration of selenium in fish } (\mu g/g \text{ dw})$$

$$C_{particulate} = \text{concentration of selenium in particulate material } (\mu g/g \text{ dw})$$

$$TTF_{invertebrate} = \text{trophic transfer factor from particulate material to invertebrates}$$

$$TTF_{foragefish} = \text{trophic transfer factor for invertebrates to foraging fish species}$$

$$TTF_{predatorfish} = \text{trophic transfer factor for forage fish to predator species}$$

The fish TTFs reported in Presser and Luoma (2010a:694) ranged from 0.5 to 1.6, so the average fish TTF of 1.1 was used for all trophic levels of fish in the Delta-wide model.

## Selenium Concentrations in Bird Eggs

Selenium concentrations in bird tissues can be estimated, but the transfer of selenium into bird eggs is more meaningful for evaluating reproductive endpoints (Presser and Luoma 2010a:696; Ohlendorf and Heinz 2011:676). Laboratory studies to determine transfer factors for selenium bioaccumulation from diet to bird eggs have been conducted with black-crowned night-herons (*Nycticorax nycticorax)* by Smith et al. (1988:178), for eastern screech owls (*Otus asio)* by Wiemeyer and Hoffman (1996:338), and for American kestrels (*Falco sparverius)* by Santolo et al. (1999:505). In each of these studies, the experimental groups also received supplemental selenium in the form of the highly bioavailable selenomethionine. Transfer factors for the selenium-supplemented birds varied from approximately 1.0 to 2.2, with a mean of 1.5.

Presser and Luoma (2010a:697) reviewed available data for selenium bioaccumulation from diet to bird eggs and concluded that a $TTF_{birdegg}$ = 1.8 was most appropriate for modeling in the Delta. Subsequently, Presser and Luoma (2010b:23, 2013:16) reported a mean $TTF_{birdegg}$ of 2.6 for modeling. The basis of this subsequent TTF was laboratory studies where mallards (*Anas platyrhynchos*), a species sensitive to selenium, were fed diets fortified with selenomethionine to evaluate reproductive effects. However, in contrast to the laboratory study findings with selenomethionine-supplemented diets for mallards, TTFs from diet to eggs determined in the field were almost always less than 2.0.

Field studies at Kesterson Reservoir and the Volta Wildlife Area reference site conducted extensive sampling of food-chain biota and bird eggs from 1983 through 1985, and birds were collected to determine qualitatively the kinds of aquatic organisms they had eaten (Hothem and Ohlendorf 1989:776; Schuler et al. 1990:848; Ohlendorf and Hothem 1995:584). Based on the kinds of food items found in each of the sampled species and the mean selenium concentrations in those kinds of organisms, a mean selenium concentration was estimated for each species at each site during each nesting season. At the Volta Wildlife Area, where diet and egg selenium concentrations were

representative of "background" conditions, transfer factors ranged from 0.63 to 2.0, with a mean of 1.35. At Kesterson Reservoir, the transfer factors ranged from less than 0.2 to 0.48.

Because selenomethionine in the mallard diet is more readily transferred to eggs than are the selenium forms in field-collected food-chain biota and because TTFs measured in the field with wild birds were not greater than 2, the $TTF_{birdegg}$ = 1.8 value from Presser and Luoma (2010a:697) was used in the bioaccumulation model.

The $K_d$, invertebrate TTF, and fish TTFs developed for use in fish bioaccumulation also were used to estimate selenium uptake into bird eggs using the following two bird egg models:

Bird egg uptake from invertebrates:

$$C_{birdegg} = C_{particulate} * TTF_{invertebrate} * TTF_{birdegg}$$

Where:

$$C_{particulate} = K_d * C_{water}$$

Bird egg uptake from predatory fish:

$$C_{birdegg} = C_{particulate} * TTF_{invertebrate} * TTF_{fish} * TTF_{fish} * TTF_{birdegg}$$

Where:

$$C_{particulate} = K_d * C_{water}$$

Where:

$C_{birdegg}$ = *concentration of selenium in bird egg (µg/g dw)*

$C_{particulate}$ = *concentration of selenium in particulate material (µg/g dw)*

$C_{water}$ = *selenium concentration in water column (µg/L)*

$K_d$ = *particulate/water ratio*

$TTF_{invertebrate}$ = *trophic transfer factor from particulate material to invertebrate*

$TTF_{fish}$ = *trophic transfer factor from invertebrate or fish to fish*

$TTF_{birdegg}$ = *trophic transfer factor from invertebrate or fish (depending on diet) to bird egg*

### 6B.3.2.3 Delta-Wide Bioaccumulation Model Calibration

This section discusses tissue uptake model calibration to identify Delta-specific $K_d$s using measured and modeled selenium concentrations in water and measured fish tissues reported by Foe (2010:27).

The partitioning from water to particulates, such as algae, represents the first step of selenium bioaccumulation into the foodweb. This factor is highly site-specific, and varies depending on the form of selenium present, water residence time and flow rates, and the type of particulates. For the Delta-wide bioaccumulation models, multiple $K_d$s were determined to describe different flow regimes based on Delta-specific calibration. Measured and modeled selenium concentrations in water and measured selenium concentrations in fish tissues were used to determine $K_d$s applicable for all water year types, wet conditions (i.e., above normal and wet years), and dry conditions (i.e.,

below normal, dry, and critical years). The refined Delta-specific $K_d$s were used in tissue uptake models for fish tissues and bird eggs incorporating modeled water column selenium concentrations, following procedures described by Presser and Luoma (2010a:703, 2010b:18).

The calibrated Delta-wide selenium bioaccumulation models are considered representative of conditions in the Delta under current and likely future conditions. They incorporate realistic concentrations of water column selenium, and they predict selenium concentrations in predatory fish that approximate measured concentrations in whole-body fish. These calibrated models take into account the variable nature of selenium bioaccumulation in relation to water column concentrations, which is reflected by the inverse relationship between $K_d$ and water column selenium concentrations.

## Measured Fish Tissue Concentrations for the Delta-Wide Bioaccumulation Model Calibration

Historical fish tissue data for selenium concentrations in whole largemouth bass collected in 2000, 2005, and 2007 were available from Foe (2010:27). These samples were collected throughout the Delta at the following locations.

- Big Break
- Cache Slough at Ryer Island
- Franks Tract
- Middle River Bullfrog
- Old River Near Paradise Cut
- Sacramento River Mile 44
- Sacramento River at Veterans Bridge
- San Joaquin River Potato Slough
- San Joaquin River at Vernalis

## Selenium Concentrations in Water for the Delta-Wide Bioaccumulation Model Calibration

Estimates of water column selenium exposure concentrations associated with measured fish tissue selenium concentrations were determined using DSM2 flow fraction output similar to the approach described in Section 6B.3.2.1, *Water Column Concentrations*, but on a quarterly basis instead of a monthly basis. Geometric mean selenium concentrations for the six Delta source waters were combined with modeled quarterly average flow fractions for DSM2 output locations near fish tissue sampling locations to calculate the water column selenium concentration at those locations.

Historical source water concentrations to inform the Delta-wide selenium bioaccumulation model calibration were identified for the Sacramento River, San Joaquin River, San Francisco Bay, eastside tributaries, and Delta agricultural return waters. Dissolved or total selenium data were available for these Delta source water inflows corresponding to the years when selenium was measured in fish tissue, as follows.

- Sacramento River below Knights Landing (representing the Yolo Bypass inflow)

- Sacramento River at Freeport (representing mainstem flow to Delta)
- San Joaquin River at Vernalis (Airport Way) (representing mainstem flow to Delta)
- Mokelumne, Calaveras, and Cosumnes Rivers (representing eastside tributaries)
- Mildred Island, Center (representing Delta agricultural return waters)
- San Joaquin River near Mallard Island (representing San Francisco Bay)

Both dissolved and total selenium data were considered suitable for purposes of model calibration because they typically do not differ greatly in the Delta. Table 6B-29 provides the geometric mean of historical selenium concentrations in these primary Delta source waters.

Selenium concentrations in surface water in the San Joaquin River at Vernalis are presented in Table 6B-29 for multiple periods. This is to reflect the lag time for selenium bioaccumulation in piscivorous largemouth bass that may be more than 1 year (Beckon 2016:172). Vernalis water data over 2 years (1999–2000, 2004–2005, and 2006–2007) were paired with each year when fish were collected to estimate surface water selenium concentrations at fish sampling locations. Insufficient data were available to do this for other source water locations.

The modeled quarterly and average annual water column selenium concentrations for selected DSM2 output locations are shown in Table 6B-30 for Year 2000, Table 6B3-31 for Year 2005, and Table 6B-32 for Year 2007.

**Table 6B-29. Selenium Concentrations (in micrograms per liter) in Delta Source Waters used for the Delta-Wide Bioaccumulation Model Calibration**

| Delta Sources | Representative Inflow Site | Geometric Mean Selenium Concentration (dissolved unless otherwise noted) | Years | Source |
|---|---|---|---|---|
| Delta Agricultural Return Waters | Mildred Island, Center | 0.11 | 2000 | Lucas and Stewart 2007 |
| Eastside Tributaries | Mokelumne, Calaveras, and Cosumnes Rivers | 0.10 [a] | None | None |
| San Francisco Bay | San Joaquin River near Mallard Island | 0.10 | 2000–2008 | San Francisco Estuary Institute 2014 |
| Sacramento River | Sacramento River at Freeport | 0.09 | 2007–2014 | U.S. Geological Survey 2014 |
| San Joaquin River | San Joaquin River at Vernalis (Airport Way) | 0.83 [b] | 1999–2000 | State Water Resources Control Board 2009 |
| San Joaquin River | San Joaquin River at Vernalis (Airport Way) | 0.85 [b] | 2004–2005 | State Water Resources Control Board 2009 |
| San Joaquin River | San Joaquin River at Vernalis (Airport Way) | 0.58 [b] | 2006–2007 | State Water Resources Control Board 2009 |
| Yolo Bypass | Sacramento River below Knights Landing | 0.23 [c] | 2004, 2007, 2008 | California Department of Water Resources 2009 |

[a] Dissolved selenium concentration is assumed to be 0.1 µg/L due to lack of available data and lack of sources that would be expected to result in concentrations greater than 0.1 µg/L.
[b] Not specified whether total or dissolved selenium; data for 1999–2000 used for bioaccumulation by bass in 2000; data for 2004–2005 for bass in 2005; and data for 2006–2007 for largemouth bass in 2007.
[c] Total selenium concentration in water.

DSM2 data were not available for the Sacramento River at Veterans Bridge, for which there were measured fish tissue data. Therefore, historical data for selenium concentrations in water collected nearby were used to calculate quarterly average water column selenium concentrations. The geometric mean of selenium concentrations in water collected from the Sacramento River below Knights Landing in 2004, 2007, and 2008 (California Department of Water Resources 2009) were used to represent quarterly averages of selenium concentrations in water for Veterans Bridge in all years.

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**Table 6B-30. Modeled Quarterly Average Selenium Concentrations in Water (in micrograms per liter) for DSM2 Output Locations, Year 2000**

| | | First Quarter Inflow Percentage | | | | | | Second Quarter Inflow Percentage | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Inflow Source** | **Delta Agricultural Return Waters** | **Eastside Tributaries** | **Sacramento River** | **San Joaquin River** | **Martinez/ Suisun Bay** | **Yolo Bypass** | **Delta Agricultural Return Waters** | **Eastside Tributaries** | **Sacramento River** | **San Joaquin River** | **Martinez/ Suisun Bay** | **Yolo Bypass** |
| | **Inflow Location** | ***Mildred Island, Center*** | ***Mokelumne Calaveras Cosumnes Rivers*** | ***Freeport*** | ***Vernalis*** | ***San Joaquin River near Mallard Island*** | ***Sacramento River below Knights Landing*** | ***Mildred Island, Center*** | ***Mokelumne Calaveras Cosumnes Rivers*** | ***Freeport*** | ***Vernalis*** | ***San Joaquin River near Mallard Island*** | ***Sacramento River below Knights Landing*** |
| **DSM2 Output Water Location** | **DSM2 Location ID** | | | | | | | | | | | | |
| Big Break | BIGBRK_MID | 2.94 | 6.88 | 53.15 | 6.59 | 0.18 | 5.70 | 2.95 | 6.37 | 73.59 | 13.55 | 0.27 | 3.12 |
| Cache Slough | CACHS_LEN | 1.46 | 0 | 53.38 | 0 | 0 | 31.91 | 1.24 | 1.5E-05 | 85.07 | 2.5E-05 | 0 | 13.25 |
| Cache Slough at Ryer Island | CACHSR_MID | 2.88 | 0 | 54.86 | 0 | 0 | 20.48 | 3.36 | 9.8E-07 | 79.75 | 1.9E-06 | 0 | 16.25 |
| Cosumnes River | COSR_LEN | 8.1E-06 | 98.82 | 0 | 0 | 0 | 0 | 0 | 100.00 | 0 | 0 | 0 | 0 |
| Franks Tract | FRANKST_MID | 5.06 | 11.56 | 43.94 | 15.79 | 0.02 | 0.32 | 4.17 | 9.42 | 61.16 | 23.89 | 0.01 | 1.22 |
| Little Holland Tract | LHOLND_L0 | 72.35 | 0 | 5.06 | 0 | 0 | 6.50 | 23.38 | 8.2E-07 | 63.10 | 1.6E-06 | 0 | 13.03 |
| Middle River at Bullfrog | MIDRBULFRG_LEN | 10.54 | 13.07 | 18.37 | 32.20 | 1.9E-03 | 3.2E-03 | 5.49 | 9.19 | 14.96 | 70.17 | 4.2E-04 | 0.10 |
| Mildred Island | MILDDRISL_MID | 7.47 | 14.31 | 22.79 | 30.23 | 2.4E-03 | 1.8E-03 | 4.77 | 10.05 | 18.48 | 66.48 | 6.7E-04 | 0.13 |
| Mokelumne River below Cosumnes River | MOKBCOS_LEN | 2.07 | 96.19 | 0 | 0 | 0 | 0 | 1.65 | 98.35 | 0 | 0 | 0 | 0 |
| Mokelumne River downstream of Cosumnes River | MOKDCOS_MID | 2.07 | 96.43 | 0 | 0 | 0 | 0 | 1.68 | 98.32 | 0 | 0 | 0 | 0 |
| Old River near Paradise Cut | OLDRNPARADSEC_MID | 6.24 | 0 | 0 | 87.26 | 0 | 0 | 14.40 | 1.67 | 5.21 | 78.66 | 1.2E-05 | 0.04 |
| Paradise Cut | PARADSECUT_LEN | 4.69 | 0 | 0 | 91.37 | 0 | 0 | 2.62 | 0.06 | 0.15 | 97.16 | 1.5E-07 | 1.1E-03 |
| Port of Stockton | PORTOSTOCK_L0 | 1.67 | 0 | 0 | 18.85 | 0 | 0 | 2.22 | 0 | 0 | 60.73 | 0 | 0 |
| Sacramento River at Isleton | SACRISLTON_L0 | 0.33 | 0 | 95.77 | 0 | 0 | 0 | 0.31 | 0.00 | 99.60 | 0 | 0 | 5.5E-05 |
| Sacramento River Mile 44 | SACR44_L0 | 0.14 | 0 | 97.93 | 0 | 0 | 0 | 0.11 | 0 | 99.81 | 0 | 0 | 0 |
| Sandmound Slough | SANDMND_MID | 6.36 | 10.51 | 43.82 | 12.90 | 0.03 | 0.57 | 5.22 | 8.81 | 63.78 | 20.40 | 0.03 | 1.63 |
| Sherman Island | SHERMNILND_L0 | 1.64 | 3.45 | 52.71 | 3.93 | 0.60 | 12.10 | 2.48 | 4.95 | 76.80 | 10.96 | 0.96 | 3.67 |
| San Joaquin River near Bowman | SJRBOWMN_MID | 1.40 | 0 | 0 | 94.03 | 0 | 0 | 1.52 | 0 | 0 | 98.48 | 0 | 0 |
| San Joaquin River near State Route 4 | SJRNHWY4_MID | 3.49 | 0 | 0 | 89.96 | 0 | 0 | 1.87 | 0 | 0 | 98.13 | 0 | 0 |
| San Joaquin River near Naval Street | SJRNAVLST_L0 | 8.89 | 12.70 | 0.00 | 65.44 | 0 | 0 | 2.69 | 6.26 | 0 | 90.94 | 0 | 0 |
| San Joaquin River at Potato Slough | SJRPOTSL_MID | 3.15 | 12.62 | 55.38 | 12.40 | 0.01 | 0.06 | 3.05 | 10.32 | 65.93 | 19.73 | 0.01 | 0.86 |
| San Joaquin River at Turner Cut | SJRTURNR_MID | 8.81 | 9.28 | 2.55 | 56.31 | 5.3E-05 | 1.0E-05 | 3.33 | 5.77 | 0.41 | 90.39 | 6.3E-06 | 2.4E-03 |
| San Joaquin River/Point Antioch/fish pier | ASRANTFSH_MID | 1.92 | 4.35 | 55.13 | 4.50 | 0.44 | 10.23 | 2.45 | 4.72 | 77.70 | 10.28 | 0.76 | 3.91 |
| Suisun Bay | SUISNB_LEN | 0.81 | 1.22 | 45.93 | 1.24 | 16.49 | 15.94 | 0.92 | 1.66 | 49.51 | 3.61 | 41.10 | 2.95 |
| Sycamore Slough | SYCAMOR_MID | 6.50 | 50.69 | 15.18 | 0 | 0 | 0 | 5.89 | 76.86 | 16.89 | 2.8E-07 | 0 | 0 |
| White Slough | WHITESL_L0 | 22.32 | 11.88 | 17.97 | 25.51 | 1.7E-08 | 6.0E-11 | 16.54 | 12.10 | 16.87 | 54.46 | 3.7E-09 | 6.1E-05 |
| White Slough downstream of Disappointment Slough | WHTSLDISPONT_LEN | 14.83 | 22.63 | 29.02 | 22.45 | 5.4E-08 | 0 | 12.45 | 13.97 | 21.21 | 52.32 | 2.2E-09 | 2.3E-04 |

**Table 6B-30 Continued. Modeled Quarterly Average Selenium Concentrations in Water (in micrograms per liter) for DSM2 Output Locations, Year 2000**

| DSM2 Output Water Location | Inflow Source | Third Quarter Inflow Percentage | | | | | | Fourth Quarter Inflow Percentage | | | | | | Estimated Waterborne Selenium Concentrations (µg/L) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | | | | | |
| | Inflow Location | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | Annual |
| | DSM2 Location ID | | | | | | | | | | | | | | | | | |
| Big Break | BIGBRK_MID | 3.13 | 0.45 | 85.63 | 0.44 | 4.15 | 6.12 | 2.13 | 0.20 | 84.85 | 0.02 | 8.76 | 3.96 | 0.13 | 0.20 | 0.10 | 0.10 | 0.13 |
| Cache Slough | CACHS_LEN | 1.66 | 4.7E-07 | 85.95 | 4.3E-07 | 5.9E-07 | 12.23 | 1.32 | 2.8E-06 | 89.83 | 1.1E-07 | 2.3E-05 | 8.67 | 0.12 | 0.11 | 0.11 | 0.10 | 0.11 |
| Cache Slough at Ryer Island | CACHSR_MID | 1.90 | 9.3E-08 | 84.53 | 1.8E-07 | 9.2E-12 | 13.38 | 1.81 | 1.0E-07 | 89.45 | 6.2E-10 | 3.0E-06 | 8.54 | 0.10 | 0.11 | 0.11 | 0.10 | 0.11 |
| Cosumnes River | COSR_LEN | 0 | 100.00 | 0 | 0 | 0 | 0 | 0 | 100.00 | 0 | 0 | 0 | 0 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Franks Tract | FRANKST_MID | 4.04 | 0.57 | 90.34 | 0.41 | 0.80 | 3.78 | 2.76 | 0.62 | 91.38 | 0.12 | 2.42 | 2.64 | 0.19 | 0.27 | 0.10 | 0.10 | 0.16 |
| Little Holland Tract | LHOLND_L0 | 18.48 | 2.2E-07 | 68.67 | 4.2E-07 | 7.2E-13 | 12.68 | 19.63 | 2.6E-09 | 72.79 | 0 | 0 | 7.42 | 0.10 | 0.11 | 0.11 | 0.10 | 0.11 |
| Middle River at Bullfrog | MIDRBULFRG_LEN | 7.81 | 6.43 | 69.63 | 14.94 | 0.12 | 1.02 | 4.86 | 6.31 | 59.79 | 27.84 | 1 | 0.68 | 0.31 | 0.61 | 0.20 | 0.30 | 0.36 |
| Mildred Island | MILDDRISL_MID | 6.57 | 4.57 | 83.28 | 4.14 | 0.15 | 1.25 | 4.50 | 6.63 | 71.28 | 16.13 | 0.61 | 0.82 | 0.29 | 0.58 | 0.12 | 0.21 | 0.30 |
| Mokelumne River below Cosumnes River | MOKBCOS_LEN | 7.23 | 92.77 | 4.7E-09 | 0 | 0 | 0 | 2.47 | 97.53 | 0 | 0 | 0 | 0 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Mokelumne River downstream of Cosumnes River | MOKDCOS_MID | 7.08 | 92.92 | 0 | 0 | 0 | 0 | 2.34 | 97.66 | 0 | 0 | 0 | 0 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Old River near Paradise Cut | OLDRNPARADSEC_MID | 10.56 | 3.9E-05 | 1.3E-04 | 89.44 | 8.8E-28 | 3.0E-07 | 2.50 | 1.1E-04 | 3.5E-04 | 97.50 | 2.8E-20 | 1.7E-07 | 0.73 | 0.68 | 0.75 | 0.81 | 0.74 |
| Paradise Cut | PARADSECUT_LEN | 3.43 | 0 | 0 | 96.57 | 0 | 0 | 0.96 | 0 | 0 | 99.04 | 0 | 0 | 0.76 | 0.81 | 0.81 | 0.82 | 0.80 |
| Port of Stockton | PORTOSTOCK_L0 | 3.09 | 0 | 0 | 81.32 | 0 | 0 | 2.70 | 0 | 0 | 89.89 | 0 | 0 | 0.16 | 0.51 | 0.68 | 0.75 | 0.52 |
| Sacramento River at Isleton | SACRISLTON_L0 | 0.44 | 0 | 99.55 | 0 | 0 | 1.3E-05 | 0.28 | 0 | 99.72 | 0 | 0 | 1.1E-03 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Sacramento River Mile 44 | SACR44_L0 | 0.13 | 0 | 99.86 | 0 | 0 | 0 | 0.05 | 0 | 99.94 | 0 | 0 | 0 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Sandmound Slough | SANDMND_MID | 5.24 | 0.61 | 87.78 | 0.49 | 1.22 | 4.59 | 3.31 | 0.43 | 89.58 | 0.06 | 3.44 | 3.11 | 0.17 | 0.25 | 0.10 | 0.10 | 0.15 |
| Sherman Island | SHERMNILND_L0 | 2.60 | 0.40 | 81.69 | 0.46 | 8.21 | 6.56 | 1.77 | 0.11 | 77.64 | 0.01 | 16.46 | 3.94 | 0.11 | 0.18 | 0.10 | 0.10 | 0.12 |
| San Joaquin River near Bowman | SJRBOWMN_MID | 3.00 | 0 | 0 | 97.00 | 0 | 0 | 0.33 | 0 | 0 | 99.67 | 0 | 0 | 0.78 | 0.82 | 0.81 | 0.83 | 0.81 |
| San Joaquin River near State Route 4 | SJRNHWY4_MID | 3.91 | 0 | 0 | 96.09 | 0 | 0 | 0.72 | 0 | 0 | 99.28 | 0 | 0 | 0.75 | 0.82 | 0.80 | 0.82 | 0.80 |
| San Joaquin River near Naval Street | SJRNAVLST_L0 | 5.98 | 10.89 | 0 | 83.00 | 0 | 0 | 2.02 | 3.10 | 0.00 | 94.84 | 0 | 0 | 0.57 | 0.76 | 0.71 | 0.79 | 0.71 |
| San Joaquin River at Potato Slough | SJRPOTSL_MID | 2.63 | 0.35 | 93.54 | 0.20 | 0.45 | 2.79 | 2.06 | 0.80 | 93.46 | 0.06 | 1.47 | 2.11 | 0.17 | 0.24 | 0.10 | 0.09 | 0.15 |
| San Joaquin River at Turner Cut | SJRTURNR_MID | 8.69 | 13.75 | 17.87 | 59.41 | 0.01 | 0.16 | 3.23 | 4.83 | 7.34 | 84.49 | 0.03 | 0.05 | 0.49 | 0.76 | 0.53 | 0.72 | 0.62 |

| DSM2 Output Water Location | Inflow Source | Third Quarter Inflow Percentage | | | | | | Fourth Quarter Inflow Percentage | | | | | | Estimated Waterborne Selenium Concentrations (µg/L) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | | | | | |
| | Inflow Location | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | Annual |
| | DSM2 Location ID | | | | | | | | | | | | | | | | | |
| San Joaquin River/Point Antioch/fish pier | ASRANTFSH_MID | 2.64 | 0.35 | 83.38 | 0.38 | 6.66 | 6.52 | 1.82 | 0.12 | 80.54 | 0.01 | 13.33 | 4.11 | 0.12 | 0.17 | 0.10 | 0.10 | 0.12 |
| Suisun Bay | SUISNB_LEN | 0.80 | 0.23 | 27.56 | 0.40 | 68.55 | 2.42 | 0.60 | 0.03 | 28.62 | 0.01 | 69.16 | 1.54 | 0.11 | 0.13 | 0.10 | 0.10 | 0.11 |
| Sycamore Slough | SYCAMOR_MID | 5.04 | 14.29 | 80.66 | 1.2E-31 | 0 | 0 | 4.23 | 31.10 | 64.66 | 0 | 0 | 0 | 0.07 | 0.10 | 0.09 | 0.09 | 0.09 |
| White Slough | WHITESL_L0 | 9.89 | 7.76 | 82.34 | 3.8E-03 | 3.0E-05 | 5.3E-04 | 11.19 | 12.92 | 75.64 | 0.24 | 4.2E-04 | 6.4E-04 | 0.26 | 0.50 | 0.09 | 0.10 | 0.24 |
| White Slough downstream of Disappointment Slough | WHTSLDISPONT_LEN | 8.74 | 7.78 | 83.47 | 2.4E-03 | 4.0E-05 | 5.6E-04 | 5.28 | 14.84 | 79.82 | 0.05 | 5.0E-04 | 7.3E-04 | 0.25 | 0.48 | 0.09 | 0.09 | 0.23 |

µg/L = microgram per liter.

**Table 6B-31. Modeled Quarterly Average Selenium Concentrations in Water (in micrograms per liter) for DSM2 Output Locations, Year 2005**

| | | First Quarter Inflow Percentage | | | | | | Second Quarter Inflow Percentage | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Inflow Source** | **Delta Agricultural Return Waters** | **Eastside Tributaries** | **Sacramento River** | **San Joaquin River** | **Martinez/ Suisun Bay** | **Yolo Bypass** | **Delta Agricultural Return Waters** | **Eastside Tributaries** | **Sacramento River** | **San Joaquin River** | **Martinez/ Suisun Bay** | **Yolo Bypass** |
| | **Inflow Location** | ***Mildred Island, Center*** | ***Mokelumne Calaveras Cosumnes Rivers*** | ***Freeport*** | ***Vernalis*** | ***San Joaquin River near Mallard Island*** | ***Sacramento River below Knights Landing*** | ***Mildred Island, Center*** | ***Mokelumne Calaveras Cosumnes Rivers*** | ***Freeport*** | ***Vernalis*** | ***San Joaquin River near Mallard Island*** | ***Sacramento River below Knights Landing*** |
| **DSM2 Output Water Location** | **DSM2 Location ID** | | | | | | | | | | | | |
| Big Break | BIGBRK_MID | 5.87 | 7.57 | 83.73 | 2.41 | 0.24 | 0.18 | 2.90 | 17.21 | 52.77 | 26.69 | 1.6E-03 | 0.43 |
| Cache Slough | CACHS_LEN | 4.89 | 2.2E-07 | 93.64 | 8.E-07 | 3.8E-07 | 1.47 | 1.48 | 7.1E-07 | 94.13 | 8.0E-07 | 1.1E-08 | 4.38 |
| Cache Slough at Ryer Island | CACHSR_MID | 8.13 | 3.0E-07 | 91.14 | 1.2E-06 | 1.3E-06 | 0.73 | 3.74 | 2.5E-08 | 91.89 | 1.0E-07 | 2.9E-08 | 4.38 |
| Cosumnes River | COSR_LEN | 0 | 100.00 | 0 | 0 | 0 | 0 | 0.00 | 100.00 | 0.00 | 0 | 0 | 0 |
| Franks Tract | FRANKST_MID | 8.65 | 11.65 | 72.50 | 7.E+00 | 0.19 | 0.05 | 4.63 | 16.63 | 26.97 | 51.74 | 1.1E-04 | 0.03 |
| Little Holland Tract | LHOLND_L0 | 97.11 | 3.2E-09 | 2.88 | 9.E-09 | 3.9E-09 | 0.01 | 44.12 | 6.5E-09 | 53.25 | 2E-08 | 1.2E-08 | 2.63 |
| Middle River at Bullfrog | MIDRBULFRG_LEN | 13.67 | 9.76 | 28.26 | 48.24 | 0.08 | 0.01 | 5.55 | 5.64 | 2.70 | 86.11 | 7.1E-05 | 8.4E-04 |
| Mildred Island | MILDDRISL_MID | 12.36 | 11.39 | 32.28 | 43.87 | 8.4E-02 | 0.01 | 4.81 | 6.98 | 2.78 | 85.43 | 3.6E-05 | 6.7E-04 |
| Mokelumne River below Cosumnes River | MOKBCOS_LEN | 2.18 | 97.82 | 0 | 0.00 | 0 | 0 | 0.53 | 99.47 | 0 | 0 | 0 | 0 |
| Mokelumne River downstream of Cosumnes River | MOKDCOS_MID | 2.22 | 97.78 | 0 | 0.00 | 0 | 0 | 0.53 | 99.47 | 0 | 0 | 0 | 0 |
| Old River near Paradise Cut | OLDRNPARADSEC_MID | 8.95 | 4.7E-05 | 1.5E-03 | 91.05 | 1.4E-05 | 1.4E-06 | 1.43 | 1.7E-07 | 1.6E-05 | 98.57 | 1.7E-08 | 3.5E-10 |
| Paradise Cut | PARADSECUT_LEN | 10.28 | 1.6E-07 | 6.8E-07 | 89.72 | 1.6E-11 | 1.7E-08 | 0.82 | 0 | 0 | 99.18 | 0 | 0 |
| Port of Stockton | PORTOSTOCK_L0 | 4.70 | 0 | 0 | 95.30 | 0 | 0 | 2.83 | 0 | 0 | 97.16 | 0 | 0 |
| Sacramento River at Isleton | SACRISLTON_L0 | 0.55 | 0 | 99.45 | 0.00 | 0 | 0 | 0.18 | 0 | 99.82 | 0.00 | 0 | 0 |
| Sacramento River Mile 44 | SACR44_L0 | 0.21 | 0 | 99.79 | 0.00 | 0 | 0 | 0.07 | 0 | 99.93 | 0.00 | 0 | 0 |
| Sandmound Slough | SANDMND_MID | 10.51 | 10.17 | 74.35 | 4.65 | 0.25 | 0.07 | 5.35 | 18.03 | 32.15 | 44.41 | 1.5E-04 | 0.06 |
| Sherman Island | SHERMNILND_L0 | 4.89 | 5.04 | 87.74 | 1.52 | 0.56 | 0.23 | 2.43 | 14.17 | 61.17 | 21.31 | 0.03 | 0.89 |
| San Joaquin River near Bowman | SJRBOWMN_MID | 1.10 | 0 | 0.00 | 98.90 | 0 | 0 | 0.45 | 0 | 0 | 99.55 | 0 | 0 |
| San Joaquin River near State Route 4 | SJRNHWY4_MID | 1.89 | 0 | 0.00 | 98.11 | 0 | 0 | 0.59 | 0 | 0 | 99.41 | 0 | 0 |
| San Joaquin River near Naval Street | SJRNAVLST_L0 | 4.70 | 5.45 | 0.00 | 89.85 | 0 | 0 | 1.06 | 5.10 | 0 | 93.84 | 0 | 0 |
| San Joaquin River at Potato Slough | SJRPOTSL_MID | 6.24 | 16.03 | 71.18 | 6.45 | 0.07 | 0.03 | 2.65 | 23.15 | 38.61 | 35.59 | 1.1E-05 | 0.01 |
| San Joaquin River at Turner Cut | SJRTURNR_MID | 6.75 | 4.55 | 1.37 | 87.31 | 0.01 | 0 | 1.49 | 3.20 | 0.00 | 95.31 | 0 | 0 |
| San Joaquin River/Point Antioch/fish pier | ASRANTFSH_MID | 4.87 | 5.29 | 87.53 | 1.67 | 0.37 | 0.27 | 2.37 | 13.56 | 62.61 | 20.61 | 0.02 | 0.84 |
| Suisun Bay | SUISNB_LEN | 2.63 | 1.36 | 66.87 | 0.33 | 28.58 | 0.23 | 1.35 | 6.21 | 59.91 | 8.33 | 22.38 | 1.82 |
| Sycamore Slough | SYCAMOR_MID | 14.41 | 68.02 | 17.57 | 8.8E-17 | 0 | 3.5E-29 | 3.66 | 95.02 | 1.31 | 1.E-18 | 0 | 3.9E-33 |
| White Slough | WHITESL_L0 | 47.62 | 12.39 | 33.06 | 6.93 | 8.2E-04 | 2.7E-06 | 15.95 | 8.06 | 2.95 | 73.04 | 1.4E-05 | 1.5E-07 |
| White Slough downstream of Disappointment Slough | WHTSLDISPONT_LEN | 20.77 | 29.09 | 44.03 | 6.11 | 2.4E-04 | 3.6E-06 | 14.40 | 8.89 | 3.00 | 73.72 | 7.9E-06 | 0 |

**Table 6B-31 Continued. Modeled Quarterly Average Selenium Concentrations in Water (in micrograms per liter) for DSM2 Output Locations, Year 2005**

| SM2 Output Water Location | Inflow Source | Third Quarter Inflow Percentage | | | | | | Fourth Quarter Inflow Percentage | | | | | | Estimated Waterborne Selenium Concentrations (µg/L) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | | | | | |
| | Inflow Location | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | Annual |
| | DSM2 Location ID | | | | | | | | | | | | | | | | | |
| Big Break | BIGBRK_MID | 3.31 | 2.21 | 88.77 | 1.70 | 3.98 | 0.03 | 2.39 | 0.24 | 90.17 | 0.01 | 6.48 | 0.70 | 0.11 | 0.30 | 0.10 | 0.09 | 0.15 |
| Cache Slough | CACHS_LEN | 1.94 | 1.7E-05 | 98.02 | 1.0E-05 | 1.6E-06 | 0.05 | 2.30 | 1.2E-05 | 92.72 | 4.6E-07 | 0.00 | 4.98 | 0.09 | 0.10 | 0.09 | 0.10 | 0.09 |
| Cache Slough at Ryer Island | CACHSR_MID | 2.15 | 5.6E-07 | 97.77 | 2.6E-07 | 4.5E-09 | 0.08 | 2.66 | 8.8E-07 | 96.37 | 1.9E-08 | 7.6E-06 | 0.97 | 0.09 | 0.10 | 0.09 | 0.09 | 0.09 |
| Cosumnes River | COSR_LEN | 0 | 100 | 0 | 0 | 0 | 0 | 1.2E-04 | 100.00 | 0 | 0 | 0 | 0 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Franks Tract | FRANKST_MID | 4.27 | 3.20 | 89.93 | 1.81 | 0.77 | 0.02 | 3.17 | 0.81 | 94.16 | 0.06 | 1.74 | 0.05 | 0.15 | 0.49 | 0.11 | 0.09 | 0.21 |
| Little Holland Tract | LHOLND_L0 | 18.61 | 5.6E-07 | 81.24 | 0.00 | 0.00 | 0.16 | 46.22 | 6.1E-08 | 53.77 | 2.8E-08 | 2.6E-09 | 0.01 | 0.11 | 0.10 | 0.09 | 0.10 | 0.10 |
| Middle River at Bullfrog | MIDRBULFRG_LEN | 7.43 | 12.50 | 53.07 | 26.88 | 0.12 | 3.1E-03 | 5.54 | 8.75 | 65.65 | 19.67 | 0.39 | 1.1E-03 | 0.46 | 0.75 | 0.30 | 0.24 | 0.44 |
| Mildred Island | MILDDRISL_MID | 6.73 | 12.68 | 65.46 | 14.98 | 0.15 | 3.9E-03 | 4.81 | 7.16 | 77.85 | 9.71 | 0.47 | 1.8E-03 | 0.43 | 0.74 | 0.21 | 0.17 | 0.38 |
| Mokelumne River below Cosumnes River | MOKBCOS_LEN | 3.05 | 96.95 | 0 | 0 | 0 | 0 | 3.00 | 97.00 | 0 | 0 | 0 | 0 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Mokelumne River downstream of Cosumnes River | MOKDCOS_MID | 3.05 | 96.95 | 0 | 0 | 0 | 0 | 2.93 | 97.07 | 0 | 0 | 0 | 0 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Old River near Paradise Cut | OLDRNPARADSEC_MID | 6.64 | 0 | 5.E-09 | 93.36 | 0 | 0 | 14.49 | 0.24 | 3.16 | 82.09 | 0.02 | 8.1E-05 | 0.78 | 0.84 | 0.80 | 0.72 | 0.79 |
| Paradise Cut | PARADSECUT_LEN | 2.39 | 0 | 0 | 97.61 | 0 | 0 | 1.08 | 0 | 0 | 98.92 | 0 | 0 | 0.77 | 0.84 | 0.83 | 0.84 | 0.82 |
| Port of Stockton | PORTOSTOCK_L0 | 2.20 | 0 | 0 | 97.80 | 0 | 0 | 2.20 | 0 | 0 | 97.79 | 0 | 0 | 0.82 | 0.83 | 0.83 | 0.83 | 0.83 |
| Sacramento River at Isleton | SACRISLTON_L0 | 0.45 | 0 | 99.55 | 0.00 | 0 | 0 | 0.41 | 0 | 99.59 | 0 | 0 | 8.2E-08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Sacramento River Mile 44 | SACR44_L0 | 0.14 | 0 | 99.86 | 0.00 | 0 | 0 | 0.17 | 0 | 99.83 | 0 | 0 | 0 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Sandmound Slough | SANDMND_MID | 5.61 | 3.13 | 87.97 | 2.10 | 1.17 | 0.02 | 3.93 | 0.55 | 92.97 | 0.03 | 2.45 | 0.07 | 0.13 | 0.43 | 0.11 | 0.09 | 0.19 |
| Sherman Island | SHERMNILND_L0 | 2.76 | 1.84 | 86.03 | 1.72 | 7.62 | 0.04 | 1.95 | 0.11 | 84.69 | 0.01 | 11.76 | 1.48 | 0.10 | 0.26 | 0.10 | 0.09 | 0.14 |
| San Joaquin River near Bowman | SJRBOWMN_MID | 2.06 | 0 | 0 | 97.94 | 0 | 0 | 0.80 | 0 | 0 | 99.20 | 0 | 0 | 0.84 | 0.85 | 0.83 | 0.84 | 0.84 |
| San Joaquin River near State Route 4 | SJRNHWY4_MID | 2.64 | 0 | 0 | 97.36 | 0 | 0 | 1.94 | 0.00 | 0 | 98.06 | 0 | 0 | 0.84 | 0.85 | 0.83 | 0.84 | 0.84 |
| San Joaquin River near Naval Street | SJRNAVLST_L0 | 4.11 | 9.43 | 0 | 86.46 | 0 | 0 | 4.97 | 12.46 | 0 | 82.57 | 0 | 0 | 0.77 | 0.80 | 0.75 | 0.72 | 0.76 |
| San Joaquin River at Potato Slough | SJRPOTSL_MID | 2.75 | 2.58 | 93.40 | 0.83 | 0.42 | 0.01 | 2.16 | 1.30 | 95.35 | 0.02 | 1.04 | 0.13 | 0.14 | 0.36 | 0.10 | 0.09 | 0.17 |
| San Joaquin River at Turner Cut | SJRTURNR_MID | 6.05 | 11.77 | 4.90 | 77.27 | 0.01 | 8.4E-05 | 5.55 | 16.96 | 10.99 | 66.44 | 0.06 | 7.4E-05 | 0.76 | 0.81 | 0.68 | 0.60 | 0.71 |
| San Joaquin River/Point Antioch/fish pier | ASRANTFSH_MID | 2.82 | 1.68 | 87.76 | 1.46 | 6.24 | 0.03 | 2.05 | 0.14 | 86.70 | 0.01 | 9.68 | 1.42 | 0.10 | 0.25 | 0.10 | 0.09 | 0.14 |
| Suisun Bay | SUISNB_LEN | 0.83 | 0.82 | 31.47 | 1.16 | 65.65 | 0.07 | 0.68 | 0.05 | 32.01 | 0.03 | 66.56 | 0.68 | 0.10 | 0.16 | 0.11 | 0.10 | 0.11 |
| Sycamore Slough | SYCAMOR_MID | 4.79 | 40.41 | 54.81 | 2.9E-20 | 0 | 1.1E-32 | 5.24 | 32.04 | 62.72 | 2.6E-18 | 7.7E-14 | 1.0E-30 | 0.10 | 0.10 | 0.09 | 0.09 | 0.10 |
| White Slough | WHITESL_L0 | 10.03 | 26.20 | 63.17 | 0.61 | 3.0E-05 | 8.1E-08 | 9.32 | 12.33 | 78.34 | 0.01 | 4.6E-04 | 4.6E-08 | 0.15 | 0.65 | 0.10 | 0.09 | 0.25 |
| White Slough downstream of Disappointment Slough | WHTSLDISPONT_LEN | 9.10 | 26.19 | 64.27 | 0.45 | 3.1E-05 | 0 | 6.26 | 14.39 | 79.35 | 1.9E-03 | 6.8E-04 | 0 | 0.14 | 0.65 | 0.10 | 0.09 | 0.25 |

**Table 6B-32. Modeled Quarterly Average Selenium Concentrations in Water (in micrograms per liter) for DSM2 Output Locations, Year 2007**

| DSM2 Output Water Location | Inflow Source | First Quarter Inflow Percentage | | | | | | Second Quarter Inflow Percentage | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass |
| | Inflow Location | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* |
| | DSM2 Location ID | | | | | | | | | | | | |
| Big Break | BIGBRK_MID | 2.66 | 1.75 | 93.01 | 0.07 | 2.30 | 0.21 | 4.40 | 3.10 | 84.13 | 4.24 | 1.24 | 2.89 |
| Cache Slough | CACHS_LEN | 1.86 | 1.4E-05 | 97.14 | 2.2E-07 | 2.8E-05 | 1.01 | 1.99 | 5.1E-04 | 88.84 | 8.8E-04 | 1.6E-05 | 9.17 |
| Cache Slough at Ryer Island | CACHSR_MID | 2.85 | 1.8E-06 | 96.46 | 4.7E-08 | 1.5E-05 | 0.68 | 2.66 | 1.2E-04 | 88.76 | 1.8E-04 | 1.4E-06 | 8.58 |
| Cosumnes River | COSR_LEN | 0.00 | 100.00 | 0 | 0 | 0 | 0.00 | 0.01 | 99.99 | 0 | 0 | 0 | 0 |
| Franks Tract | FRANKST_MID | 3.85 | 4.08 | 90.69 | 0.32 | 0.94 | 0.11 | 6.16 | 5.35 | 77.86 | 9.10 | 0.16 | 1.38 |
| Little Holland Tract | LHOLND_L0 | 29.80 | 0.00 | 69.38 | 1.2E-07 | 5.3E-05 | 0.81 | 22.80 | 8.0E-05 | 71.18 | 1.1E-04 | 5.2E-06 | 6.02 |
| Middle River at Bullfrog | MIDRBULFRG_LEN | 8.32 | 10.69 | 59.08 | 21.39 | 0.48 | 0.04 | 9.69 | 10.67 | 38.75 | 40.64 | 0.03 | 0.22 |
| Mildred Island | MILDDRISL_MID | 7.42 | 11.13 | 68.24 | 12.63 | 0.54 | 0.04 | 8.53 | 10.39 | 42.57 | 38.23 | 0.03 | 0.25 |
| Mokelumne River below Cosumnes River | MOKBCOS_LEN | 1.46 | 98.54 | 0 | 0 | 0 | 0 | 6.32 | 93.68 | 6.5E-04 | 0 | 0 | 0 |
| Mokelumne River downstream of Cosumnes River | MOKDCOS_MID | 1.46 | 98.54 | 0 | 0 | 0 | 0 | 6.42 | 93.58 | 0 | 0 | 0 | 0 |
| Old River near Paradise Cut | OLDRNPARADSEC_MID | 3.95 | 5E-12 | 3E-06 | 96.05 | 1.7E-16 | 2.5E-17 | 15.73 | 1.81 | 12.66 | 69.68 | 0.02 | 0.10 |
| Paradise Cut | PARADSECUT_LEN | 1.91 | 0 | 0 | 98.09 | 0 | 0 | 4.98 | 0.11 | 0.61 | 94.29 | 6.7E-04 | 3.7E-03 |
| Port of Stockton | PORTOSTOCK_L0 | 1.48 | 0 | 0 | 98.52 | 0 | 0 | 2.29 | 0 | 0 | 97.71 | 0 | 0 |
| Sacramento River at Isleton | SACRISLTON_L0 | 0.45 | 0 | 99.55 | 0 | 0 | 2.1E-06 | 0.63 | 8.8E-05 | 99.36 | 5.7E-08 | 0 | 0.01 |
| Sacramento River Mile 44 | SACR44_L0 | 0.20 | 0 | 99.80 | 0 | 0 | 0 | 0.30 | 0 | 99.70 | 0 | 0 | 0 |
| Sandmound Slough | SANDMND_MID | 4.47 | 3.23 | 90.83 | 0.17 | 1.17 | 0.13 | 7.20 | 4.64 | 79.23 | 6.98 | 0.23 | 1.71 |
| Sherman Island | SHERMNILND_L0 | 2.14 | 0.95 | 92.16 | 0.04 | 4.49 | 0.23 | 3.69 | 2.31 | 83.94 | 2.94 | 4.01 | 3.11 |
| San Joaquin River near Bowman | SJRBOWMN_MID | 0.88 | 0 | 0 | 99.12 | 0 | 0 | 3.52 | 0 | 0 | 96.48 | 0 | 0 |
| San Joaquin River near State Route 4 | SJRNHWY4_MID | 1.82 | 2.8E-08 | 0 | 98.18 | 0 | 0 | 4.35 | 1.4E-07 | 0 | 95.65 | 0 | 0 |
| San Joaquin River near Naval Street | SJRNAVLST_L0 | 4.83 | 6.83 | 0 | 88.35 | 0 | 0 | 5.86 | 11.12 | 1.3E-06 | 83.02 | 0 | 0 |
| San Joaquin River at Potato Slough | SJRPOTSL_MID | 2.91 | 5.22 | 91.00 | 0.15 | 0.61 | 0.10 | 4.89 | 5.67 | 79.70 | 8.49 | 0.10 | 1.16 |
| San Joaquin River at Turner Cut | SJRTURNR_MID | 7.22 | 10.11 | 10.82 | 71.76 | 0.08 | 0.01 | 7.49 | 11.95 | 7.23 | 73.31 | 2.9E-03 | 0.02 |
| San Joaquin River/Point Antioch/fish pier | ASRANTFSH_MID | 2.17 | 1.01 | 92.90 | 0.04 | 3.62 | 0.26 | 3.74 | 2.30 | 84.37 | 3.04 | 3.24 | 3.31 |
| Suisun Bay | SUISNB_LEN | 0.87 | 0.23 | 46.77 | 0.01 | 51.97 | 0.14 | 0.94 | 0.51 | 31.58 | 0.43 | 65.55 | 0.98 |
| Sycamore Slough | SYCAMOR_MID | 10.20 | 72.58 | 17.22 | 5.1E-10 | 9.7E-14 | 4.3E-29 | 13.62 | 50.90 | 35.47 | 0.01 | 4.0E-09 | 1.1E-07 |
| White Slough | WHITESL_L0 | 20.35 | 16.73 | 61.67 | 1.25 | 4.8E-03 | 2.4E-04 | 33.31 | 13.41 | 23.49 | 29.78 | 3.9E-04 | 3.2E-03 |
| White Slough downstream of Disappointment Slough | WHTSLDISPONT_LEN | 10.09 | 24.12 | 65.07 | 0.71 | 4.1E-03 | 1.9E-04 | 17.00 | 13.60 | 32.29 | 37.10 | 1.4E-03 | 0.01 |

**Table 6B-32 Continued. Modeled Quarterly Average Selenium Concentrations in Water (in micrograms per liter) for DSM2 Output Locations, Year 2007**

| DSM2 Output Water Location | Inflow Source | Third Quarter Inflow Percentage | | | | | | Fourth Quarter Inflow Percentage | | | | | | Estimated Waterborne Selenium Concentrations (µg/L) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | | | | | |
| | Inflow Location | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | Annual |
| | DSM2 Location ID | | | | | | | | | | | | | | | | | |
| Big Break | BIGBRK_MID | 3.58 | 0.32 | 81.60 | 0.79 | 9.45 | 4.27 | 2.60 | 0.11 | 84.06 | 0.04 | 8.53 | 4.65 | 0.09 | 0.12 | 0.10 | 0.10 | 0.10 |
| Cache Slough | CACHS_LEN | 1.92 | 9.1E-06 | 89.20 | 1.9E-05 | 1.6E-06 | 8.88 | 1.64 | 1.9E-05 | 91.73 | 8.5E-06 | 5.1E-04 | 6.62 | 0.09 | 0.10 | 0.10 | 0.10 | 0.10 |
| Cache Slough at Ryer Island | CACHSR_MID | 2.16 | 1.5E-05 | 88.35 | 3.1E-05 | 3.1E-07 | 9.49 | 1.96 | 4.5E-06 | 90.83 | 2.8E-06 | 1.9E-04 | 7.21 | 0.09 | 0.10 | 0.10 | 0.10 | 0.10 |
| Cosumnes River | COSR_LEN | 0.09 | 99.91 | 0 | 0 | 0 | 0 | 0 | 100.00 | 0 | 0 | 0 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Franks Tract | FRANKST_MID | 4.86 | 0.34 | 88.03 | 0.84 | 2.96 | 2.98 | 3.19 | 0.32 | 91.15 | 0.17 | 2.23 | 2.95 | 0.09 | 0.14 | 0.10 | 0.10 | 0.11 |
| Little Holland Tract | LHOLND_L0 | 18.52 | 2.4E-05 | 73.18 | 0.00 | 4.9E-07 | 8.30 | 21.64 | 5.2E-07 | 71.72 | 1.4E-06 | 4.9E-05 | 6.64 | 0.10 | 0.10 | 0.11 | 0.10 | 0.10 |
| Middle River at Bullfrog | MIDRBULFRG_LEN | 8.41 | 3.92 | 81.16 | 4.51 | 0.87 | 1.14 | 5.81 | 4.90 | 72.42 | 15.36 | 0.57 | 0.94 | 0.20 | 0.29 | 0.12 | 0.17 | 0.19 |
| Mildred Island | MILDDRISL_MID | 6.49 | 1.12 | 88.25 | 1.83 | 1.00 | 1.30 | 4.91 | 4.55 | 80.81 | 7.99 | 0.66 | 1.08 | 0.15 | 0.28 | 0.10 | 0.13 | 0.17 |
| Mokelumne River below Cosumnes River | MOKBCOS_LEN | 15.09 | 84.81 | 0.10 | 6.2E-35 | 0 | 0 | 2.30 | 97.70 | 0 | 0 | 0 | 0 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Mokelumne River downstream of Cosumnes River | MOKDCOS_MID | 15.19 | 84.81 | 3.2E-04 | 0 | 0 | 0 | 2.27 | 97.73 | 0 | 0 | 0 | 0 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Old River near Paradise Cut | OLDRNPARADSEC_MID | 10.18 | 1.9E-05 | 1.6E-04 | 89.82 | 6.9E-08 | 6.5E-07 | 2.31 | 9.2E-04 | 0.01 | 97.68 | 0 | 9.7E-05 | 0.56 | 0.43 | 0.53 | 0.57 | 0.52 |
| Paradise Cut | PARADSECUT_LEN | 7.14 | 0 | 0 | 92.86 | 0 | 0 | 1.24 | 4.1E-03 | 0.05 | 98.71 | 4.1E-04 | 4.5E-04 | 0.57 | 0.55 | 0.55 | 0.57 | 0.56 |
| Port of Stockton | PORTOSTOCK_L0 | 6.32 | 0.04 | 0 | 93.64 | 0 | 0 | 7.16 | 0.05 | 0 | 92.78 | 0 | 0 | 0.57 | 0.57 | 0.55 | 0.55 | 0.56 |
| Sacramento River at Isleton | SACRISLTON_L0 | 0.49 | 0 | 99.51 | 0 | 0 | 2.9E-04 | 0.39 | 1.0E-08 | 99.61 | 0 | 6.7E-07 | 0.01 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Sacramento River Mile 44 | SACR44_L0 | 0.15 | 0 | 99.85 | 0 | 0 | 0 | 0.11 | 0 | 99.89 | 0 | 0 | 0 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Sandmound Slough | SANDMND_MID | 6.15 | 0.39 | 84.96 | 0.98 | 4.06 | 3.46 | 3.79 | 0.22 | 89.26 | 0.10 | 3.11 | 3.51 | 0.09 | 0.13 | 0.10 | 0.10 | 0.10 |
| Sherman Island | SHERMNILND_L0 | 2.99 | 0.32 | 77.36 | 0.77 | 14.22 | 4.34 | 2.22 | 0.06 | 75.89 | 0.03 | 17.11 | 4.68 | 0.09 | 0.11 | 0.10 | 0.10 | 0.10 |
| San Joaquin River near Bowman | SJRBOWMN_MID | 8.49 | 2.5E-04 | 0 | 91.51 | 0 | 0 | 0.91 | 0 | 0 | 99.09 | 0 | 0 | 0.58 | 0.56 | 0.54 | 0.58 | 0.56 |
| San Joaquin River near State Route 4 | SJRNHWY4_MID | 12.54 | 0.08 | 4.0E-26 | 87.39 | 0 | 0 | 1.89 | 1.3E-04 | 0 | 98.11 | 0 | 0 | 0.57 | 0.56 | 0.52 | 0.57 | 0.56 |
| San Joaquin River near Naval Street | SJRNAVLST_L0 | 12.06 | 40.15 | 3.4E-03 | 47.78 | 6.2E-07 | 6.3E-06 | 4.73 | 6.37 | 2.5E-04 | 88.90 | 5.4E-09 | 7.0E-09 | 0.52 | 0.50 | 0.33 | 0.53 | 0.47 |
| San Joaquin River at Potato Slough | SJRPOTSL_MID | 3.16 | 0.19 | 91.86 | 0.46 | 1.88 | 2.44 | 2.37 | 0.33 | 93.43 | 0.10 | 1.44 | 2.33 | 0.09 | 0.13 | 0.10 | 0.09 | 0.10 |
| San Joaquin River at Turner Cut | SJRTURNR_MID | 11.09 | 11.29 | 65.50 | 11.02 | 0.46 | 0.63 | 6.16 | 6.57 | 36.18 | 50.55 | 0.19 | 0.35 | 0.44 | 0.45 | 0.15 | 0.34 | 0.35 |
| San Joaquin River/Point Antioch/fish pier | ASRANTFSH_MID | 3.00 | 0.27 | 79.62 | 0.65 | 12.05 | 4.40 | 2.27 | 0.07 | 78.73 | 0.03 | 14.08 | 4.82 | 0.09 | 0.11 | 0.10 | 0.10 | 0.10 |
| Suisun Bay | SUISNB_LEN | 0.84 | 0.16 | 21.30 | 0.36 | 76.08 | 1.25 | 0.59 | 0.02 | 21.39 | 0.01 | 76.63 | 1.36 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Sycamore Slough | SYCAMOR_MID | 5.33 | 3.90 | 90.77 | 1.9E-16 | 3.8E-25 | 1.1E-22 | 3.69 | 20.36 | 75.95 | 6.0E-19 | 1.1E-37 | 2.4E-31 | 0.10 | 0.10 | 0.09 | 0.09 | 0.10 |
| White Slough | WHITESL_L0 | 15.53 | 1.33 | 83.05 | 0.09 | 1.2E-03 | 2.0E-03 | 9.35 | 8.62 | 81.98 | 0.04 | 3.7E-04 | 7.1E-04 | 0.10 | 0.24 | 0.09 | 0.09 | 0.13 |

| DSM2 Output Water Location | Inflow Source | Third Quarter Inflow Percentage | | | | | | Fourth Quarter Inflow Percentage | | | | | | Estimated Waterborne Selenium Concentrations (µg/L) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | Delta Agricultural Return Waters | Eastside Tributaries | Sacramento River | San Joaquin River | Martinez/ Suisun Bay | Yolo Bypass | | | | | |
| | Inflow Location | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | *Mildred Island, Center* | *Mokelumne Calaveras Cosumnes Rivers* | *Freeport* | *Vernalis* | *San Joaquin River near Mallard Island* | *Sacramento River below Knights Landing* | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | Annual |
| | DSM2 Location ID | | | | | | | | | | | | | | | | | |
| White Slough downstream of Disappointment Slough | WHTSLDISPONT_LEN | 7.70 | 1.46 | 90.83 | 1.5E-03 | 1.3E-03 | 2.2E-03 | 5.21 | 9.69 | 85.06 | 0.03 | 9.7E-04 | 2.1E-03 | 0.10 | 0.28 | 0.09 | 0.09 | 0.14 |

## Delta-Wide Water to Particulate Partitioning Factor Calibration

The selenium bioaccumulation model was calibrated by determining Delta-specific $K_d$s that most accurately describe the relationship between measured selenium in fish tissue and modeled water column selenium concentrations. Modeled water concentrations at the fish sampling locations (refer to Section 6B.3.2.3, under *Delta-Wide Bioaccumulation Model Calibration*, *Selenium Concentrations in Water for the Delta-Wide Bioaccumulation Model Calibration*) were input to the fish tissue model for piscivorous fish (Section 6B.3.2.2, *Biota Concentrations,* under *Selenium Concentrations in Whole-Body Fish*) and the modeled fish tissue concentrations were compared with measured selenium concentrations in whole largemouth bass from Foe (2010:27). The modeled selenium concentration in fish to measured selenium in whole largemouth bass relationship was evaluated to describe the model accuracy and inform refinements. The fish tissue bioaccumulation model always used the same TTFs for invertebrates (2.8) and fish (1.1) as discussed in Sections 6B.3.2.2, under *Selenium Concentrations in Invertebrates*, and *Selenium Concentrations in Whole-Body Fish*, respectively.

Several iterations of the fish tissue bioaccumulation model were developed to calibrate $K_d$. Generic tissue uptake Model 1 (trophic level 3 fish eating invertebrates) and Model 2 (trophic level 4 fish eating fish) were first developed as benchmark for comparison of refinements. Both Models 1 and 2 used a default $K_d$ of 1,000 from Presser and Luoma (2010a:701). The resulting fish tissue concentrations substantially underestimated the measured bass tissue concentrations reported by Foe (2010:27) as shown in Figure 6B.3-1 and Table 6B-33. This was partly because Model 1 estimated selenium concentrations in a forage fish (trophic level 3), whereas bass are a predatory fish with expected higher dietary exposure. Model 2 is representative of predatory fish, but the default $K_d$ did not reflect Delta-specific conditions. As noted above and described in much greater detail by Presser and Luoma (2010a:690, 2010b:20, 2013:14), the $K_d$ values for selenium uptake from water are highly variable, much more variable than the TTFs for invertebrates or fish. Models 1 and 2 may also reflect the tendency for selenium, as an essential nutrient, to be more bioaccumulative when water column concentrations are low, as described by Stewart et al. (2010:126). Modeled water column selenium concentrations were relatively low and ranged from 0.09 to 0.85 µg/L. Available $K_d$ values from various sampling efforts in the Delta provided by Presser and Luoma (2010b:21) indicate variability based on locations within the Delta and Suisun Bay and also by water year and flow characteristics, with $K_d$ values often greater than 5,000 and sometimes exceeding 10,000. However, efforts to incorporate default $K_d$ value of 2,000 or 3,000 into the model over- or underestimated fish selenium concentrations because of variability in site conditions.

Two refinements were made to $K_d$ for Delta-specific calibrations. The first was based on the inverse relationship between water column selenium concentrations and bioaccumulation in aquatic organisms reported by Stewart et al. (2010:126) and U.S. Environmental Protection Agency (EPA) (2016:129). The second refinement to $K_d$ was based on water year type. Characteristics of water flow in the Delta affect selenium bioaccumulation because longer residence times can be expected to increase bioaccumulation by increasing $K_d$ (Section 6B.3.2.2, under *Selenium Concentrations in Particulates*). Foe (2010:23) reported the water year types when fish were sampled. Both the Sacramento River and San Joaquin River watersheds were above normal in 2000 and preceded by a wet year. Year 2005 was wetter than 2000 and was reported as above normal for the Sacramento River watershed and wet for the San Joaquin River watershed. A dry year preceded 2005. Water year 2007 was reported as dry for the Sacramento River watershed and critical for the San Joaquin River watershed and followed a dry year.

Differences in modeled tissue selenium concentrations among years were expected to be associated with hydrology and water flow through the Delta. Wetter conditions in 2005 and 2000 would have relatively shorter water residence times, resulting in less selenium recycling, lower $K_d$ values, and lower concentrations of selenium entering the foodweb. The dry water year (2007) was expected to have a longer water residence time, higher $K_d$ values, greater selenium recycling, and higher concentrations of bioavailable selenium entering the foodweb. Different $K_d$s were therefore incorporated into model calibration to describe different water year types.

Based on these refinements, back calculation of $K_d$ values associated with measured fish tissues and modeled water column concentrations confirmed the Delta-specific data displayed a concentration-dependent negative relationship between water column selenium and $K_d$s. Figure 6B.3-2 presents the log-log regression relationship of $K_d$ to water column selenium concentration for all years referred to as Model 3, while Figure 6B.3-3 presents the relationship for above normal and wet years (2000 and 2005) referred to as Model 4, and Figure 6B.3-4 presents the regression for a dry year (2007) referred to as Model 5.

Model 3 results provide an example of the inverse relationship between selenium water column concentrations and $K_d$ (refer to Figure 9J-2). Water column selenium concentrations ranging from 0.09 to 0.13 µg/L (n = 50) produced a median $K_d$ of 5,575. Water column selenium concentrations ranging from 0.14 to 0.40 µg/L (n = 19) produced a median $K_d$ of 2,431. Finally, water column selenium concentrations ranging from 0.41 to 0.85 µg/L (n = 19) produced a median $K_d$ of 748. The $K_d$ values generated with Model 4 (above normal and wet years) were higher and the $K_d$ values generated with Model 5 for a dry year were lower than those calculated by Model 3.

These water year-based log-log relationships were used to calculate $K_d$ for each modeled water column concentration associated with measured whole largemouth bass from Foe (2010:27). Whole-body fish tissue concentrations were then calculated using these $K_d$s in the fish tissue uptake model. Model 3 produced a median ratio of predicted-to-observed selenium in whole largemouth bass that slightly exceeded 1 (Figure 6B.3-1); details are provided in Table 6B-37. Models 4 and 5 produced ratios of predicted-to-observed selenium in whole largemouth bass approximating 1, as shown in Figure 6B.3-1 and Table 6B-35. As expected in a large, complex, and diverse ecological habitat such as the Delta, there was variability in the data distribution for measured fish tissues. However, the range of concentration-dependent log-log $K_d$ values in Model 3 (674–6,060; Table 6B34), Model 4 (651–4,997; Table 6B-35), and Model 5 (1,206–8,064; Table 6B-35) are consistent with the $K_d$ ranges summarized by Presser and Luoma (2010b:21) for the Delta.

Figures 6B.3-5 and 6B.3-6 illustrate the distribution of data for selenium concentrations in largemouth bass (Foe 2010:27) relative to the measured or modeled water column selenium concentrations (Tables 6B-30 through 6B-32) and Models 3, 4, and 5 to complement the boxplots in Figure 6B.3-1. There is notably more variability in selenium concentrations in bass between 0.09 and 0.13 µg/L than at higher water column selenium concentrations (as shown in both Figures 6B.3-5 and 6B.3-6); most of the higher bass tissue concentrations are from 2007 and most of the lower concentrations are from 2005.

Evaluation of water year type effects on selenium concentration in bass concluded that Model 4 was predictive of selenium concentration in whole largemouth bass during above normal and wet years. Model 5 was considered predictive for dry water years (e.g., 2007). Model 3 incorporates the varying bioaccumulation when all years are considered (2000, 2005, and 2007). Although Model 3 can slightly overestimate selenium bioaccumulation (Figure 6B.3-1 and Table 6B-34), it was used for

estimating selenium concentrations in whole-body fish from average water concentrations for all years.

Foe (2010:8) did not find a difference in bass tissue selenium concentrations in the Sacramento River at Rio Vista compared to the San Joaquin River at Vernalis in 2000, 2005, and 2007, despite a nearly 10-fold difference in water column selenium concentrations. This could have been due to the lag effect, where fish tissues do not instantaneously reflect water column concentrations. Rather, fish integrate water concentrations they are exposed to over time. The calibrated fish tissue models incorporated these longer-term average concentrations by considering source water concentrations at Vernalis over a 2-year period and Models 3, 4, and 5 reasonably approximated the measured selenium concentrations in whole largemouth bass (Figure 6B.3-1).

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**Table 6B-33. Selenium Bioaccumulation from Water (in micrograms per liter) to Particulates and Fish (in micrograms per gram, dry weight) Using Models 1 and 2**

| DSM2 Delta Water Location | Year 2000 | | | | | | | | Year 2005 | | | | | | | | Year 2007 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Concentration | | | | | Measured Whole Large mouth Bass [a] | Fish-to-Bass Ratio | | Concentration | | | | | Measured Whole Large mouth Bass [a] | Fish-to-Bass Ratio | | Concentration | | | | | Measured Whole Large mouth Bass [a] | Fish-to-Bass Ratio | |
| | Modeled Water | Particulate from Water | Invertebrate from Particulate | Model 1 Fish | Model 2 Fish | | Model 1 | Model 2 | Modeled Water [e] | Particulate from Water | Invertebrate from Particulate | Model 1 Fish | Model 2 Fish | | Model 1 | Model 2 | Modeled Water [e] | Particulate from Water | Invertebrate from Particulate | Model 1 Fish | Model 2 Fish | | Model 1 | Model 2 |
| **First Quarter** | | | | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.09 | 0.25 | 0.27 | 0.30 | 2.6 | 0.10 | 0.11 | 0.09 | 0.09 | 0.25 | 0.28 | 0.31 | 1.5 | 0.19 | 0.21 | 0.09 | 0.09 | 0.25 | 0.28 | 0.31 | 1.8 | 0.15 | 0.17 |
| Cache Slough at Ryer Island [b] | 0.10 | 0.10 | 0.28 | 0.31 | 0.34 | 1.5 | 0.21 | 0.23 | 0.09 | 0.09 | 0.26 | 0.29 | 0.31 | 1.7 | 0.17 | 0.18 | 0.09 | 0.09 | 0.26 | 0.28 | 0.31 | 2.5 | 0.11 | 0.12 |
| San Joaquin River Potato Slough | 0.17 | 0.17 | 0.47 | 0.52 | 0.57 | 1.4 | 0.38 | 0.42 | 0.14 | 0.14 | 0.40 | 0.44 | 0.48 | 1.3 | 0.33 | 0.37 | 0.09 | 0.09 | 0.26 | 0.28 | 0.31 | 2.5 | 0.11 | 0.13 |
| Franks Tract | 0.19 | 0.19 | 0.53 | 0.58 | 0.64 | 1.6 | 0.35 | 0.39 | 0.15 | 0.15 | 0.41 | 0.45 | 0.49 | 1.1 | 0.39 | 0.43 | 0.09 | 0.09 | 0.26 | 0.29 | 0.32 | 3.0 | 0.10 | 0.11 |
| Big Break | 0.13 | 0.13 | 0.35 | 0.39 | 0.43 | 1.6 | 0.25 | 0.28 | 0.11 | 0.11 | 0.31 | 0.34 | 0.37 | 1.0 | 0.33 | 0.37 | 0.09 | 0.09 | 0.26 | 0.28 | 0.31 | 2.8 | 0.10 | 0.11 |
| Middle River Bullfrog | 0.31 | 0.31 | 0.86 | 0.95 | 1.05 | NA | NA | NA | 0.46 | 0.46 | 1.29 | 1.42 | 1.56 | 1.9 | 0.7 | 0.8 | 0.20 | 0.20 | 0.55 | 0.61 | 0.67 | 2.1 | 0.3 | 0.3 |
| Old River near Paradise Cut [c] | 0.73 | 0.73 | 2.05 | 2.25 | 2.48 | NA | NA | NA | 0.78 | 0.78 | 2.19 | 2.41 | 2.66 | 2.4 | 1.0 | 1.1 | 0.56 | 0.56 | 1.57 | 1.73 | 1.90 | NA | NA | NA |
| Knights Landing [d] | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | NA | NA | NA | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | 2.2 | 0.3 | 0.4 | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | NA | NA | NA |
| Vernalis [e] | 0.83 | 0.83 | 2.32 | 2.56 | 2.81 | 1.7 | 1.50 | 1.65 | 0.85 | 0.85 | 2.38 | 2.62 | 2.88 | 1.9 | 1.38 | 1.52 | 0.58 | 0.58 | 1.62 | 1.79 | 1.97 | 2.4 | 0.74 | 0.82 |
| **Second Quarter** | | | | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.09 | 0.25 | 0.28 | 0.30 | 2.6 | 0.11 | 0.12 | 0.09 | 0.09 | 0.25 | 0.28 | 0.30 | 1.5 | 0.19 | 0.21 | 0.09 | 0.09 | 0.25 | 0.28 | 0.31 | 1.8 | 0.15 | 0.17 |
| Cache Slough at Ryer Island [b] | 0.11 | 0.11 | 0.32 | 0.35 | 0.38 | 1.5 | 0.23 | 0.26 | 0.10 | 0.10 | 0.27 | 0.30 | 0.33 | 1.7 | 0.17 | 0.19 | 0.10 | 0.10 | 0.29 | 0.32 | 0.35 | 2.5 | 0.12 | 0.14 |
| San Joaquin River Potato Slough | 0.24 | 0.24 | 0.67 | 0.74 | 0.81 | 1.4 | 0.54 | 0.60 | 0.36 | 0.36 | 1.02 | 1.12 | 1.23 | 1.3 | 0.86 | 0.94 | 0.13 | 0.13 | 0.38 | 0.42 | 0.46 | 2.5 | 0.17 | 0.18 |
| Franks Tract | 0.27 | 0.27 | 0.76 | 0.83 | 0.92 | 1.6 | 0.51 | 0.56 | 0.49 | 0.49 | 1.36 | 1.50 | 1.65 | 1.1 | 1.31 | 1.44 | 0.14 | 0.14 | 0.39 | 0.43 | 0.47 | 3.0 | 0.14 | 0.16 |
| Big Break | 0.20 | 0.20 | 0.55 | 0.60 | 0.66 | 1.6 | 0.39 | 0.43 | 0.30 | 0.30 | 0.83 | 0.91 | 1.00 | 1.0 | 0.89 | 0.98 | 0.12 | 0.12 | 0.33 | 0.36 | 0.39 | 2.8 | 0.13 | 0.14 |
| Middle River Bullfrog | 0.61 | 0.61 | 1.71 | 1.88 | 2.07 | NA | NA | NA | 0.75 | 0.75 | 2.09 | 2.30 | 2.53 | 1.9 | 1.2 | 1.3 | 0.29 | 0.29 | 0.82 | 0.90 | 0.99 | 2.1 | 0.4 | 0.5 |
| Old River near Paradise Cut [c] | 0.68 | 0.68 | 1.89 | 2.08 | 2.29 | NA | NA | NA | 0.84 | 0.84 | 2.35 | 2.59 | 2.84 | 2.4 | 1.1 | 1.2 | 0.43 | 0.43 | 1.22 | 1.34 | 1.47 | NA | NA | NA |
| Knights Landing [d] | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | NA | NA | NA | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | 2.2 | 0.3 | 0.4 | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | NA | NA | NA |
| Vernalis [e] | 0.83 | 0.83 | 2.32 | 2.56 | 2.81 | 1.7 | 1.50 | 1.65 | 0.85 | 0.85 | 2.38 | 2.62 | 2.88 | 1.9 | 1.38 | 1.52 | 0.58 | 0.58 | 1.62 | 1.79 | 1.97 | 2.4 | 0.74 | 0.82 |
| **Third Quarter** | | | | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.09 | 0.25 | 0.28 | 0.30 | 2.6 | 0.11 | 0.12 | 0.09 | 0.09 | 0.25 | 0.28 | 0.31 | 1.5 | 0.19 | 0.21 | 0.09 | 0.09 | 0.25 | 0.28 | 0.31 | 1.8 | 0.15 | 0.17 |

| DSM2 Delta Water Location | Year 2000 | | | | | | | | Year 2005 | | | | | | | | Year 2007 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Concentration | | | | | Measured Whole Large mouth Bass [a] | Fish-to-Bass Ratio | | Concentration | | | | | Measured Whole Large mouth Bass [a] | Fish-to-Bass Ratio | | Concentration | | | | | Measured Whole Large mouth Bass [a] | Fish-to-Bass Ratio | |
| | Modeled Water | Particulate from Water | Invertebrate from Particulate | Model 1 Fish | Model 2 Fish | | Model 1 | Model 2 | Modeled Water [e] | Particulate from Water | Invertebrate from Particulate | Model 1 Fish | Model 2 Fish | | Model 1 | Model 2 | Modeled Water [e] | Particulate from Water | Invertebrate from Particulate | Model 1 Fish | Model 2 Fish | | Model 1 | Mode l 2 |
| Cache Slough at Ryer Island [b] | 0.11 | 0.11 | 0.31 | 0.34 | 0.37 | 1.5 | 0.22 | 0.25 | 0.09 | 0.09 | 0.25 | 0.28 | 0.31 | 1.7 | 0.16 | 0.18 | 0.10 | 0.10 | 0.29 | 0.32 | 0.35 | 2.5 | 0.13 | 0.14 |
| San Joaquin River Potato Slough | 0.10 | 0.10 | 0.27 | 0.30 | 0.32 | 1.4 | 0.22 | 0.24 | 0.10 | 0.10 | 0.27 | 0.30 | 0.33 | 1.3 | 0.23 | 0.25 | 0.10 | 0.10 | 0.27 | 0.30 | 0.33 | 2.5 | 0.12 | 0.13 |
| Franks Tract | 0.10 | 0.10 | 0.28 | 0.31 | 0.34 | 1.6 | 0.19 | 0.20 | 0.11 | 0.11 | 0.29 | 0.32 | 0.36 | 1.1 | 0.28 | 0.31 | 0.10 | 0.10 | 0.28 | 0.31 | 0.34 | 3.0 | 0.10 | 0.11 |
| Big Break | 0.10 | 0.10 | 0.29 | 0.32 | 0.35 | 1.6 | 0.20 | 0.22 | 0.10 | 0.10 | 0.29 | 0.32 | 0.35 | 1.0 | 0.31 | 0.35 | 0.10 | 0.10 | 0.28 | 0.31 | 0.34 | 2.8 | 0.11 | 0.12 |
| Middle River Bullfrog | 0.20 | 0.20 | 0.57 | 0.63 | 0.69 | NA | NA | NA | 0.30 | 0.30 | 0.83 | 0.91 | 1.01 | 1.9 | 0.5 | 0.5 | 0.12 | 0.12 | 0.32 | 0.36 | 0.39 | 2.1 | 0.2 | 0.2 |
| Old River near Paradise Cut [c] | 0.75 | 0.75 | 2.11 | 2.32 | 2.55 | NA | NA | NA | 0.80 | 0.80 | 2.24 | 2.47 | 2.71 | 2.4 | 1.0 | 1.1 | 0.53 | 0.53 | 1.49 | 1.64 | 1.80 | NA | NA | NA |
| Knights Landing [d] | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | NA | NA | NA | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | 2.2 | 0.3 | 0.4 | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | NA | NA | NA |
| Vernalis [e] | 0.83 | 0.83 | 2.32 | 2.56 | 2.81 | 1.7 | 1.50 | 1.65 | 0.85 | 0.85 | 2.38 | 2.62 | 2.88 | 1.9 | 1.38 | 1.52 | 0.58 | 0.58 | 1.62 | 1.79 | 1.97 | 2.4 | 0.74 | 0.82 |
| **Fourth Quarter** | | | | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.09 | 0.25 | 0.28 | 0.30 | 2.6 | 0.11 | 0.12 | 0.09 | 0.09 | 0.25 | 0.28 | 0.31 | 1.5 | 0.19 | 0.21 | 0.09 | 0.09 | 0.25 | 0.28 | 0.30 | 1.8 | 0.15 | 0.17 |
| Cache Slough at Ryer Island [b] | 0.10 | 0.10 | 0.29 | 0.31 | 0.35 | 1.5 | 0.21 | 0.23 | 0.09 | 0.09 | 0.26 | 0.28 | 0.31 | 1.7 | 0.16 | 0.18 | 0.10 | 0.10 | 0.28 | 0.31 | 0.34 | 2.5 | 0.12 | 0.13 |
| San Joaquin River Potato Slough | 0.09 | 0.09 | 0.26 | 0.29 | 0.32 | 1.4 | 0.21 | 0.23 | 0.09 | 0.09 | 0.25 | 0.28 | 0.31 | 1.3 | 0.21 | 0.24 | 0.09 | 0.09 | 0.26 | 0.29 | 0.32 | 2.5 | 0.12 | 0.13 |
| Franks Tract | 0.10 | 0.10 | 0.27 | 0.29 | 0.32 | 1.6 | 0.18 | 0.20 | 0.09 | 0.09 | 0.26 | 0.28 | 0.31 | 1.1 | 0.25 | 0.27 | 0.10 | 0.10 | 0.27 | 0.30 | 0.32 | 3.0 | 0.10 | 0.11 |
| Big Break | 0.10 | 0.10 | 0.27 | 0.30 | 0.33 | 1.6 | 0.19 | 0.21 | 0.09 | 0.09 | 0.26 | 0.28 | 0.31 | 1.0 | 0.28 | 0.31 | 0.10 | 0.10 | 0.27 | 0.30 | 0.33 | 2.8 | 0.11 | 0.12 |
| Middle River Bullfrog | 0.30 | 0.30 | 0.84 | 0.92 | 1.01 | NA | NA | NA | 0.24 | 0.24 | 0.68 | 0.74 | 0.82 | 1.9 | 0.4 | 0.4 | 0.17 | 0.17 | 0.47 | 0.52 | 0.57 | 2.1 | 0.2 | 0.3 |
| Old River near Paradise Cut [c] | 0.81 | 0.81 | 2.27 | 2.50 | 2.75 | NA | NA | NA | 0.72 | 0.72 | 2.01 | 2.21 | 2.43 | 2.4 | 0.9 | 1.0 | 0.57 | 0.57 | 1.59 | 1.75 | 1.93 | NA | NA | NA |
| Knights Landing [d] | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | NA | NA | NA | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | 2.2 | 0.3 | 0.4 | 0.23 | 0.23 | 0.64 | 0.71 | 0.78 | NA | NA | NA |
| Vernalis [e] | 0.83 | 0.83 | 2.32 | 2.56 | 2.81 | 1.7 | 1.50 | 1.65 | 0.85 | 0.85 | 2.38 | 2.62 | 2.88 | 1.9 | 1.38 | 1.52 | 0.58 | 0.58 | 1.62 | 1.79 | 1.97 | 2.4 | 0.74 | 0.82 |

Equations from Presser and Luoma (2010a, 2010b) were used to calculate selenium concentrations for fish. Models 1 and 2 used the default $K_d$ (1000) and the average selenium trophic transfer factors to aquatic insects (2.8) and fish (1.1 for all trophic levels).
Model 1 = Trophic level 3 fish-eating invertebrates.
Model 2 = Trophic level 4 fish-eating trophic level 3 fish.
[a] Geometric mean calculated from whole largemouth bass data presented in Foe (2010).
[b] Fish data collected at Rio Vista (Foe 2010) were used to calculate geometric mean whole largemouth bass and ratios.
[c] Fish data collected at Old River near Tracy (Foe 2010) were used to calculate geometric mean whole largemouth bass and ratios.
[d] Geometric mean of total selenium concentrations in water collected from years 2004, 2007, and 2008 (California Department of Water Resources 2009) was used to estimate selenium concentrations in particulates and biota. Fish data collected from Sacramento River at Veterans Bridge (Foe 2010) were used to calculate geometric mean whole largemouth bass and ratios.
[e] Geometric mean of selenium concentrations (total or dissolved was not specified) in water collected from years 1999–2000 (State Water Resources Control Board 2009) was used to estimate Year 2000 selenium concentrations in particulates and biota (DSM2 data were not available); years 2004-2005 were used for Year 2005 estimates; and years 2006–2007 were used for Year 2007 estimates.
$K_d$ = particulate concentration/water concentration ratio; NA = not available; bass not collected here.

**Table 6B-34. Selenium Bioaccumulation from Water (in micrograms per liter) to Particulates and Fish (in micrograms per gram dry weight) Using Model 3 with Estimated $K_d$ from All Years Regression**

| | Year 2000 | | | | | | | Year 2005 | | | | | | | Year 2007 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Concentration | | | | | Measured Whole | Fish-to-Bass Ratio | Concentration | | | | | Measured Whole | Fish-to-Bass Ratio | Concentration | | | | | Measured Whole | Fish-to-Bass Ratio |
| DSM2 Delta Water Location | Modeled Water | Particulate from Water | Invertebrate from Particulate | Model 3 Fish | $K_d$ | Large mouth Bass [a] | Model 3 | Modeled Water | Particulate from Water | Invertebrate from Particulate | Model 3 Fish | $K_d$ | Large mouth Bass [a] | Model 3 | Modeled Water | Particulate from Water | Invertebrate from Particulate | Model 3 Fish | $K_d$ | Largemouth Bass [a] | Model 3 |
| **First Quarter** | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.54 | 1.50 | 1.81 | 6061 | 2.6 | 0.69 | 0.09 | 0.54 | 1.50 | 1.81 | 5945 | 1.5 | 1.25 | 0.09 | 0.54 | 1.50 | 1.81 | 5946 | 1.8 | 0.98 |
| Cache Slough at Ryer Island [b] | 0.10 | 0.54 | 1.50 | 1.82 | 5389 | 1.5 | 1.22 | 0.09 | 0.54 | 1.50 | 1.82 | 5783 | 1.7 | 1.05 | 0.09 | 0.54 | 1.50 | 1.81 | 5852 | 2.5 | 0.71 |
| San Joaquin River Potato Slough | 0.17 | 0.55 | 1.50 | 1.85 | 3229 | 1.4 | 1.36 | 0.14 | 0.54 | 1.52 | 1.84 | 3724 | 1.3 | 1.41 | 0.09 | 0.54 | 1.50 | 1.81 | 5819 | 2.5 | 0.73 |
| Franks Tract | 0.19 | 0.55 | 1.53 | 1.85 | 2904 | 1.6 | 1.13 | 0.15 | 0.54 | 1.52 | 1.84 | 3724 | 1.1 | 1.61 | 0.09 | 0.54 | 1.50 | 1.82 | 5762 | 3.0 | 0.61 |
| Big Break | 0.13 | 0.54 | 1.51 | 1.83 | 4295 | 1.6 | 1.18 | 0.11 | 0.54 | 1.51 | 1.82 | 4873 | 1.0 | 1.79 | 0.09 | 0.54 | 1.50 | 1.81 | 5850 | 2.8 | 0.64 |
| Middle River Bullfrog | 0.31 | 0.56 | 1.56 | 1.88 | 1801 | NA | NA | 0.46 | 0.56 | 1.57 | 1.90 | 1221 | 1.9 | 1.0 | 0.20 | 0.55 | 1.53 | 1.86 | 2773 | 2.1 | 0.87 |
| Old River near Paradise Cut [3] | 0.73 | 0.57 | 1.60 | 1.93 | 780 | NA | NA | 0.78 | 0.57 | 1.60 | 1.94 | 729 | 2.4 | 0.8 | 0.56 | 0.57 | 1.58 | 1.95 | 1007 | NA | NA |
| Knights Landing [4] | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | NA | NA | 0.23 | 0.55 | 1.64 | 1.87 | 2394 | 2.2 | 0.8 | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | NA | NA |
| Vernalis [5] | 0.83 | 0.57 | 1.60 | 1.94 | 689 | 1.7 | 1.14 | 0.85 | 0.57 | 1.60 | 1.94 | 674 | 1.9 | 1.02 | 0.58 | 0.57 | 1.59 | 1.92 | 976 | 2.4 | 0.80 |
| **Second Quarter** | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.54 | 1.50 | 1.81 | 5952 | 2.6 | 0.69 | 0.09 | 0.54 | 1.50 | 1.81 | 5947 | 1.5 | 1.25 | 0.09 | 0.54 | 1.50 | 1.81 | 5944 | 1.8 | 0.98 |
| Cache Slough at Ryer Island [b] | 0.11 | 0.54 | 1.51 | 1.83 | 4777 | 1.5 | 1.22 | 0.10 | 0.54 | 1.50 | 1.82 | 5538 | 1.7 | 1.05 | 0.10 | 0.54 | 1.50 | 1.82 | 5241 | 2.5 | 0.72 |
| San Joaquin River Potato Slough | 0.24 | 0.55 | 1.54 | 1.87 | 2309 | 1.4 | 1.38 | 0.36 | 0.56 | 1.56 | 1.89 | 1537 | 1.3 | 1.45 | 0.13 | 0.54 | 1.52 | 1.84 | 4020 | 2.5 | 0.74 |
| Franks Tract | 0.27 | 0.55 | 1.55 | 1.87 | 2048 | 1.6 | 1.14 | 0.49 | 0.56 | 1.58 | 1.91 | 1159 | 1.1 | 1.67 | 0.14 | 0.54 | 1.52 | 1.84 | 3921 | 3.0 | 0.61 |
| Big Break | 0.20 | 0.55 | 1.53 | 1.86 | 2800 | 1.6 | 1.20 | 0.30 | 0.55 | 1.55 | 1.88 | 1876 | 1.0 | 1.84 | 0.12 | 0.54 | 1.51 | 1.83 | 4645 | 2.8 | 0.64 |
| Middle River Bullfrog | 0.61 | 0.57 | 1.59 | 1.92 | 928 | NA | NA | 0.75 | 0.57 | 1.60 | 1.93 | 764 | 1.9 | 1.0 | 0.29 | 0.55 | 1.55 | 1.88 | 1896 | 2.1 | 0.9 |
| Old River near Paradise Cut [c] | 0.68 | 0.57 | 1.59 | 1.93 | 842 | NA | NA | 0.84 | 0.57 | 1.60 | 1.94 | 682 | 2.4 | 0.8 | 0.43 | 0.56 | 1.57 | 1.90 | 1291 | NA | NA |
| Knights Landing [d] | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | NA | NA | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | 2.2 | 0.8 | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | NA | NA |
| Vernalis [e] | 0.83 | 0.57 | 1.60 | 1.94 | 689 | 1.7 | 1.14 | 0.85 | 0.57 | 1.60 | 1.94 | 674 | 1.9 | 1.02 | 0.58 | 0.57 | 1.59 | 1.92 | 976 | 2.4 | 0.80 |
| **Third Quarter** | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.54 | 1.50 | 1.81 | 5947 | 2.6 | 0.69 | 0.09 | 0.54 | 1.50 | 1.81 | 5946 | 1.5 | 1.25 | 0.09 | 0.54 | 1.50 | 1.81 | 5946 | 1.8 | 0.98 |
| Cache Slough at Ryer Island [b] | 0.11 | 0.54 | 1.51 | 1.82 | 4942 | 1.5 | 1.22 | 0.09 | 0.54 | 1.50 | 1.81 | 5914 | 1.7 | 1.05 | 0.10 | 0.54 | 1.51 | 1.82 | 5184 | 2.5 | 0.72 |
| San Joaquin River Potato Slough | 0.10 | 0.54 | 1.50 | 1.82 | 5592 | 1.4 | 1.34 | 0.10 | 0.54 | 1.50 | 1.82 | 5523 | 1.3 | 1.39 | 0.10 | 0.54 | 1.50 | 1.82 | 5557 | 2.5 | 0.73 |
| Franks Tract | 0.10 | 0.54 | 1.50 | 1.82 | 5412 | 1.6 | 1.10 | 0.11 | 0.54 | 1.51 | 1.82 | 5121 | 1.1 | 1.59 | 0.10 | 0.54 | 1.50 | 1.82 | 5393 | 3.0 | 0.61 |
| Big Break | 0.10 | 0.54 | 1.50 | 1.82 | 5227 | 1.6 | 1.17 | 0.10 | 0.54 | 1.51 | 1.82 | 5159 | 1.0 | 1.79 | 0.10 | 0.54 | 1.50 | 1.82 | 5291 | 2.8 | 0.64 |
| Middle River Bullfrog | 0.20 | 0.55 | 1.54 | 1.86 | 2688 | NA | NA | 0.30 | 0.55 | 1.55 | 1.88 | 1868 | 1.9 | 1.0 | 0.12 | 0.54 | 1.51 | 1.83 | 4656 | 2.1 | 0.86 |
| Old River near Paradise Cut [c] | 0.75 | 0.57 | 1.60 | 1.93 | 757 | NA | NA | 0.80 | 0.57 | 1.60 | 1.94 | 714 | 2.4 | 0.8 | 0.53 | 0.56 | 1.58 | 1.91 | 1061 | NA | NA |
| Knights Landing [d] | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | NA | NA | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | 2.2 | 0.8 | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | NA | NA |
| Vernalis [e] | 0.83 | 0.57 | 1.60 | 1.94 | 689 | 1.7 | 1.14 | 0.85 | 0.57 | 1.60 | 1.94 | 674 | 1.9 | 1.02 | 0.58 | 0.57 | 1.59 | 1.92 | 976 | 2.4 | 0.80 |

| DSM2 Delta Water Location | Year 2000 | | | | | | | Year 2005 | | | | | | | Year 2007 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Concentration | | | | | Measured Whole | Fish-to-Bass Ratio | Concentration | | | | | Measured Whole | Fish-to-Bass Ratio | Concentration | | | | | Measured Whole | Fish-to-Bass Ratio |
| | Modeled Water | Particulate from Water | Invertebrate from Particulate | Model 3 Fish | $K_d$ | Large mouth Bass [a] | Model 3 | Modeled Water | Particulate from Water | Invertebrate from Particulate | Model 3 Fish | $K_d$ | Large mouth Bass [a] | Model 3 | Modeled Water | Particulate from Water | Invertebrate from Particulate | Model 3 Fish | $K_d$ | Largemouth Bass [a] | Model 3 |
| **Fourth Quarter** | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.54 | 1.50 | 1.81 | 5948 | 2.6 | 0.69 | 0.09 | 0.54 | 1.50 | 1.82 | 5946 | 1.5 | 1.25 | 0.09 | 0.54 | 1.50 | 1.81 | 5947 | 1.8 | 0.98 |
| Cache Slough at Ryer Island [b] | 0.10 | 0.54 | 1.50 | 1.82 | 5261 | 1.5 | 1.22 | 0.09 | 0.54 | 1.50 | 1.81 | 5830 | 1.7 | 1.05 | 0.10 | 0.54 | 1.50 | 1.82 | 5345 | 2.5 | 0.71 |
| San Joaquin River Potato Slough | 0.09 | 0.54 | 1.50 | 1.82 | 5704 | 1.4 | 1.34 | 0.09 | 0.54 | 1.50 | 1.81 | 5885 | 1.3 | 1.39 | 0.09 | 0.54 | 1.50 | 1.82 | 5678 | 2.5 | 0.73 |
| Franks Tract | 0.10 | 0.54 | 1.50 | 1.82 | 5621 | 1.6 | 1.10 | 0.09 | 0.54 | 1.50 | 1.81 | 5859 | 1.1 | 1.59 | 0.10 | 0.54 | 1.50 | 1.82 | 5678 | 3.0 | 0.61 |
| Big Break | 0.10 | 0.54 | 1.50 | 1.82 | 5534 | 1.6 | 1.17 | 0.09 | 0.54 | 1.50 | 1.82 | 5809 | 1.0 | 1.78 | 0.10 | 0.54 | 1.50 | 1.82 | 5470 | 2.8 | 0.64 |
| Middle River Bullfrog | 0.30 | 0.55 | 1.55 | 1.88 | 1859 | NA | NA | 0.24 | 0.55 | 1.54 | 1.87 | 2283 | 1.9 | 1.0 | 0.17 | 0.55 | 1.53 | 1.85 | 3241 | 2.1 | 0.87 |
| Old River near Paradise Cut [c] | 0.81 | 0.57 | 1.60 | 1.94 | 704 | NA | NA | 0.72 | 0.57 | 1.60 | 1.93 | 794 | 2.4 | 0.8 | 0.57 | 0.57 | 1.58 | 1.92 | 994 | NA | NA |
| Knights Landing [d] | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | NA | NA | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | 2.2 | 0.8 | 0.23 | 0.55 | 1.54 | 1.87 | 2394 | NA | NA |
| Vernalis [e] | 0.83 | 0.57 | 1.60 | 1.94 | 689 | 1.7 | 1.14 | 0.85 | 0.57 | 1.60 | 1.94 | 676 | 1.9 | 1.02 | 0.58 | 0.57 | 1.59 | 1.92 | 976 | 2.4 | 0.80 |

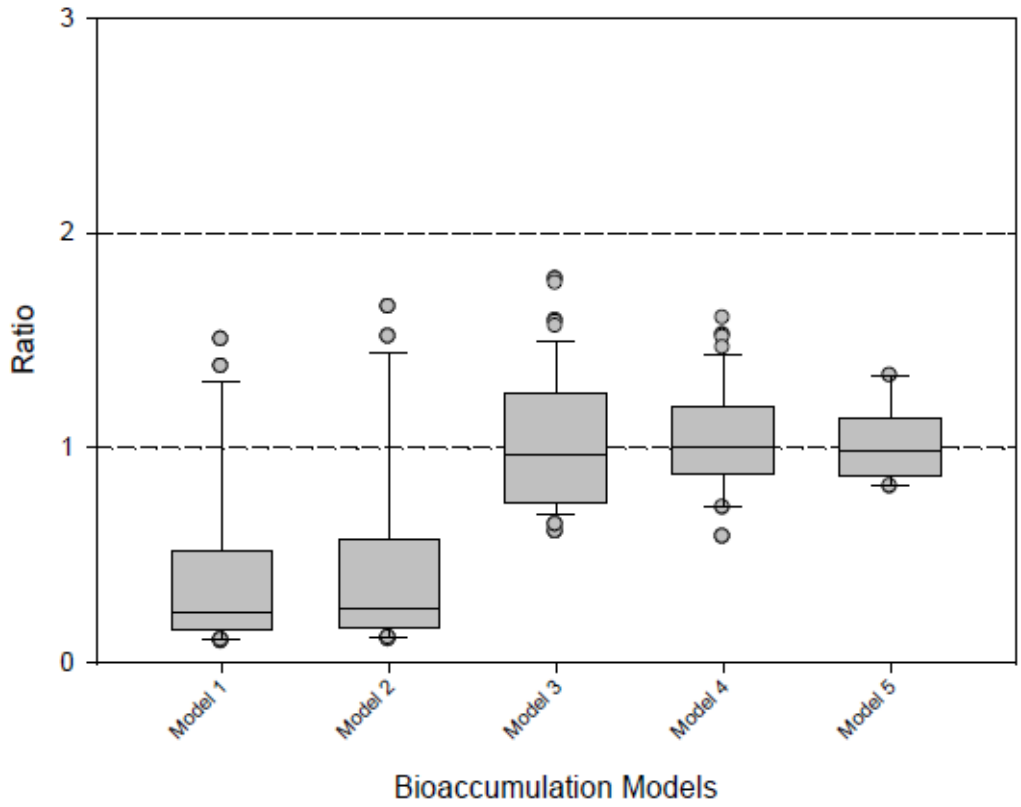
Equations from Presser and Luoma (2010a, 2010b) were used to calculate selenium concentrations for fish. Model 3 used the average selenium trophic transfer factors to aquatic insects (2.8) and fish (1.1 for all trophic levels).
Model 3 = Model 2 (trophic level 4 fish-eating trophic level 3 fish) with $K_d$ estimated using all years regression (log $K_d$ = 2.76-0.97(logDSM2))
[a] Geometric mean calculated from whole largemouth bass data presented in Foe (2010).
[b] Fish data collected at Rio Vista (Foe 2010) were used to calculate geometric mean whole largemouth bass and ratios.
[c] Fish data collected at Old River near Tracy (Foe 2010) were used to calculate geometric mean whole largemouth bass and ratios.
[d] Geometric mean of total selenium concentrations in water collected from years 2004, 2007, and 2008 (California Department of Water Resources 2009) was used to estimate selenium concentrations in particulates and biota. Fish data collected from Sacramento River at Veterans Bridge (Foe 2010) were used to calculate geometric mean whole largemouth bass and ratios.
$K_d$ = particulate concentration/water concentration ratio;
NA = not available; bass not collected here.

**Table 6B-35. Selenium Bioaccumulation from Water (in micrograms per liter) to Particulates and Fish (in micrograms per gram dry weight) Using Estimated $K_d$ from Above Normal and Wet Years Regression for Model 4 and Dry Years Regression for Model 5**

| | Year 2000 | | | | | | | Year 2005 | | | | | | | Year 2007 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Concentration | | | | | Measured Whole | Fish-to-Bass Ratio | Concentration | | | | | Measured Whole | Fish-to-Bass Ratio | Concentration | | | | | Measured Whole | Fish-to-Bass Ratio |
| DSM2 Delta Water Location | Modeled Water | Particulate from Water | Invert. from Particulate | Model 4 Fish | $K_d$ | Large mouth Bass [a] | Model 4 | Modeled Water | Particulate from Water | Invert. from Particulate | Model 4 Fish | $K_d$ | Large mouth Bass [1] | Model 4 | Modeled Water | Particulate from Water | Invert. from Particulate | Model 5 Fish | $K_d$ | Large mouth Bass [a] | Model 5 |
| **First Quarter** | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.44 | 1.24 | 1.49 | 4997 | 2.6 | 0.57 | 0.09 | 0.44 | 1.24 | 1.50 | 4909 | 1.5 | 1.03 | 0.09 | 0.73 | 2.03 | 2.46 | 8063 | 1.8 | 1.33 |
| Cache Slough at Ryer Island [b] | 0.10 | 0.45 | 1.25 | 1.51 | 4481 | 1.5 | 1.01 | 0.09 | 0.44 | 1.24 | 1.50 | 4784 | 1.7 | 0.87 | 0.09 | 0.73 | 2.03 | 2.46 | 7929 | 2.5 | 0.97 |
| San Joaquin River Potato Slough | 0.17 | 0.47 | 1.32 | 1.59 | 2786 | 1.4 | 1.17 | 0.14 | 0.46 | 1.30 | 1.57 | 3260 | 1.3 | 1.20 | 0.09 | 0.73 | 2.03 | 2.46 | 7883 | 2.5 | 0.99 |
| Franks Tract | 0.19 | 0.48 | 1.33 | 1.61 | 2525 | 1.6 | 0.98 | 0.15 | 0.46 | 1.30 | 1.57 | 3181 | 1.1 | 1.37 | 0.09 | 0.73 | 2.03 | 2.46 | 7802 | 3.0 | 0.82 |
| Big Break | 0.13 | 0.46 | 1.28 | 1.55 | 3630 | 1.6 | 1.00 | 0.11 | 0.45 | 1.26 | 1.53 | 4082 | 1.0 | 1.50 | 0.09 | 0.73 | 2.03 | 2.46 | 7926 | 2.8 | 0.87 |
| Middle River Bullfrog | 0.31 | 0.50 | 1.40 | 1.69 | 1621 | NA | NA | 0.46 | 0.52 | 1.46 | 1.76 | 1130 | 1.9 | 0.90 | 0.20 | 0.71 | 2.00 | 2.42 | 3616 | 2.1 | 1.14 |
| Old River near Paradise Cut [c] | 0.73 | 0.55 | 1.53 | 1.85 | 745 | NA | NA | 0.78 | 0.55 | 1.54 | 1.86 | 700 | 2.4 | 0.80 | 0.56 | 0.70 | 1.96 | 2.37 | 1247 | NA | NA |
| Knights Landing [d] | 0.23 | 0.49 | 1.36 | 1.64 | 2111 | NA | NA | 0.23 | 0.49 | 1.36 | 1.64 | 2111 | 2.2 | 0.70 | 0.23 | 0.71 | 1.99 | 2.41 | 3098 | NA | NA |
| Vernalis [e] | 0.83 | 0.52 | 1.55 | 1.87 | 665 | 1.7 | 1.10 | 0.85 | 0.55 | 1.55 | 1.87 | 651 | 1.9 | 0.99 | 0.58 | 0.70 | 1.96 | 2.37 | 1206 | 2.4 | 0.99 |
| **Second Quarter** | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.44 | 1.24 | 1.50 | 4914 | 2.6 | 0.57 | 0.09 | 0.44 | 1.24 | 1.50 | 4910 | 1.5 | 1.03 | 0.09 | 0.73 | 2.03 | 2.46 | 8061 | 1.8 | 1.33 |
| Cache Slough at Ryer Island [b] | 0.11 | 0.45 | 1.27 | 1.53 | 4007 | 1.5 | 1.03 | 0.10 | 0.45 | 1.25 | 1.51 | 4596 | 1.7 | 0.87 | 0.10 | 0.72 | 2.03 | 2.45 | 7061 | 2.5 | 0.96 |
| San Joaquin River Potato Slough | 0.24 | 0.49 | 1.36 | 1.65 | 2041 | 1.4 | 1.22 | 0.36 | 0.51 | 1.42 | 1.72 | 1399 | 1.3 | 1.32 | 0.13 | 0.72 | 2.02 | 2.44 | 5343 | 2.5 | 0.98 |
| Franks Tract | 0.27 | 0.49 | 1.38 | 1.67 | 1826 | 1.6 | 1.02 | 0.49 | 0.52 | 1.46 | 1.77 | 1077 | 1.1 | 1.55 | 0.14 | 0.72 | 2.02 | 2.44 | 5204 | 3.0 | 0.82 |
| Big Break | 0.20 | 0.48 | 1.34 | 1.62 | 2441 | 1.6 | 1.04 | 0.30 | 0.50 | 1.39 | 1.69 | 1683 | 1.0 | 1.65 | 0.12 | 0.72 | 2.02 | 2.45 | 6220 | 2.8 | 0.86 |
| Middle River Bullfrog | 0.61 | 0.54 | 1.50 | 1.81 | 876 | NA | NA | 0.75 | 0.55 | 1.53 | 1.85 | 732 | 1.9 | 1.00 | 0.29 | 0.71 | 1.99 | 2.40 | 2424 | 2.1 | 1.1 |
| Old River near Paradise Cut [c] | 0.68 | 0.54 | 1.51 | 1.83 | 801 | NA | NA | 0.84 | 0.55 | 1.55 | 1.87 | 658 | 2.4 | 0.80 | 0.43 | 0.70 | 1.97 | 2.38 | 1617 | NA | NA |
| Knights Landing [d] | 0.23 | 0.49 | 1.36 | 1.64 | 2111 | NA | NA | 0.23 | 0.49 | 1.36 | 1.64 | 2111 | 2.2 | 0.70 | 0.23 | 0.71 | 1.99 | 2.41 | 3098 | NA | NA |
| Vernalis [e] | 0.83 | 0.55 | 1.55 | 1.87 | 665 | 1.7 | 1.10 | 0.85 | 0.55 | 1.55 | 1.87 | 651 | 1.9 | 0.99 | 0.58 | 0.70 | 1.96 | 2.37 | 1206 | 2.4 | 0.99 |
| **Third Quarter** | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.44 | 1.24 | 1.50 | 4910 | 2.6 | 0.57 | 0.09 | 0.44 | 1.24 | 1.50 | 4910 | 1.5 | 1.03 | 0.09 | 0.73 | 2.03 | 2.46 | 8064 | 1.8 | 1.33 |
| Cache Slough at Ryer Island [b] | 0.11 | 0.45 | 1.26 | 1.53 | 4135 | 1.5 | 1.02 | 0.09 | 0.44 | 1.24 | 1.50 | 4885 | 1.7 | 0.87 | 0.10 | 0.72 | 2.03 | 2.45 | 6980 | 2.5 | 0.96 |
| San Joaquin River Potato Slough | 0.10 | 0.44 | 1.25 | 1.51 | 4637 | 1.4 | 1.11 | 0.10 | 0.45 | 1.25 | 1.51 | 4584 | 1.3 | 1.15 | 0.10 | 0.72 | 2.03 | 2.46 | 7510 | 2.5 | 0.99 |
| Franks Tract | 0.10 | 0.45 | 1.25 | 1.51 | 4499 | 1.6 | 0.92 | 0.11 | 0.45 | 1.26 | 1.52 | 4274 | 1.1 | 1.33 | 0.10 | 0.72 | 2.03 | 2.45 | 7276 | 3.0 | 0.82 |
| Big Break | 0.10 | 0.45 | 1.25 | 1.52 | 4356 | 1.6 | 0.98 | 0.10 | 0.45 | 1.26 | 1.52 | 4304 | 1.0 | 1.49 | 0.10 | 0.72 | 2.03 | 2.45 | 7131 | 2.8 | 0.87 |
| Middle River Bullfrog | 0.20 | 0.48 | 1.34 | 1.63 | 2350 | NA | NA | 0.30 | 0.50 | 1.39 | 1.69 | 1677 | 1.9 | 0.90 | 0.12 | 0.72 | 2.02 | 2.45 | 6235 | 2.1 | 1.15 |
| Old River near Paradise Cut [c] | 0.75 | 0.55 | 1.53 | 1.85 | 725 | NA | NA | 0.80 | 0.55 | 1.54 | 1.86 | 687 | 2.4 | 0.80 | 0.53 | 0.70 | 1.96 | 2.37 | 1317 | NA | NA |
| Knights Landing [d] | 0.23 | 0.49 | 1.36 | 1.64 | 2111 | NA | NA | 0.23 | 0.49 | 1.36 | 1.64 | 2111 | 2.2 | 0.70 | 0.23 | 0.71 | 1.99 | 2.41 | 3098 | NA | NA |
| Vernalis [e] | 0.83 | 0.55 | 1.55 | 1.87 | 665 | 1.7 | 1.10 | 0.85 | 0.55 | 1.55 | 1.87 | 651 | 1.9 | 0.99 | 0.58 | 0.70 | 1.96 | 2.37 | 1206 | 2.4 | 0.99 |
| **Fourth Quarter** | | | | | | | | | | | | | | | | | | | | | |
| Sacramento River Mile 44 | 0.09 | 0.44 | 1.24 | 1.50 | 4911 | 2.6 | 0.57 | 0.09 | 0.44 | 1.24 | 1.50 | 4909 | 1.5 | 1.03 | 0.09 | 0.73 | 2.03 | 2.46 | 8064 | 1.8 | 1.33 |
| Cache Slough at Ryer Island [b] | 0.10 | 0.45 | 1.25 | 1.52 | 4383 | 1.5 | 1.02 | 0.09 | 0.44 | 1.24 | 1.50 | 4820 | 1.7 | 0.87 | 0.10 | 0.72 | 2.03 | 2.45 | 7209 | 2.5 | 0.96 |
| San Joaquin River Potato Slough | 0.09 | 0.44 | 1.24 | 1.50 | 4723 | 1.4 | 1.11 | 0.09 | 0.44 | 1.24 | 1.50 | 4862 | 1.3 | 1.15 | 0.09 | 0.73 | 2.03 | 2.46 | 7682 | 2.5 | 0.99 |
| Franks Tract | 0.10 | 0.44 | 1.24 | 1.51 | 4660 | 1.6 | 0.91 | 0.09 | 0.44 | 1.24 | 1.50 | 4843 | 1.1 | 1.31 | 0.10 | 0.73 | 2.03 | 2.46 | 7564 | 3.0 | 0.82 |

| DSM2 Delta Water Location | Year 2000 | | | | | | | Year 2005 | | | | | | | Year 2007 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Concentration | | | | $K_d$ | Measured Whole | Fish-to-Bass Ratio | Concentration | | | | $K_d$ | Measured Whole | Fish-to-Bass Ratio | Concentration | | | | $K_d$ | Measured Whole | Fish-to-Bass Ratio |
| | Modeled Water | Particulate from Water | Invert. from Particulate | Model 4 Fish | | Large mouth Bass [a] | Model 4 | Modeled Water | Particulate from Water | Invert. from Particulate | Model 4 Fish | | Large mouth Bass [1] | Model 4 | Modeled Water | Particulate from Water | Invert. from Particulate | Model 5 Fish | | Large mouth Bass [a] | Model 5 |
| Big Break | 0.10 | 0.45 | 1.25 | 1.51 | 4593 | 1.6 | 0.97 | 0.09 | 0.44 | 1.24 | 1.50 | 4804 | 1.0 | 1.47 | 0.10 | 0.72 | 2.03 | 2.46 | 7386 | 2.8 | 0.87 |
| Middle River Bullfrog | 0.30 | 0.50 | 1.40 | 1.69 | 1669 | NA | NA | 0.24 | 0.49 | 1.37 | 1.65 | 2020 | 1.9 | 0.90 | 0.17 | 0.72 | 2.01 | 2.43 | 4260 | 2.1 | 1.14 |
| Old River near Paradise Cut [c] | 0.81 | 0.55 | 1.54 | 1.87 | 678 | NA | NA | 0.72 | 0.54 | 1.52 | 1.84 | 759 | 2.4 | 0.80 | 0.57 | 0.70 | 1.96 | 2.37 | 1229 | NA | NA |
| Knights Landing [d] | 0.23 | 0.49 | 1.36 | 1.64 | 2111 | NA | NA | 0.23 | 0.49 | 1.36 | 1.64 | 2111 | 2.2 | 0.70 | 0.23 | 0.71 | 1.99 | 2.41 | 3098 | NA | NA |
| Vernalis [e] | 0.83 | 0.55 | 1.55 | 1.87 | 665 | 1.27 | 1.10 | 0.85 | 0.55 | 1.55 | 1.87 | 651 | 1.9 | 0.99 | 0.58 | 0.70 | 1.96 | 2.37 | 1206 | 2.4 | 0.99 |

Equations from Presser and Luoma (2010a, 2010b) were used to calculate selenium concentrations for fish. Models 4 and 5 used the average selenium trophic transfer factors to aquatic insects (2.8) and fish (1.1 for all trophic levels).
Model 4 = Model 2 (trophic level 4 fish eating trophic level 3 fish) with $K_d$ estimated using normal and wet years regression (log $K_d$ = 2.75-0.90(logDSM2))
Model 5 = Model 2 (trophic level 4 fish eating trophic level 3 fish) with $K_d$ estimated using dry years (2007) regression (log $K_d$ = 2.84-1.02(logDSM2))
[a] Geometric mean calculated from whole largemouth bass data presented in Foe (2010).
[b] Fish data collected at Rio Vista (Foe 2010) were used to calculate geometric mean whole largemouth bass and ratios.
[c] Fish data collected at Old River near Tracy (Foe 2010) were used to calculate geometric mean whole largemouth bass and ratios.
[d] Geometric mean of total selenium concentrations in water collected from years 2004, 2007, and 2008 (California Department of Water Resources 2009) was used to estimate selenium concentrations in particulates and biota (DSM2 data were not available). Fish data collected from Sacramento River at Veterans Bridge (Foe 2010) were used to calculate geometric mean whole largemouth bass and ratios.
$K_d$ = particulate concentration/water concentration ratio
NA = not available; bass not collected here




For Models 1 and 2, default values ($K_d$ = 1000, $TTF_{Invert}$ = 2.8, $TTF_{fish}$ = 1.1) were used in calculations as follows:

Model 1=Trophic level 3 (TL-3) fish eating invertebrates

Model 2= TL-4 fish eating TL-3 fish

Model 3=Model 2 with $K_d$ estimated using all years regression (log Kd = 2.72-1.01(logDSM2))

Model 4=Model 2 with $K_d$ estimated using normal/wet years (2000/2005) regression (log Kd = 2.71-0.95(logDSM2))

Model 5=Model 2 with $K_d$ estimated using dry years (2007) regression (logKd = 2.84-1.02(logDSM2))

**Figure 6B.3-1. Ratios of Predicted Selenium Concentrations in Fish Models 1 through 5 to Observed Selenium Concentrations in Largemouth Bass**

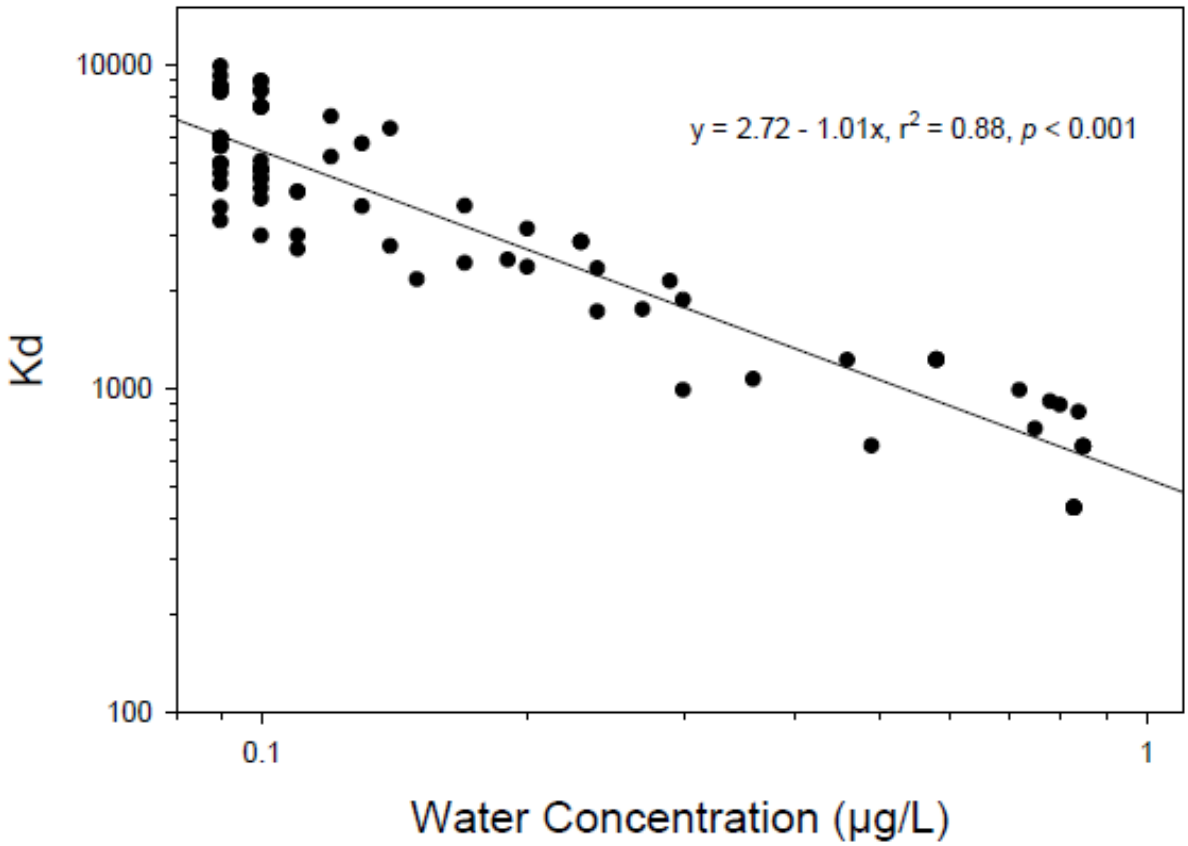



**Figure 6B.3-2. Log-Log Regression Relation of Estimated $K_d$ to Water Column Selenium Concentration for Model 3 in All Years (Based on Years 2000, 2005, and 2007)**

To predict the $K_d$ (y) from water concentrations using the regression equation, take the log of the water concentration (x), multiply it by the slope (-1.01), which gives a positive number for x<1 (i.e., water column selenium concentrations less than 1 µg/L); then add this number to the intercept (2.72) and take the antilog.

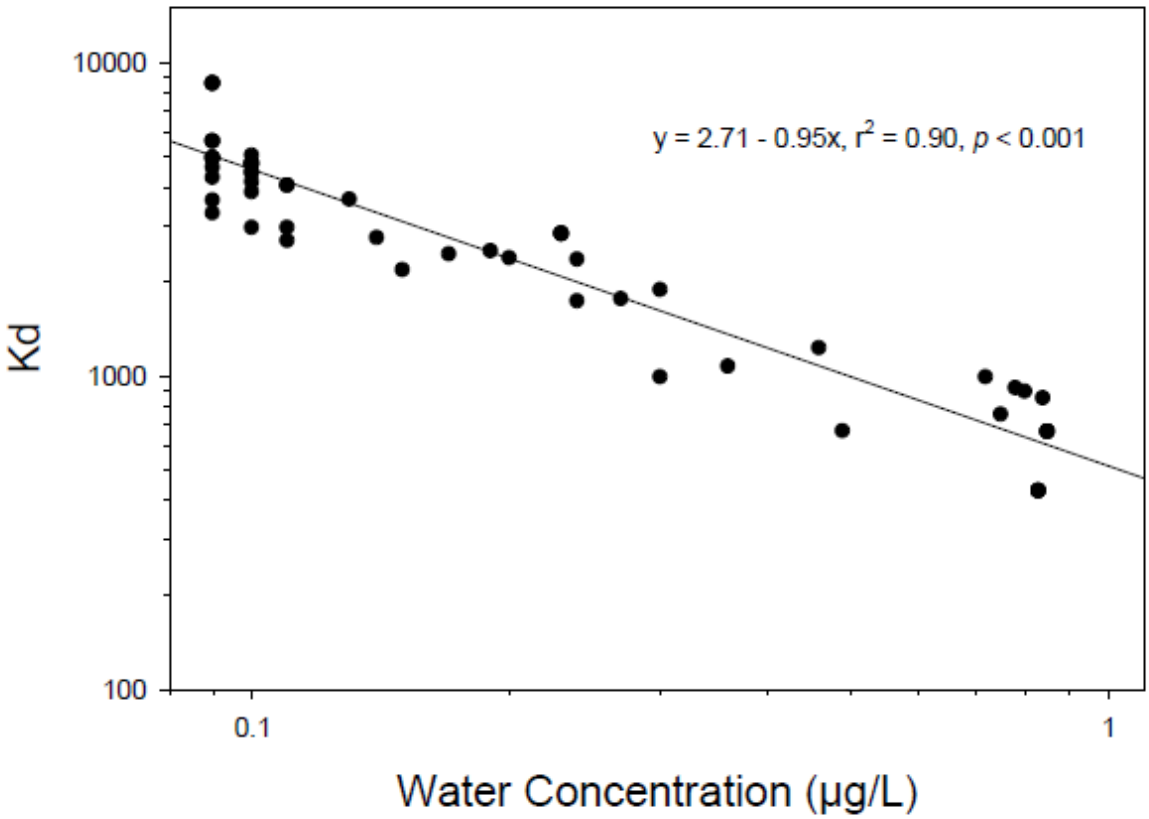



**Figure 6B.3-3. Log-Log Regression Relation of Estimated $K_d$ to Water Column Selenium Concentration for Model 4 in Above Normal/Wet Years (Based on Years 2000 and 2005)**

To predict the $K_d$ (y) from water concentrations using the regression equation, take the log of the water concentration (x), multiply it by the slope (-0.95), which gives a positive number for x<1 (i.e., water column selenium concentrations less than 1 µg/L); then add this number to the intercept (2.71) and take the antilog.

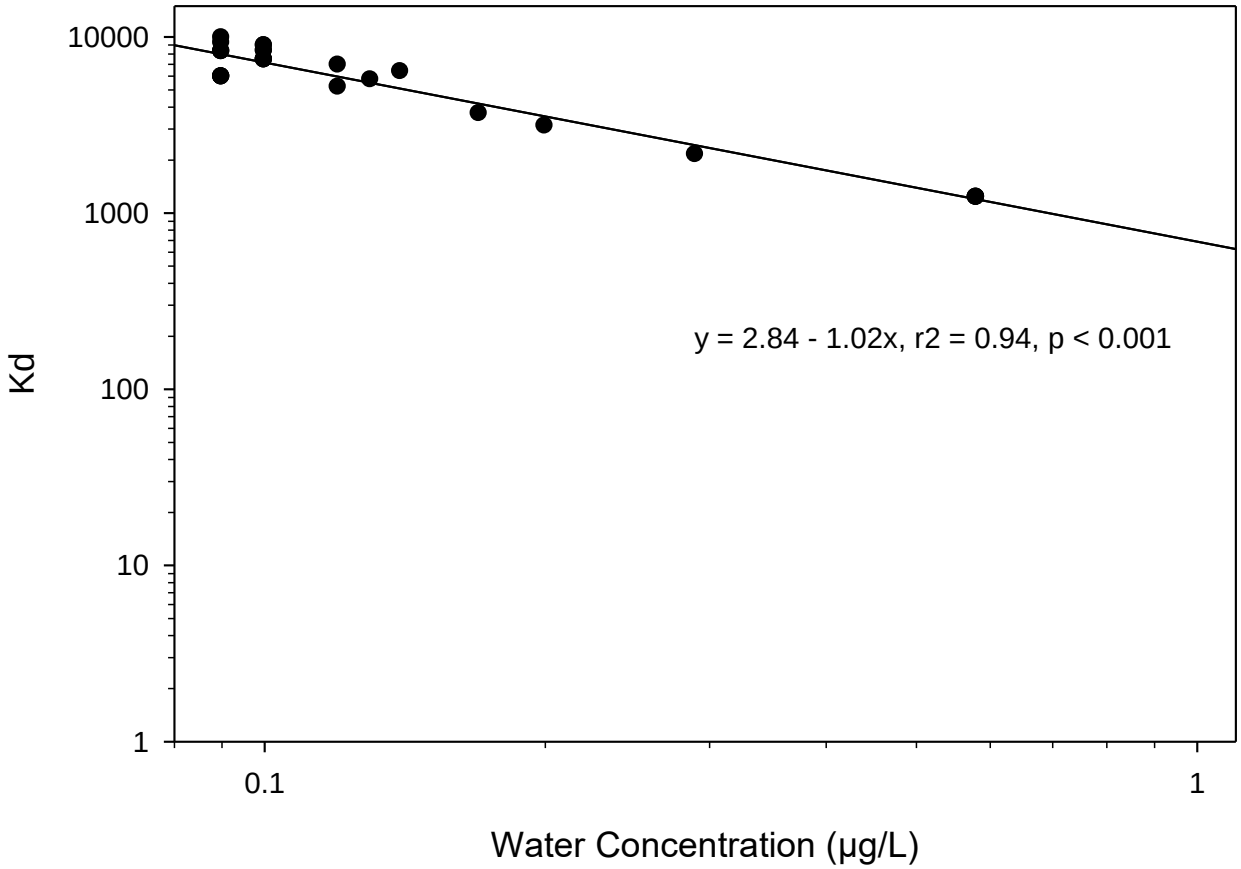



**Figure 6B.3-4. Log-Log Regression Relation of Estimated $K_d$ to Water Column Selenium Concentration for Model 5 in Below Normal, Dry, and Critical Years (Based on Year 2007)**

To predict the $K_d$ (y) from water concentrations using the regression equation, take the log of the water concentration (x), multiply it by the slope (-1.02), which gives a positive number for x<1 (i.e., water column selenium concentrations less than 1 µg/L); then add this number to the intercept (2.84) and take the antilog.

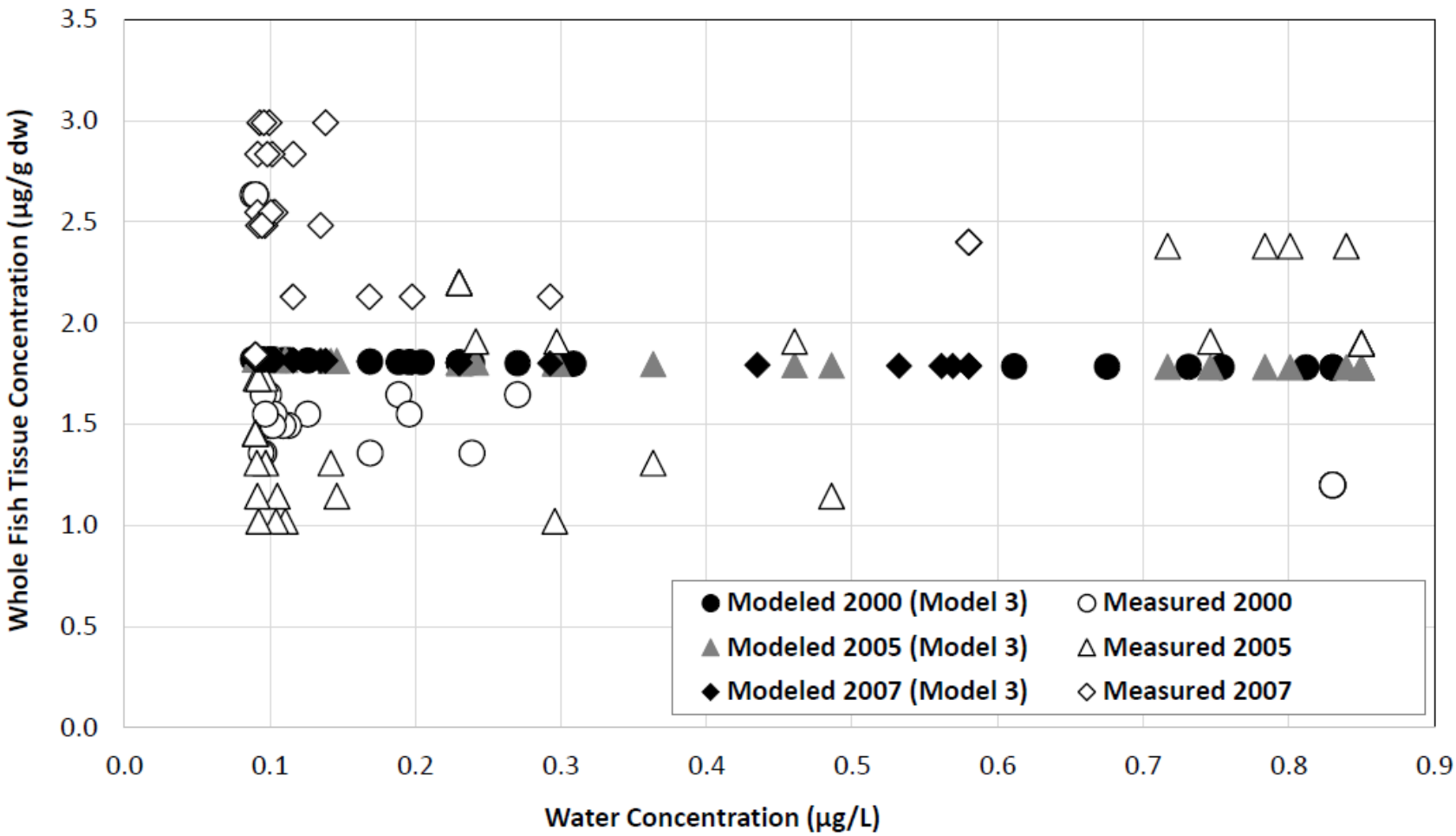



**Figure 6B.3-5. Distribution of Data for Selenium Concentrations in Largemouth Bass Relative to Water Column Selenium for Model 3**

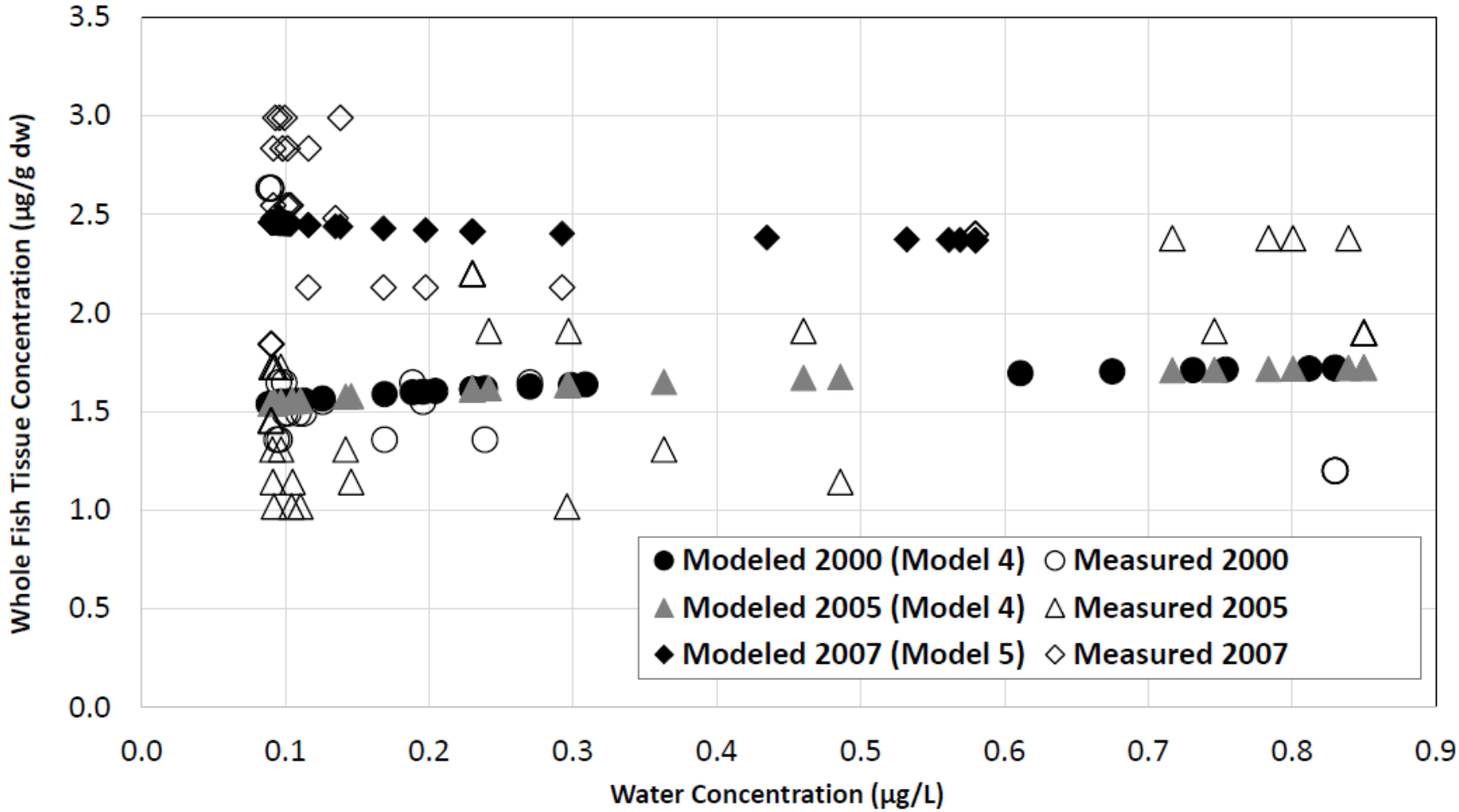



**Figure 6B.3-6. Distribution of Data for Selenium Concentrations in Largemouth Bass Relative to Water Column Selenium for Model 4 and Mode 5**

### 6B.3.2.4 Source Water Concentrations

An input to the mass-balance calculation of selenium concentrations in water at the Delta assessment locations is the concentrations in the primary source waters to the Delta: Sacramento River, San Joaquin River, San Francisco Bay, eastside tributaries (i.e., the Cosumnes, Mokelumne, and Calaveras Rivers), Delta agricultural return waters, and Yolo Bypass. Table 6B-36 provides summary statistics for the primary source water concentrations of dissolved selenium, as well as information on the source of the data. Due to data availability, Yolo Bypass concentrations were set equal to Sacramento River concentrations, which is a primary source of flows to the Yolo Bypass.

Both dissolved and total selenium are suitable for purposes of selenium modeling in this assessment because they typically do not differ greatly in the Delta. However, recent data at the source water locations (e.g., since 2011 in the San Joaquin River at Vernalis) were only available for dissolved selenium. These recent data are most appropriate for this assessment because detection limits have decreased in recent decades and concentrations in the San Joaquin River have decreased due to implementation of selenium TMDLs and the Grasslands Bypass Project (U.S. Environmental Protection Agency 2015:5; San Francisco Bay Regional Water Quality Control Board 2008:2-6). Figure 6B.3-7 presents selenium concentrations in the San Joaquin River at Vernalis over time.

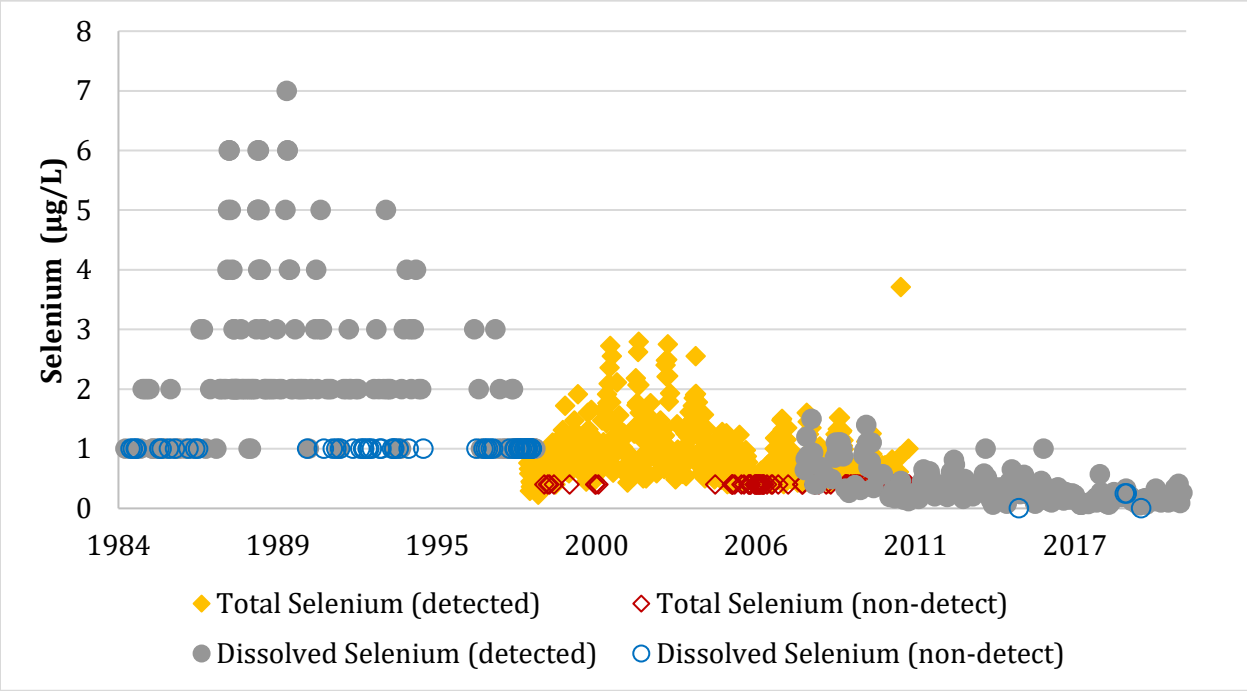



**Figure 6B.3-7. Measured Selenium Concentrations (total and dissolved in micrograms per liter) in the San Joaquin River at Vernalis**

**Table 6B-36. Source Water Dissolved Selenium Concentrations (in micrograms per liter)**

| Data Parameter | Sacramento River | San Joaquin River | San Francisco Bay | Eastside Tributaries | Delta Agriculture Return Waters |
|---|---|---|---|---|---|
| Average | 0.090 | 0.370 | 0.116 | 0.055 | 0.110 |
| Minimum | 0.040 | 0.050 | 0.068 | 0.030 | - |
| Maximum | 0.220 | 1.50 | 0.214 | 0.180 | - |
| 75th percentile | 0.100 | 0.460 | 0.140 | 0.050 | - |
| 99th percentile | 0.198 | 1.21 | 0.211 | 0.168 | - |
| Data source | U.S. Geological Survey 2020 | U.S. Geological Survey 2020 | CEDEN 2020 | U.S. Geological Survey 2020 | Lucas and Stewart 2007:182 |
| Station(s) | Sacramento River at Freeport | San Joaquin River at Vernalis | Suisun Bay (SU029W, SU034W, SU040W, SU047W, Su050W, SU054W, SU056W) | Cosumnes River at Michigan Bar | Mildred Island |
| Date range | 2007–2020 | 2000–2020 | 2008–2019 | 2012–2015 | 2000 |
| Non-detect results replaced with reporting limit for statistics | Yes | Yes | No | Yes | - |
| Data omitted | None | None | 15 Values from Sacramento River at Mallard Island all below a high detection limit (1 µg/L) | None | - |
| Number of data points | 174 | 198 | 7 | 17 | - |

CEDEN = California Environmental Data Exchange Network.

Source water data for the Sacramento River and San Joaquin River were evaluated to determine whether the primary source water concentration should be represented by a single value or as different values for each month. Analysis of the Sacramento River (ANOVA; $p<0.05$) and San Joaquin River, (ANOVA; $p<0.05$) data indicated significantly different concentrations by month. Therefore, monthly average concentrations were used for these locations in the mass-balance calculations. There were insufficient data for this analysis at the other source water locations; thus, selenium concentrations in San Francisco Bay, eastside tributaries, and Delta agriculture return water are represented by a single average of the entire dataset in the mass-balance calculations. Tables 6B-37 and 6B-38 provide the monthly average dissolved selenium concentrations for the Sacramento River and San Joaquin River.

**Table 6B-37. Monthly Average Source Water Dissolved Selenium Concentrations for the Sacramento River (in micrograms per liter)**

| Data Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Concentration | 0.104 | 0.111 | 0.107 | 0.093 | 0.083 | 0.084 | 0.071 | 0.078 | 0.077 | 0.073 | 0.065 | 0.077 |
| Number of data points | 24 | 26 | 13 | 11 | 21 | 19 | 9 | 14 | 3 | 12 | 2 | 20 |

**Table 6B-38. Monthly Average Source Water Dissolved Selenium Concentrations for the San Joaquin River (in micrograms per liter)**

| Data Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Concentration | 0.574 | 0.514 | 0.535 | 0.195 | 0.159 | 0.306 | 0.231 | 0.276 | 0.252 | 0.215 | 0.265 | 0.478 |
| Number of data points | 24 | 26 | 16 | 12 | 17 | 17 | 15 | 16 | 9 | 11 | 10 | 25 |

Selenium data from agricultural return drains in the Delta were queried from the DWR Water Data Library (California Department of Water Resources 2020). These 356 sample results, collected between 1985 and 1997 from locations distributed around the Delta, were either below the detection limit of 1 µg/L or near the detection limit, ranging from 1 µg/L to 4 µg/L. Given the relatively high detection limit for these analyses and detected concentrations near the reporting limit, these data were not considered sufficiently reliable to use for estimating source water concentrations. Instead, more recent estimates of selenium in agricultural return water from Lucas and Stewart (2007:182) were used to represent these source waters in Table 6B-37 and in modeling calculations.

### 6B.3.2.5 Applicable Water Quality Criteria/Objectives

Applicable water quality criteria and objectives for selenium are included in the Water Quality Control Plans (WQCP) for the Central Valley Regional Water Quality Control Board and San Francisco Bay Regional Water Quality Control Board, as well as the National Toxics Rule (NTR) and California Toxics Rule (CTR).

- The Central Valley Regional Water Quality Control Board WQCP objectives for total selenium include 12 µg/L (maximum concentration) and 5 µg/L (4-day average) concentration for the San Joaquin River, mouth of the Merced River to Vernalis (Central Valley Regional Water Quality Control Board 2018:3-5).
- The San Francisco Bay Regional Water Quality Control Board WQCP refers to total selenium criteria of 5 µg/L (4-day average) and 20 µg/L (1-hour average) promulgated for all San Francisco Bay/Delta waters in the NTR. The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and Delta (San Francisco Bay Regional Water Quality Control Board 2019:Table 3-4). In addition, the North San Francisco Bay selenium TMDL includes a target of 0.5 µg/L as dissolved selenium applicable to a portion of the Delta (within the San Francisco Bay region), Suisun Bay, Carquinez Strait, San Pablo Bay, North Bay, and the Central Bay (San Francisco Bay Regional Water Quality Control Board 2019:7-53).

- The CTR freshwater criteria for selenium consist of a 5 µg/L chronic criterion (4-day average) and a 20 µg/l maximum concentration (1-hour average) (*Federal Register* Vol. 65, No. 97, 31682–31717).

In addition to water column criteria and objectives, the following tissue benchmarks were used in the analysis of modeled data for the purpose of making impact determinations.

- Whole-body fish for the Delta-wide model were compared to the Level of Concern of 4 mg/kg dw (Beckon 2017:133) and the North San Francisco Bay TMDL target of 8 mg/kg dw (San Francisco Bay Regional Water Quality Control Board 2019:7-53). The EPA (2016:xv) recommended freshwater selenium ambient chronic water quality criterion for the protection of aquatic life and the proposed criterion for California (U.S. Environmental Protection Agency 2018:xi) also include a whole-body fish tissue concentration of 8.5 mg/kg dw.
- Modeled bird egg selenium concentrations were compared to Level of Concern of 6 mg/kg dw and Toxicity Level of 10 mg/kg dw from Beckon (2017:133). The EPA (2018:xi) proposed selenium ambient chronic water quality criterion for the protection of aquatic life and aquatic-dependent wildlife also includes a bird egg selenium concentration of 11.2 mg/kg dw.
- Fish fillet data were compared to the Advisory Tissue Level of 2.5 mg/kg ww for human consumption of fish (Office of Environmental Health Hazard Assessment 2017:61) and the North San Francisco Bay TMDL target of 11.3 mg/kg dw (San Francisco Bay Regional Water Quality Control Board 2019:7-53). The EPA (2016:xv) recommended freshwater selenium ambient chronic water quality criterion for the protection of aquatic life and the proposed criterion for California (U.S. Environmental Protection Agency 2018:xi) also include a fish tissue concentration of 11.3 mg/kg dw in skinless, boneless fillets.

## 6B.3.3 Modeling Results

This section present modeling output for selenium concentrations in water and biota.

Water diverted at the north Delta intakes would be conveyed directly to Bethany Reservoir, the upstream terminus of the California Aqueduct into which Banks Pumping Plant water is pumped. Under the proposed action, both the north Delta intakes and Banks Pumping Plant will be operated conjunctively to deliver water to the California Aqueduct, depending on environmental and regulatory conditions. The modeling results are actually for water delivered to Bethany Reservoir from both the north Delta intakes and Banks Pumping Plant, and the term “California Aqueduct” is used to label the concentrations exported to the California Aqueduct from both north Delta intakes and Banks Pumping Plant.

### 6B.3.3.1 Water Column Concentrations

Modeled concentrations of dissolved selenium in water are presented in tables on the following pages. The tables present the average dissolved selenium concentrations for water years 1923 to 2015, and average concentrations by water year type (i.e., wet, above normal, below normal, dry, critical), for existing conditions and the proposed action. Differences between the proposed action and existing conditions also are presented.

At most locations and most water year types, modeled selenium concentrations in water under the proposed action did not change from existing conditions. Negligibly small modeled changes from

existing conditions up to a 0.02 µg/L decrease occurred at California Aqueduct in all water year types but dry years and critical years, which had no change from existing conditions.

**Table 6B-39. Dissolved Selenium Concentrations in Water (in micrograms per liter), Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Sacramento River at Emmaton | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| San Joaquin River at Antioch | 0.10 | 0.10 | 0.10 | 0.09 | 0.09 | 0.09 |
| Sacramento River at Mallard Island | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| South Fork Mokelumne River at Terminous | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| San Joaquin River at Empire Tract | 0.13 | 0.17 | 0.14 | 0.13 | 0.11 | 0.11 |
| Contra Costa Water District Pumping Plant #1 | 0.11 | 0.13 | 0.11 | 0.10 | 0.09 | 0.09 |
| Old River at State Route 4 | 0.12 | 0.15 | 0.12 | 0.11 | 0.10 | 0.10 |
| Victoria Canal | 0.15 | 0.19 | 0.16 | 0.14 | 0.12 | 0.12 |
| California Aqueduct | 0.14 | 0.18 | 0.14 | 0.13 | 0.11 | 0.11 |
| Jones Pumping Plant | 0.21 | 0.24 | 0.22 | 0.20 | 0.18 | 0.18 |

**Table 6B-40. Dissolved Selenium Concentrations in Water (in micrograms per liter), Proposed Action**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Sacramento River at Emmaton | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| San Joaquin River at Antioch | 0.10 | 0.10 | 0.10 | 0.09 | 0.09 | 0.09 |
| Sacramento River at Mallard Island | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| South Fork Mokelumne River at Terminous | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| San Joaquin River at Empire Tract | 0.13 | 0.17 | 0.14 | 0.13 | 0.11 | 0.11 |
| Contra Costa Water District Pumping Plant #1 | 0.11 | 0.13 | 0.11 | 0.10 | 0.09 | 0.09 |
| Old River at State Route 4 | 0.12 | 0.15 | 0.12 | 0.11 | 0.10 | 0.11 |
| Victoria Canal | 0.15 | 0.19 | 0.16 | 0.14 | 0.12 | 0.12 |
| California Aqueduct | 0.13 | 0.16 | 0.13 | 0.12 | 0.11 | 0.11 |
| Jones Pumping Plant | 0.21 | 0.24 | 0.22 | 0.20 | 0.18 | 0.18 |

**Table 6B-41. Dissolved Selenium Concentrations in Water (in micrograms per liter), Proposed Action minus Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sacramento River at Emmaton | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Antioch | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sacramento River at Mallard Island | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| South Fork Mokelumne River at Terminous | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Empire Tract | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Contra Costa Water District Pumping Plant #1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Old River at State Route 4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Victoria Canal | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| California Aqueduct | -0.01 | -0.02 | -0.01 | -0.01 | 0.00 | 0.00 |
| Jones Pumping Plant | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

### 6B.3.3.2 Whole-Body Fish

Modeled concentrations of selenium in whole-body fish are presented in Tables 6B-42 and 6B-43. The tables present the average selenium concentrations for water years 1923 to 2015, and average concentrations by water year type (i.e., wet, above normal, below normal, dry, critical), for existing conditions and the proposed action. Differences between the proposed action and existing conditions also are presented in Table 6B-44.

At most locations and most water year types, modeled selenium concentrations in fish under the proposed action did not change from existing conditions. Negligibly small modeled changes from a 0.01 µg/L decrease to 0.01 µg/L increase occurred at California Aqueduct and Jones Pumping Plant in above normal, below normal, and critical years.

**Table 6B-42. Selenium Concentrations in Whole-Body Fish (in milligrams per kilogram, dry weight), Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 1.82 | 1.54 | 1.54 | 2.46 | 2.46 | 2.46 |
| Sacramento River at Emmaton | 1.82 | 1.54 | 1.54 | 2.46 | 2.46 | 2.46 |
| San Joaquin River at Antioch | 1.82 | 1.55 | 1.54 | 2.46 | 2.46 | 2.46 |
| Sacramento River at Mallard Island | 1.82 | 1.55 | 1.55 | 2.45 | 2.45 | 2.45 |
| South Fork Mokelumne River at Terminous | 1.82 | 1.53 | 1.53 | 2.47 | 2.46 | 2.46 |
| San Joaquin River at Empire Tract | 1.81 | 1.59 | 1.57 | 2.44 | 2.45 | 2.45 |
| Contra Costa Water District Pumping Plant #1 | 1.82 | 1.57 | 1.55 | 2.46 | 2.46 | 2.46 |
| Old River at State Route 4 | 1.82 | 1.58 | 1.56 | 2.45 | 2.45 | 2.45 |
| Victoria Canal | 1.81 | 1.60 | 1.58 | 2.44 | 2.44 | 2.44 |
| California Aqueduct | 1.81 | 1.59 | 1.58 | 2.44 | 2.45 | 2.45 |
| Jones Pumping Plant | 1.81 | 1.62 | 1.61 | 2.42 | 2.43 | 2.43 |

**Table 6B-43. Selenium Concentrations in Whole-Body Fish (in milligrams per kilogram, dry weight), Proposed Action**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 1.82 | 1.54 | 1.54 | 2.46 | 2.46 | 2.46 |
| Sacramento River at Emmaton | 1.82 | 1.54 | 1.54 | 2.46 | 2.46 | 2.46 |
| San Joaquin River at Antioch | 1.82 | 1.55 | 1.54 | 2.46 | 2.46 | 2.46 |
| Sacramento River at Mallard Island | 1.82 | 1.55 | 1.55 | 2.45 | 2.45 | 2.45 |
| South Fork Mokelumne River at Terminous | 1.82 | 1.53 | 1.53 | 2.47 | 2.46 | 2.46 |
| San Joaquin River at Empire Tract | 1.81 | 1.59 | 1.57 | 2.44 | 2.45 | 2.45 |
| Contra Costa Water District Pumping Plant #1 | 1.82 | 1.57 | 1.55 | 2.46 | 2.46 | 2.46 |
| Old River at State Route 4 | 1.82 | 1.58 | 1.56 | 2.45 | 2.45 | 2.45 |
| Victoria Canal | 1.81 | 1.60 | 1.58 | 2.44 | 2.44 | 2.44 |
| California Aqueduct | 1.81 | 1.59 | 1.57 | 2.45 | 2.45 | 2.45 |
| Jones Pumping Plant | 1.81 | 1.62 | 1.61 | 2.42 | 2.43 | 2.42 |

**Table 6B-44. Selenium Concentrations in Whole-Body Fish (in milligrams per kilogram, dry weight), Proposed Action minus Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sacramento River at Emmaton | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Antioch | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sacramento River at Mallard Island | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| South Fork Mokelumne River at Terminous | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Empire Tract | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Contra Costa Water District Pumping Plant #1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Old River at State Route 4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Victoria Canal | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| California Aqueduct | 0.00 | 0.00 | -0.01 | 0.01 | 0.00 | 0.00 |
| Jones Pumping Plant | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 |

### 6B.3.3.3 Bird Eggs: Invertebrate Diet

Modeled concentrations of selenium in eggs of birds with an invertebrate diet are presented in tables 6B-45 and 6B-46. The tables present the average selenium concentrations for water years 1923 to 2015, and average concentrations by water year type (i.e., wet, above normal, below normal, dry, critical), for existing conditions and the proposed action. Differences between the proposed action and existing conditions also are presented in Table 6B-47.

At most locations and most water year types, modeled selenium concentrations in eggs of birds with invertebrate diets under the proposed action did not change from existing conditions. Negligibly small modeled changes from a 0.02 µg/L decrease to 0.01 µg/L increases occurred at several locations in most water year types.

**Table 6B-45. Selenium Concentrations in Bird Eggs, Invertebrate Diet (in milligrams per kilogram, dry weight), Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 2.71 | 2.29 | 2.29 | 3.66 | 3.66 | 3.66 |
| Sacramento River at Emmaton | 2.71 | 2.29 | 2.29 | 3.66 | 3.66 | 3.66 |
| San Joaquin River at Antioch | 2.71 | 2.31 | 2.30 | 3.66 | 3.66 | 3.66 |
| Sacramento River at Mallard Island | 2.71 | 2.30 | 2.30 | 3.65 | 3.65 | 3.65 |
| South Fork Mokelumne River at Terminous | 2.71 | 2.27 | 2.28 | 3.67 | 3.67 | 3.66 |
| San Joaquin River at Empire Tract | 2.70 | 2.36 | 2.34 | 3.64 | 3.65 | 3.65 |
| Contra Costa Water District Pumping Plant #1 | 2.71 | 2.33 | 2.31 | 3.65 | 3.66 | 3.66 |
| Old River at State Route 4 | 2.70 | 2.35 | 2.33 | 3.64 | 3.65 | 3.65 |
| Victoria Canal | 2.70 | 2.38 | 2.35 | 3.63 | 3.64 | 3.64 |
| California Aqueduct | 2.70 | 2.37 | 2.35 | 3.63 | 3.64 | 3.64 |
| Jones Pumping Plant | 2.69 | 2.41 | 2.39 | 3.60 | 3.61 | 3.61 |

**Table 6B-46. Selenium Concentrations in Bird Eggs, Invertebrate Diet (in milligrams per kilogram, dry weight), Proposed Action**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 2.71 | 2.29 | 2.29 | 3.66 | 3.66 | 3.66 |
| Sacramento River at Emmaton | 2.71 | 2.29 | 2.29 | 3.66 | 3.66 | 3.66 |
| San Joaquin River at Antioch | 2.71 | 2.31 | 2.30 | 3.66 | 3.66 | 3.66 |
| Sacramento River at Mallard Island | 2.71 | 2.30 | 2.30 | 3.65 | 3.65 | 3.65 |
| South Fork Mokelumne River at Terminous | 2.71 | 2.27 | 2.28 | 3.67 | 3.67 | 3.66 |
| San Joaquin River at Empire Tract | 2.70 | 2.37 | 2.34 | 3.63 | 3.65 | 3.65 |
| Contra Costa Water District Pumping Plant #1 | 2.70 | 2.34 | 2.31 | 3.65 | 3.66 | 3.66 |
| Old River at State Route 4 | 2.70 | 2.35 | 2.33 | 3.64 | 3.65 | 3.65 |
| Victoria Canal | 2.70 | 2.38 | 2.36 | 3.63 | 3.64 | 3.64 |
| California Aqueduct | 2.70 | 2.36 | 2.33 | 3.64 | 3.65 | 3.64 |
| Jones Pumping Plant | 2.69 | 2.41 | 2.39 | 3.60 | 3.61 | 3.61 |

**Table 6B-47. Selenium Concentrations in Bird Eggs, Invertebrate Diet (in milligrams per kilogram, dry weight), Proposed Action minus Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sacramento River at Emmaton | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Antioch | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sacramento River at Mallard Island | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| South Fork Mokelumne River at Terminous | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Empire Tract | 0.00 | 0.01 | 0.00 | -0.01 | 0.00 | 0.00 |
| Contra Costa Water District Pumping Plant #1 | -0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Old River at State Route 4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Victoria Canal | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| California Aqueduct | 0.00 | -0.01 | -0.02 | 0.01 | 0.01 | 0.00 |
| Jones Pumping Plant | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

### 6B.3.3.4 Bird Eggs: Fish Diet

Modeled concentrations of selenium in eggs of birds with a fish diet are presented in tables 6B-48 and 6B-49. The tables present the average selenium concentrations for water years 1923 to 2015, and average concentrations by water year type (i.e., wet, above normal, below normal, dry, critical), for existing conditions and the proposed action. Differences between the proposed action and existing conditions also are presented in Table 6B-50.

At most locations and most water year types, modeled selenium concentrations in eggs of birds with fish diets under the proposed action did not change from existing conditions. Negligibly small modeled changes from a 0.01 µg/L decrease to 0.02 µg/L increase occurred at California Aqueduct and Jones Pumping Plant in above normal, below normal, and critical years.

**Table 6B-48. Selenium Concentrations in Bird Eggs, Fish Diet (in milligrams per kilogram, dry weight), Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 3.28 | 2.77 | 2.77 | 4.43 | 4.43 | 4.43 |
| Sacramento River at Emmaton | 3.28 | 2.77 | 2.77 | 4.43 | 4.43 | 4.43 |
| San Joaquin River at Antioch | 3.28 | 2.79 | 2.77 | 4.43 | 4.43 | 4.43 |
| Sacramento River at Mallard Island | 3.28 | 2.79 | 2.79 | 4.41 | 4.41 | 4.41 |
| South Fork Mokelumne River at Terminous | 3.28 | 2.75 | 2.75 | 4.45 | 4.43 | 4.43 |
| San Joaquin River at Empire Tract | 3.26 | 2.86 | 2.83 | 4.39 | 4.41 | 4.41 |
| Contra Costa Water District Pumping Plant #1 | 3.28 | 2.83 | 2.79 | 4.43 | 4.43 | 4.43 |
| Old River at State Route 4 | 3.28 | 2.84 | 2.81 | 4.41 | 4.41 | 4.41 |
| Victoria Canal | 3.26 | 2.88 | 2.84 | 4.39 | 4.39 | 4.39 |
| California Aqueduct | 3.26 | 2.86 | 2.84 | 4.39 | 4.41 | 4.41 |
| Jones Pumping Plant | 3.26 | 2.92 | 2.90 | 4.36 | 4.37 | 4.37 |

**Table 6B-49. Selenium Concentrations in Bird Eggs, Fish Diet (in milligrams per kilogram, dry weight), Proposed Action**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 3.28 | 2.77 | 2.77 | 4.43 | 4.43 | 4.43 |
| Sacramento River at Emmaton | 3.28 | 2.77 | 2.77 | 4.43 | 4.43 | 4.43 |
| San Joaquin River at Antioch | 3.28 | 2.79 | 2.77 | 4.43 | 4.43 | 4.43 |
| Sacramento River at Mallard Island | 3.28 | 2.79 | 2.79 | 4.41 | 4.41 | 4.41 |
| South Fork Mokelumne River at Terminous | 3.28 | 2.75 | 2.75 | 4.45 | 4.43 | 4.43 |
| San Joaquin River at Empire Tract | 3.26 | 2.86 | 2.83 | 4.39 | 4.41 | 4.41 |
| Contra Costa Water District Pumping Plant #1 | 3.28 | 2.83 | 2.79 | 4.43 | 4.43 | 4.43 |
| Old River at State Route 4 | 3.28 | 2.84 | 2.81 | 4.41 | 4.41 | 4.41 |
| Victoria Canal | 3.26 | 2.88 | 2.84 | 4.39 | 4.39 | 4.39 |
| California Aqueduct | 3.26 | 2.86 | 2.83 | 4.41 | 4.41 | 4.41 |
| Jones Pumping Plant | 3.26 | 2.92 | 2.90 | 4.36 | 4.37 | 4.36 |

**Table 6B-50. Selenium Concentrations in Bird Eggs, Fish Diet (in milligrams per kilogram, dry weight), Proposed Action minus Existing Conditions**

| Assessment Location | All Years | Wet Years | Above Normal Years | Below Normal Years | Dry Years | Critical Years |
|---|---|---|---|---|---|---|
| Barker Slough at North Bay Aqueduct | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sacramento River at Emmaton | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Antioch | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sacramento River at Mallard Island | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| South Fork Mokelumne River at Terminous | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| San Joaquin River at Empire Tract | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Contra Costa Water District Pumping Plant #1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Old River at State Route 4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Victoria Canal | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| California Aqueduct | 0.00 | 0.00 | -0.01 | 0.02 | 0.00 | 0.00 |
| Jones Pumping Plant | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 |

# 6B.3.4 Selenium Effects Analysis and Conclusions

## 6B.3.4.1 Operations

Modeled average water column selenium concentrations were below the 5 µg/L freshwater chronic CTR criterion (60 FR 2228 [May 4, 1995]; 65 FR 3162 [May 18, 2000]; 66 FR 9960 [February 13, 2001]) at all Delta locations and water year types and differed negligibly from existing conditions and total selenium concentrations (Section 6B.3.3.1, *Water Colum Concentrations*). Similarly, modeled whole-body fish tissue selenium concentrations, used as a surrogate for giant garter snake dietary exposure, were below the No Effect threshold for whole-body fish of 4 mg/kg dry weight from Beckon (2017:133) or the EPA (2016:xv; 2018:xi) water quality criterion of 8.5 mg/kg dry weight at any Delta location for any water year type and changed by less than 0.01 mg/kg dry weight as averages over the full simulation period and in all water year types at all Delta assessment locations, relative to existing conditions and (Section 6B.3.3.2, *Whole-Body Fish*). Modeled selenium concentrations in the eggs of birds consuming invertebrates or fish, such as California least tern, western yellow-billed cuckoo, and least Bell's vireo, were below the No Effect threshold for bird eggs of 6 mg/kg dry weight from Beckon (2017:133) and did not change by more than 0.02 mg/kg dry weight as averages, relative to existing conditions (Section 6B.3.3.3, *Bird Eggs: Invertebrate Diet* and Section 6B.3.3.4, *Bird Eggs: Fish Diet*).

Because modeled selenium concentrations in fish tissue and bird eggs differed negligibly from existing conditions, it is expected that exposure to selenium to California least tern, western yellow-billed cuckoo, least Bell's vireo, and giant garter snake would also not change. Therefore, operation of the north Delta intakes is not anticipated to substantially increase the risk of selenium toxicity in these species.

### 6B.3.4.2 Compensatory Mitigation Plan

#### Bouldin Island and I-5 Ponds

Creation and enhancement of wetlands on Bouldin Island and at the I-5 ponds is not expected to increase the risk of selenium exposure to wildlife species using these habitats because existing selenium concentrations in the Sacramento River watershed are low (Central Valley Regional Water Quality Control Board 1988:14) and, therefore, existing selenium in sediments at Bouldin Island or the I-5 ponds are expected to be low. Also, existing land use at the wetland creation and enhancement sites includes seasonally flooded agricultural fields at Bouldin Island and created ponds at the I-5 ponds, which likely already produce conditions that could mobilize selenium in sediments. Finally, modeled selenium concentrations in water, fish tissue, and bird eggs under existing conditions were well below levels of concern (Section 6B.3.3 *Modeling Results*). Therefore, wetland creation and enhancement on Bouldin Island and at the I-5 ponds would not be expected to increase the bioavailability of selenium, relative to existing conditions, and is not likely to result in selenium exposure that would result in significant adverse effects on western yellow-billed cuckoo, least Bell's vireo, and giant garter snake, if these species are present.

#### Tidal Habitat Mitigation Framework

Implementation of tidal habitat creation as part of the CMP that would be hydrodynamically connected to Delta channels could create new areas with slower water velocities and associated increases in water residence times that, if sufficiently large, promote greater selenium uptake and recycling by plants, algae, and microorganisms. In algae, less-bioaccumulative dissolved forms of selenium, such as selenate, are biotransformed into the more bioaccumulative organoselenium. An increase in more bioavailable forms of particulate selenium could result in increased selenium concentrations in California least tern, western yellow-billed cuckoo, least Bell's vireo, and giant garter snake through dietary uptake.

The locations and sizes of the new tidal habitat are currently undetermined and would be selected in accordance with the tidal habitat mitigation framework in Appendix 3B. Because locations and sizes of the CMP tidal habitat are currently undetermined, the extent that water residence times within the created tidal habitats would differ from that of adjacent Delta waters is unknown. However, the tidal habitat is expected to be predominantly sited in the northern Delta, and its area is expected to be less than 1% of the total acres of the Delta's wetted habitat. Therefore, any potential increases in selenium bioaccumulation would occur in a very small geographic area of the Delta even if some tidal habitat resulted in longer residence times that are conducive to greater bioaccumulation of selenium.

Implementation of the CMP tidal habitat is not expected to cause substantial additional bioaccumulation of selenium in California least tern, western yellow-billed cuckoo, least Bell's vireo, and giant garter snake, if these species are in and near the created habitats, for several reasons. First, the CMP tidal habitats would not involve actions that increase selenium loading, and thus would not substantially increase selenium concentrations in the study area waterbodies. Second, modeled water and fish tissue selenium concentrations are below levels of concern. Third, the CMP tidal habitats would contain a very small fraction of all Delta primary production, and thus would have little, likely immeasurable, effects on average selenium levels in phytoplankton or aquatic-dependent wildlife and fish throughout the Delta. Fourth, it is not certain that the magnitude of greater residence time in the new tidal habitats would result in measurably higher (i.e., significantly

greater) average selenium bioaccumulation into phytoplankton within the tidal habitats as compared to other wetted habitats throughout the Delta. Nor is it certain that changes to selenium forms or concentrations in algae, should they occur in the tidal habitats, would result in statistically significant increases in average selenium concentrations in aquatic-dependent wildlife and fish in those habitats. Even if this were to occur at some of the tidal habitats where tidal water exchange rates were low, their total acreage would not be of sufficient magnitude or geographic extent to affect average selenium levels in phytoplankton or aquatic-dependent wildlife and fish within the northern Delta, or across the Delta. Furthermore, the tidal habitats would have tidal exchange of water and are unlikely to have such substantially increased residence times compared to adjacent habitats such that there would be measurably higher bioaccumulation into phytoplankton within the tidal habitats.

Based on the above discussion, the CMP would result in negligible, if any, change in selenium in action area waterbodies relative to existing conditions. Because selenium concentrations are not expected to increase substantially, the CMP would not cause long-term increase of selenium in study area waterbodies that would result in substantially increased risk for adverse effects on California least tern, western yellow-billed cuckoo, least Bell's vireo, and giant garter snake. Furthermore, the CMP would not increase selenium concentrations by frequency, magnitude, and geographic extent such that it would cause measurably higher body burdens of selenium in aquatic organisms that result in substantially increasing the health risks to California least tern, western yellow-billed cuckoo, least Bell's vireo, and giant garter snake consuming those organisms.

# 6B.4 Surface Water Flows

This section describes potential changes to surface water flows and water levels from operation of the proposed action that could result in adverse effects on riparian vegetation that could be used by western yellow-billed cuckoo and least Bell's vireo. Habitat creation and enhancement actions implemented as part of the CMP would not affect surface water.

The surface water study area comprises the Sacramento River Basin and the Delta—located at the confluence of the Sacramento and San Joaquin Rivers. Specifically, this chapter examines the Trinity, Sacramento, Feather, and American Rivers (and relevant, associated reservoirs) in the Sacramento River Basin. These surface waters represent the geographic areas where potential changes could occur to surface waters as a result of the operation of new diversion and conveyance facilities for the State Water Project (SWP) and, potentially, the Central Valley Project (CVP) identified in the proposed action.

## 6B.4.1 Background and Existing Conditions

The Delta is a complex network of over 700 miles of tidally influenced channels and sloughs. Four strong forcing mechanisms drive circulation, transport, and mixing of water in the Delta:
(1) freshwater river flow from drainages to the Delta; (2) tides from the west propagating from the Pacific Ocean through San Francisco Bay; (3) SWP/CVP water supply facilities operating in the Delta; and (4) collective effects of in-Delta agricultural diversions. Operation of the proposed action has the potential to change surface water flows, relative to existing conditions, which could result in adverse effects on individual Mason's lilaeopsis plants or their habitat if the changes caused sustained drying or inundation that substantially reduced habitat suitability.

A more detailed description of the existing hydrologic conditions in the Delta is included in Chapter 4, *Action Area and Environmental Baseline,* Section 4.3.2, *Physical Environment*, and a description of Mason's lilaeopsis habitat requirements is found in Chapter 2, *Covered Species*.

## 6B.4.2 Assessment Methodology

This section describes the qualitative and quantitative methods used to evaluate surface water-related changes associated with the proposed action within the action area. These changes would be associated with construction, operation, and maintenance of the project, and implementation of the compensatory mitigation plan (Appendix 3B, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*).

The qualitative and quantitative analyses discussed in this section assess the magnitude of project related changes in relation to the existing conditions, (which includes existing facilities and ongoing programs that existed as of January 15, 2020 [i.e., the publication date of the CEQA Notice of Preparation]).

SWP/CVP operations for the existing conditions were determined in accordance with federal and state regulations—including the 2019 Biological Assessment on the coordinated long-term operation of the CVP and SWP (Bureau of Reclamation 2019), the 2019 Biological Opinions (BiOps) from the National Marine Fisheries Service and the U.S. Fish and Wildlife Service (USFWS) on the long-term operations of the CVP and SWP (U.S. Fish and Wildlife Service 2019; National Marine Fisheries Service 2019), and the 2020 Incidental Take Permit (ITP) from the CFDW for long-term operations of the SWP (California Department of Fish and Wildlife 2020).

Potential changes in water levels that could affect Mason's lilaeopsis habitat were assessed using the analysis of riparian and wetland bench inundation provided in Appendix 5A, *Bay-Delta Methods and Results*, Section 5A.6, *Riparian and Wetland Bench Inundation*.

### 6B.4.2.1 Methods to Identify Potential Changes to Surface Water

This section describes the changes to surface water resources within the action area associated with construction and operation of the project. Specifically, the following potential changes were assessed by evaluating the proposed action's potential to:

- Result in changes to Trinity, Sacramento, Feather, and American River flows.
- Result in changes to SWP or CVP reservoir storage levels.

Modeling tools were used to identify these potential changes to use as the basis for impact assessment. While no changes are being proposed in operational rules and water supply allocation procedures for the SWP/CVP system, operation of the proposed north Delta intakes (as part of a dynamic system) could result in changes in simulated river flows and reservoir storage levels.

CalSim 3 is a monthly reservoir-river basin planning model developed by DWR and Bureau of Reclamation to simulate the operation of the SWP and CVP over a range of different hydrologic conditions. Inputs to CalSim 3 include water demands (including the pertinent terms and conditions of associated water rights), stream accretions and depletions, reservoir inflows, irrigation efficiencies, and parameters to calculate return flows, nonrecoverable losses, and groundwater hydrology. Model outputs include river flows, reservoir storage, Delta outflow, and diversions

including Delta exports. CalSim 3 uses the Sacramento Valley and tributary rim basin hydrology with an adjusted historical sequence of monthly stream flows over a 94-year period (1922 to 2015).

CalSim 3 was used to simulate SWP/CVP operations—providing information about the surface water flows and reservoir storage. It should be noted that CalSim 3 results are not indicative of daily real-time operations decisions, especially for extreme conditions. Instead, model results and potential changes approximate operational conditions on a monthly average basis and should always be evaluated in a comparative manner.

Under extreme hydrologic and operational conditions when there is not enough surface water to meet all requirements, CalSim 3 utilizes a series of operating rules to reach a solution to allow for the continuation of the simulation. These operating rules are a simplified version of the complex decision processes that SWP and CVP operators would use in actual extreme conditions. Such extreme operational conditions are infrequent in CalSim 3 simulations but can occur during critical operational periods.

As an example, CalSim 3 results show very infrequent simulated occurrences of extremely low storage conditions at SWP and CVP reservoirs during critical drought periods, when reservoir storage is at "dead pool" levels (below the elevation of the lowest river outlet). When reservoir storage is at dead pool levels, there may be instances in the simulation results in which flow conditions fall short of minimum flow criteria, salinity conditions may exceed salinity standards, diversion conditions fall short of allocated diversion amounts, and operating agreements are not met. During real-life operations, operators would use allowable real-time adjustments in operation to satisfy regulatory, legal, and contractual requirements given the current conditions and hydrologic constraints—as has always been the case in the past. In some cases, certain voluntary extraordinary water conservation and changes in regulatory requirements for water rights or for flow and water quality requirements may be imposed to accommodate extreme conditions, such as during the drought emergency of 2012 to 2016. These conditions are not simulated in CalSim 3.

#### 6B.4.2.2 Evaluation of Operations

The project would provide an additional conveyance facility for transporting water from the north Delta for SWP/CVP export without changing the operational rules of other SWP/CVP facilities or the procedures for specifying the overall water supply allocations for their corresponding contractors. However, as part of a dynamic system, the opportunities for using the north Delta intakes for diversion of additional water supplies could result in changes in corresponding simulated river flows and reservoir storage levels even without any change in operational rules and procedures. Unless stated otherwise, changes are relative to 2020 (i.e., existing conditions).

Changes to Sacramento River Basin flows at several key locations that can depict the SWP/CVP system operation were examined, including Sacramento River at Freeport (i.e., upstream of the proposed north Delta intakes) and Sacramento River just south of Hood (i.e., downstream of the proposed north Delta intakes), which represent changes within the proposed project area. For comparative analyses, the simulated monthly flows from CalSim 3 are summarized on a long-term average basis and are also averaged by water year type (i.e., wet, above normal, below normal, dry, critical, and dry/critical years) for existing conditions and the proposed action. The project is not expected to affect San Joaquin River flows; therefore, locations on the San Joaquin River were not evaluated further.

#### 6B.4.2.3 Comparison of the Proposed Action with Existing Conditions

This section provides the simulated river and storage conditions for the proposed action, compared with existing conditions. As described in Chapter 3, *Description of the Proposed Action*, the proposed action includes the proposed construction of new north Delta conveyance facilities capable of conveying up to 6,000 cfs in total directly to Bethany Reservoir through new tunnels. The north Delta conveyance could provide additional opportunities for transporting water across the Delta for south-of-Delta export; however, there are no additional changes in other SWP/CVP facilities, operation rules, or water allocation for the SWP/CVP system. As a dynamic system, the additional opportunities for water conveyance could result in changes to the simulated SWP/CVP operation including river flows and storage conditions.

The proposed north Delta intakes would operate in conjunction with the existing SWP/CVP intakes in the south Delta. Operation of the proposed north Delta intakes would remain consistent with existing regulatory requirements and any additional requirements that result from project permitting. In addition, diversions at the proposed north Delta intakes would be governed by new operational criteria specific to these intakes, such as the fish screen approach velocity requirements, bypass flow requirements, and pulse protection. The proposed north Delta intakes would augment the ability to capture excess flows and improve the flexibility of the SWP operations for meeting the State Water Resources Control Board D-1641 Delta salinity requirements.

During the winter and spring, when there are excess flows in the system, the proposed north Delta intakes would be used to capture additional excess flows when south Delta exports are limited and unable to capture those flows. During the late spring, summer, and fall—when the SWP and CVP are typically operating to meet the D-1641 salinity requirements in the Delta—both the existing south Delta intakes and the proposed north Delta intakes would be operated together to meet the D-1641 salinity requirements. Use of the proposed north Delta intakes, particularly in July through December, can be used to reduce carriage water requirements—which are necessary to move exports through the south Delta when D-1641 salinity requirements are controlling. The resulting carriage water savings can then be exported or retained in upstream reservoirs, since the water no longer needs to be released. In the CalSim 3 model, increasing exports is always prioritized; however, these savings would remain in storage when sufficient export capacity does not exist. Carriage water savings from operation of the proposed north Delta intakes benefits both the SWP and CVP under proposed action in accordance with the provisions of the Coordinated Operations Agreement.

## 6B.4.3 Modeling Results

#### 6B.4.3.1 Summary Comparison of Changes by Location

Table 6B-51 provides a summary comparison of changes to surface water resources for the proposed action at select locations. This table provides information on the magnitude of the most pertinent changes to Sacramento River Basin flows and SWP/CVP reservoir storages that are expected to result from implementation of the proposed action. Existing regulations, operational rules, and water supply allocation procedures governing SWP and CVP system operations would not change because of operation of the proposed action. However, because of the effect that integration of the proposed north Delta intakes has on the overall system, their operation could lead to changes in river flows and upstream storages.

Generally, long-term average monthly flows for the proposed action are similar to existing conditions for all locations examined. However, there are consistent decreases in long-term average flows for all months on the Sacramento River just south of Hood (i.e., downstream of the proposed north Delta intakes) due to the diversions of excess water at the proposed north Delta intakes.

**Table 6B-51. Comparison of Surface Water Flows Under the Proposed Action to Existing Conditions**

| Surface Water Flows | Existing Conditions | Proposed Action |
|---|---|---|
| Sacramento River Basin Flows, Sacramento River at Freeport (Long-Term Annual Average [a] [cfs]) | 21,218 | 21,220 |
| Sacramento River Basin Flows, Sacramento River Just South of Hood (Long-Term Annual Average [a] [cfs]) | 21,522 | 20,444 |
| SWP and CVP Reservoir Storage, San Luis Reservoir (End-of-September Storage; Long-Term Average [a] [TAF]) | 580 | 634 |
| SWP and CVP Reservoir Storage, San Luis Reservoir (End-of-September Storage; Dry/Critical Years [b] [TAF]) | 350 | 324 |

cfs = cubic feet per second; TAF = thousand acre-feet.
[a] Long-term average is the average annual flow or storage for the period October 1921–September 2015 simulated in CalSim 3.
[b] Water year types are State Water Resources Control Board Water Right Decision 1641 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

### 6B.4.3.2 Sacramento River at Freeport, Upstream of Proposed North Delta Intakes

In general, operation of the proposed action would result in small to no change in surface water flows in the Sacramento River at Freeport, upstream of the proposed north Delta intakes, relative to existing conditions. Table 6B-52 presents the flow modeling results at Sacramento River at Freeport under existing conditions. Table 6B-53 presents the percent change of the proposed action from existing conditions. Long-term average flows would have no change from existing conditions in most months, and small changes of a 1% increase in October and 1% decreases in July, August, and September. Similarly, in wet years the project would result in small to no change in flows from existing conditions. In above normal years, there would be no change from December through June, increases up to 4% in October and November, and decreases up to 2% in July through September. In below normal years, the proposed action would not change from existing conditions in October, November, January, February, March, and May; a 1% increase in flow in April and June, and up to 4% decrease in flows in December, July, August, and September. In dry years, the proposed action would result in up to 3% increase in flows in October, November, January, March, April, and August, a 1% decrease in flows in July, and no change from existing conditions in the remaining months. In critical years, the proposed action could result in flow increases up to 2% in December, February, April, and August, a 1% decrease in flows in November, and no change in flows in all other months.

### Table 6B-52. Sacramento River at Freeport (Upstream of Proposed North Delta Intakes), Mean Monthly Flow under Existing Conditions

| Statistic | Sacramento River at Freeport (Upstream of North Delta Diversion), Mean Monthly Flow (cfs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| **Average** | | | | | | | | | | | | |
| Long-Term Average [a] | 11,293 | 13,562 | 22,637 | 30,220 | 36,637 | 32,330 | 22,617 | 20,606 | 16,907 | 18,089 | 14,716 | 14,303 |
| **Water Year Types** | | | | | | | | | | | | |
| Wet Years | 13,378 | 18,176 | 37,641 | 50,377 | 59,125 | 51,372 | 39,498 | 32,887 | 23,421 | 20,108 | 17,047 | 18,866 |
| Above Normal Years | 11,365 | 12,709 | 20,152 | 38,521 | 43,056 | 39,245 | 22,527 | 25,489 | 19,074 | 20,498 | 18,210 | 17,974 |
| Below Normal Years | 10,937 | 12,928 | 17,577 | 20,647 | 26,152 | 23,879 | 15,614 | 15,189 | 13,581 | 20,093 | 16,491 | 13,670 |
| Dry Years | 10,372 | 11,128 | 12,133 | 14,212 | 23,221 | 19,660 | 12,265 | 11,656 | 13,497 | 16,859 | 11,327 | 9,365 |
| Critical Years | 8,374 | 8,182 | 12,573 | 13,251 | 14,757 | 13,356 | 9,359 | 8,847 | 10,214 | 9,951 | 7,809 | 8,019 |
| Dry/ Critical Years [b] | 9,439 | 9,753 | 12,338 | 13,764 | 19,271 | 16,718 | 10,909 | 10,345 | 11,965 | 13,636 | 9,685 | 8,737 |

CalSim 3 output variable: C_SAC049.
cfs = cubic feet per second.
[a] Long-Term Average is the average monthly flow for the period of October 1921 through September 2015 simulated in CalSim 3.
[b] Water year types are State Water Resources Control Board Water Right Decision 1641 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

### Table 6B-53. Proposed Action, Percent Change from Existing Conditions for Sacramento River at Freeport (Upstream of Proposed North Delta Intakes), Mean Monthly Flow

| Statistic | Percent Change from Existing Conditions | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| **Average** | | | | | | | | | | | | |
| Long-Term Average [a] | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | -1% | -1% | -1% |
| **Water Year Types** | | | | | | | | | | | | |
| Wet Years | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | -1% | -1% | 0% |
| Above Normal Years | 3% | 4% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | -2% | -2% | -1% |
| Below Normal Years | 0% | 0% | -1% | 0% | 0% | 0% | 1% | 0% | 1% | -2% | -1% | -4% |
| Dry Years | 3% | 1% | 0% | 2% | 0% | 1% | 1% | 0% | 0% | -1% | 3% | 0% |
| Critical Years | 0% | -1% | 1% | 0% | 1% | 0% | 2% | 0% | 0% | 0% | 2% | 0% |
| Dry/Critical Years [b] | 2% | 0% | 1% | 1% | 1% | 1% | 1% | 0% | 0% | 0% | 2% | 0% |

CalSim 3 output variable: C_SAC049.
[a] Long-Term Average is the average monthly flow for the period of October 1921 through September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

### 6B.4.3.3 Sacramento River Just South of Hood, Downstream of the Proposed North Delta Intakes

In general, operation of the proposed action would result in small to no change in surface water flows in the Sacramento River south of Hood, downstream of the proposed north Delta intakes, relative to existing conditions. Table 6B-54 presents the flow modeling results at Sacramento River south of Hood under existing conditions. Table 6B-55 presents the percent change of the proposed action from existing conditions. Long-term average flows would decrease up to 7% in November through March, and July; modeled flows would decrease by 1% to 5% in October, April, May, June, August, and September. The project would result in similar decreases in flows from existing conditions. In above normal years, the proposed action would result in no change from existing conditions in October, decreases up to 4% in April, May, August, and September, and decreases up to 10% in November through March, June, and July. In below normal years, the proposed action would result in decreases up to 3% in October, April, May June, and August, 9% decreases in November, January, and February, and decreases up to 14% in March, July, and September. In dry years, the proposed action would result in up to 2% increase in flows in October, April, and August, up to 5% decrease in flows in November through March, July, and September, and no change from existing conditions in May and June. In critical years, the proposed action could result in flow increases up to 2% in April and August, up to 4% decrease in flows in November, July, and September, 7% decrease in January through March, and no change in flows in all other months.

**Table 6B-54. Sacramento River at Hood (Near the Proposed North Delta Intakes), Mean Monthly Flow under Existing Condition**

| | Sacramento River at Hood (Downstream of North Delta Diversion), Mean Monthly Flow (cfs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Statistic** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** |
| **Average** | | | | | | | | | | | | |
| Long-Term Average [a] | 11,567 | 13,833 | 23,010 | 30,632 | 37,168 | 32,710 | 22,922 | 20,835 | 17,119 | 18,288 | 14,933 | 14,549 |
| **Water Year Types** | | | | | | | | | | | | |
| Wet Years | 13,673 | 18,509 | 38,106 | 50,948 | 59,731 | 51,815 | 39,851 | 33,121 | 23,635 | 20,310 | 17,265 | 19,111 |
| Above Normal Years | 11,640 | 12,975 | 20,541 | 38,982 | 43,664 | 39,609 | 22,806 | 25,712 | 19,288 | 20,696 | 18,428 | 18,217 |
| Below Normal Years | 11,201 | 13,188 | 17,922 | 20,975 | 26,619 | 24,239 | 15,902 | 15,416 | 13,790 | 20,292 | 16,708 | 13,923 |
| Dry Years | 10,634 | 11,360 | 12,402 | 14,529 | 23,715 | 20,001 | 12,559 | 11,881 | 13,705 | 17,058 | 11,541 | 9,607 |
| Critical Years | 8,635 | 8,389 | 12,896 | 13,517 | 15,203 | 13,696 | 9,621 | 9,075 | 10,427 | 10,147 | 8,024 | 8,259 |
| Dry/ Critical Years [b] | 9,701 | 9,973 | 12,632 | 14,057 | 19,743 | 17,059 | 11,188 | 10,572 | 12,175 | 13,833 | 9,900 | 8,978 |

CalSim 3 output variable: C_SAC041.
cfs = cubic feet per second.
[a] Long-Term Average is the average monthly flow for the period of October 1921 through September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

**Table 6B-55. Proposed Action, Percent Change from Existing Conditions for Sacramento River at Hood (Near the Proposed North Delta Intakes), Mean Monthly Flow**

| Statistic | Percent Change from Existing Conditions | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| **Average** | | | | | | | | | | | | |
| Long-Term Average [a] | -2% | -6% | -6% | -7% | -6% | -6% | -1% | -3% | -4% | -6% | -2% | -5% |
| **Water Year Types** | | | | | | | | | | | | |
| Wet Years | -3% | -6% | -7% | -6% | -4% | -3% | -2% | -3% | -6% | -5% | -2% | -2% |
| Above Normal Years | 0% | -6% | -7% | -10% | -9% | -9% | -3% | -4% | -10% | -10% | -3% | -1% |
| Below Normal Years | -2% | -9% | -6% | -9% | -9% | -13% | 1% | -1% | -1% | -11% | -3% | -14% |
| Dry Years | 2% | -5% | -4% | -7% | -8% | -9% | 1% | 0% | 0% | -1% | 2% | -5% |
| Critical Years | -2% | -3% | -4% | -8% | -4% | -5% | 2% | 0% | 0% | 0% | 2% | 0% |
| Dry/Critical Years [b] | 0% | -4% | -4% | -7% | -7% | -7% | 1% | 0% | 0% | -1% | 2% | -3% |

CalSim 3 output variable: C_SAC041.
[a] Long-Term Average is the average monthly flow for the period of October 1921 through September 2015 simulated in CalSim 3.
[b] Water year types are State Water Resources Control Board Water Right Decision 1641 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

## 6B.4.4 Surface Water Flow Effects Analysis and Conclusions

As demonstrated in the modeling results presented in Section 6B.4.3, long-term average monthly flows for the proposed action are generally similar to existing conditions, with some minor differences described below. Differences vary by water year type and are sometimes more extreme and/or more concentrated in certain month and water year type combinations.

There are consistent, small decreases in long-term average flows for all months on the Sacramento River just south of Hood (i.e., downstream of the proposed north Delta intakes). These decreases occur in most water year type and month combinations, although the decreases are smaller or nonexistent in the summer of drier years. During the winter and spring in most years, and in wetter years when the Delta is in excess, these decreases are due to diversions of excess flows at the proposed north Delta intakes.

In the summer and early fall, the decreases on the Sacramento River just south of Hood (i.e., downstream of the proposed north Delta intakes) are due to two reasons. First, releases for exports from upstream reservoirs can be lower in these months because San Luis Reservoir is fuller entering the summer; this is due to the diversions of excess water at the proposed north Delta intakes previously discussed. Second, in months when carriage water requirements are lower because of the use of the proposed north Delta intakes (and this carriage water savings cannot be exported), reservoir releases are reduced, which decreases downstream flows.

Analysis of riparian and wetland bench inundation indicates that the proposed action would result in modeled decreases in existing riparian and wetland bench inundation of 0% to 22% compared to existing conditions, depending on location, season, and water year type (Chapter 5, *Effects Analysis for Chinook Salmon, Central Valley Steelhead, Green Sturgeon, and Killer Whale*, Section 5.6.2, *Far-Field Effects*). The analysis indicates potential short-term decreases in water levels at many locations in the Delta, which could result in changes in water levels adjacent to riparian habitat.

Overall, surface water flows would not change substantially, relative to existing conditions. Decreases in modeled surface water flows and water levels downstream of the north Delta intakes in some month and water year-type combinations could result in short-term reduced inundation of existing riparian habitat within the action area. However, short-term reduction in inundation is not expected to decrease the availability of riparian habitat, relative to existing conditions. Therefore, operation of the proposed action is not expected to reduce habitat availability that could result in adverse effects on western yellow-billed cuckoo or least Bell's vireo if the species are present in the action area.

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## 6B.5.2 Personal Communications

Foe, C. Staff Environmental Scientist. Central Valley Regional Water Quality Control Board, Sacramento, CA. April 23, 2010—Email to H. Ohlendorf, Technology Fellow, CH2M HILL, Sacramento, CA.

# Attachment 6B.1
# Water Quality Modeling Data

This attachment contains modeling data tables and figures for cyanobacterial harmful algal blooms (CHABs) and surface water flows referenced in Appendix 6B.1, *Water Quality* for analysis of potential effects on terrestrial listed species. Of note, this modeling was completed for the Delta Conveyance Project Final Environmental Impact Report (EIR) (California Department of Water Resources 2023), thus, the terms *Alt 5* and *Alternative 5* are utilized in the tables and figures and are assumed to be equitable to the proposed action.

## 6B.1.1.1 CHABs

### 6B.1.1.1.1 Temperature

Table 6B.1-1 through Table 6B.1-12 show modeled average temperature under existing conditions, the proposed action, and the change between existing conditions and the proposed action for the nine Delta assessment locations.

**Table 6B.1-1. Brannan Island, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative(s) | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 66.1 | 69.5 | 68.7 | 66.2 | 61.3 | 55.2 |
| Proposed action | 66.1 | 69.5 | 68.7 | 66.2 | 61.3 | 55.2 |
| Change | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 6B.1-2. San Joaquin River at Jersey Point, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative(s) | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 65.9 | 69.3 | 68.5 | 66.0 | 61.2 | 55.3 |
| Proposed action | 65.9 | 69.3 | 68.5 | 66.0 | 61.2 | 55.4 |
| Change | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |

**Table 6B.1-3. Old River at Rock Slough, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative(s) | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 66.3 | 69.7 | 68.8 | 66.1 | 61.0 | 55.0 |
| Proposed action | 66.3 | 69.7 | 68.8 | 66.1 | 61.0 | 55.0 |
| Change | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 6B.1-4. Channels around Franks Tract, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative(s) | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 66.2 | 69.5 | 68.6 | 66.0 | 60.9 | 54.9 |
| Proposed action | 66.2 | 69.5 | 68.6 | 66.0 | 60.9 | 54.9 |
| Change | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 6B.1-5. Franks Tract, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 66.3 | 69.6 | 68.6 | 65.9 | 60.6 | 54.6 |
| Proposed action | 66.3 | 69.6 | 68.6 | 65.8 | 60.6 | 54.6 |
| Change | 0.0 | 0.0 | 0.0 | -0.1 | 0.0 | 0.0 |

**Table 6B.1-6. Victoria Canal, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 66.4 | 69.7 | 68.8 | 66.1 | 60.9 | 55.1 |
| Proposed action | 66.4 | 69.7 | 68.8 | 66.1 | 60.9 | 55.1 |
| Change | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 6B.1-7. Stockton Deep Water Ship Channel, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 67.5 | 70.4 | 69.3 | 66.7 | 62.1 | 55.4 |
| Proposed action | 67.5 | 70.4 | 69.3 | 66.7 | 62.1 | 55.4 |
| Change | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 6B.1-8. Mildred Island, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 66.1 | 69.6 | 68.7 | 66.1 | 61.1 | 55.3 |
| Proposed action | 66.1 | 69.6 | 68.7 | 66.1 | 61.1 | 55.3 |
| Change | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 6B.1-9. San Joaquin Near Venice Cut, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 66.5 | 69.8 | 69.0 | 66.4 | 61.4 | 55.2 |
| Proposed action | 66.5 | 69.8 | 69.0 | 66.4 | 61.4 | 55.3 |
| Change | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |

**Table 6B.1-10. Mokelumne River, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 66.3 | 69.6 | 68.9 | 66.5 | 61.6 | 55.3 |
| Proposed action | 66.4 | 69.6 | 68.9 | 66.5 | 61.6 | 55.4 |
| Change | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |

**Table 6B.1-11. Sacramento River at I Street Bridge, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 68.4 | 70.4 | 70.0 | 68.1 | 62.9 | 54.9 |
| Proposed action | 68.4 | 70.4 | 70.0 | 68.1 | 62.9 | 54.9 |
| Change | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 6B.1-12. Sacramento River at Freeport, Monthly Average Temperature (in degrees Fahrenheit), Full Simulation Period**

| Alternative | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|
| Existing Conditions | 68.1 | 70.3 | 69.8 | 67.8 | 62.7 | 54.9 |
| Proposed action | 68.1 | 70.3 | 69.8 | 67.8 | 62.7 | 54.9 |
| Change | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

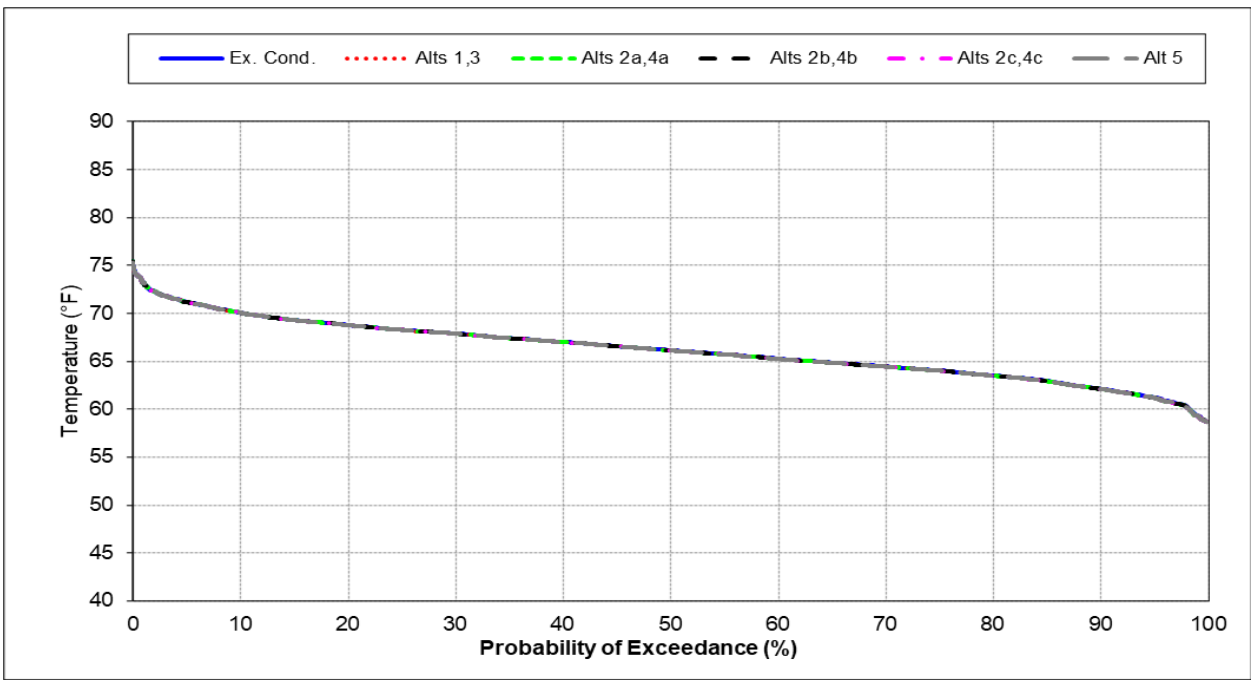



**Figure 6B.1-1. Brannan Island, Daily Average Temperature (in degrees Fahrenheit), June**

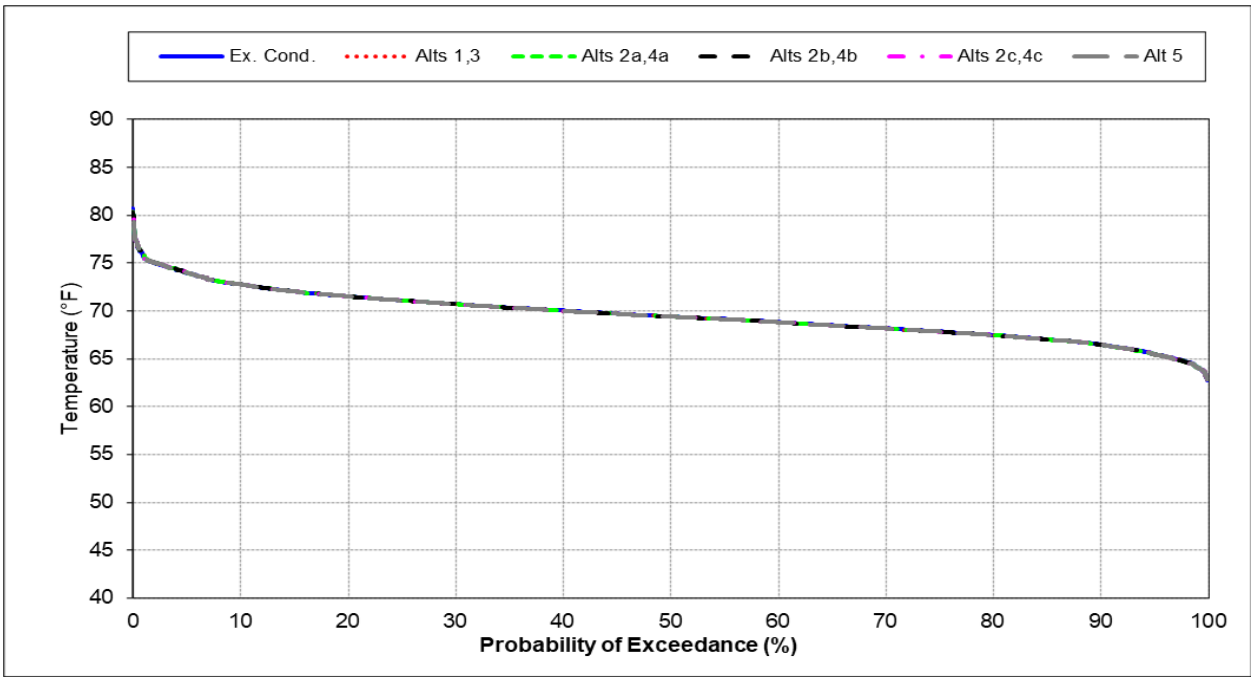



**Figure 6B.1-2. Brannan Island, Daily Average Temperature (in degrees Fahrenheit), July**

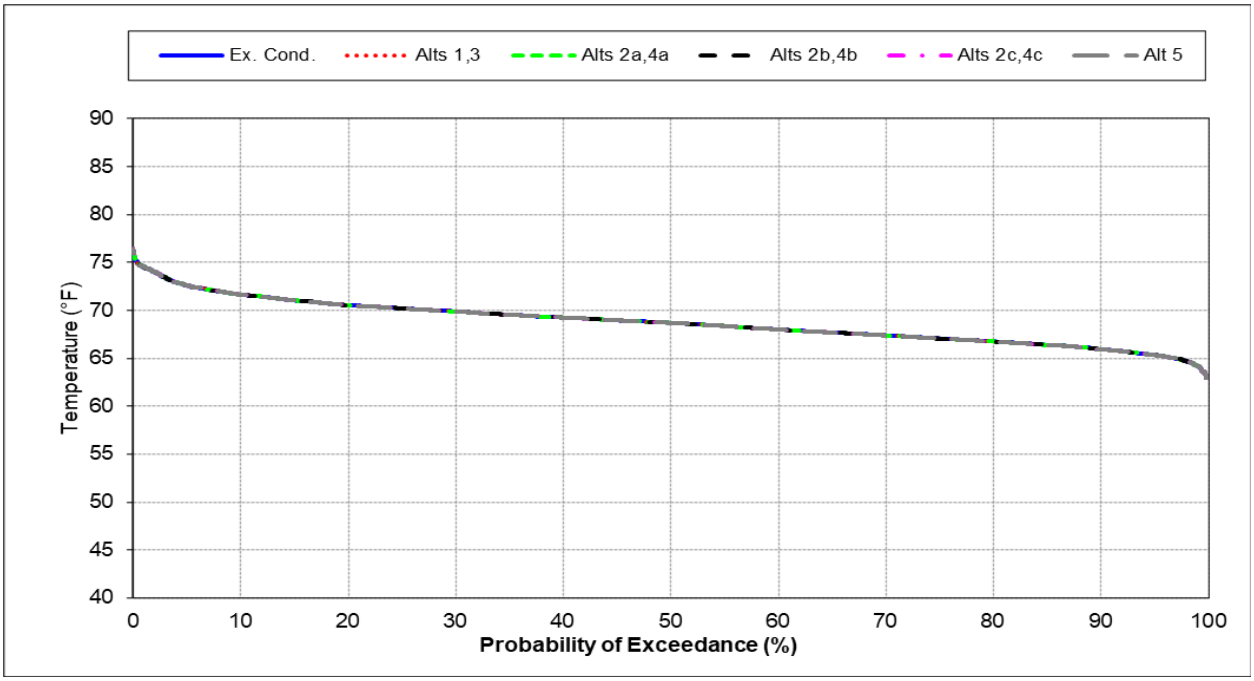



**Figure 6B.1-3. Brannan Island, Daily Average Temperature (in degrees Fahrenheit), August**

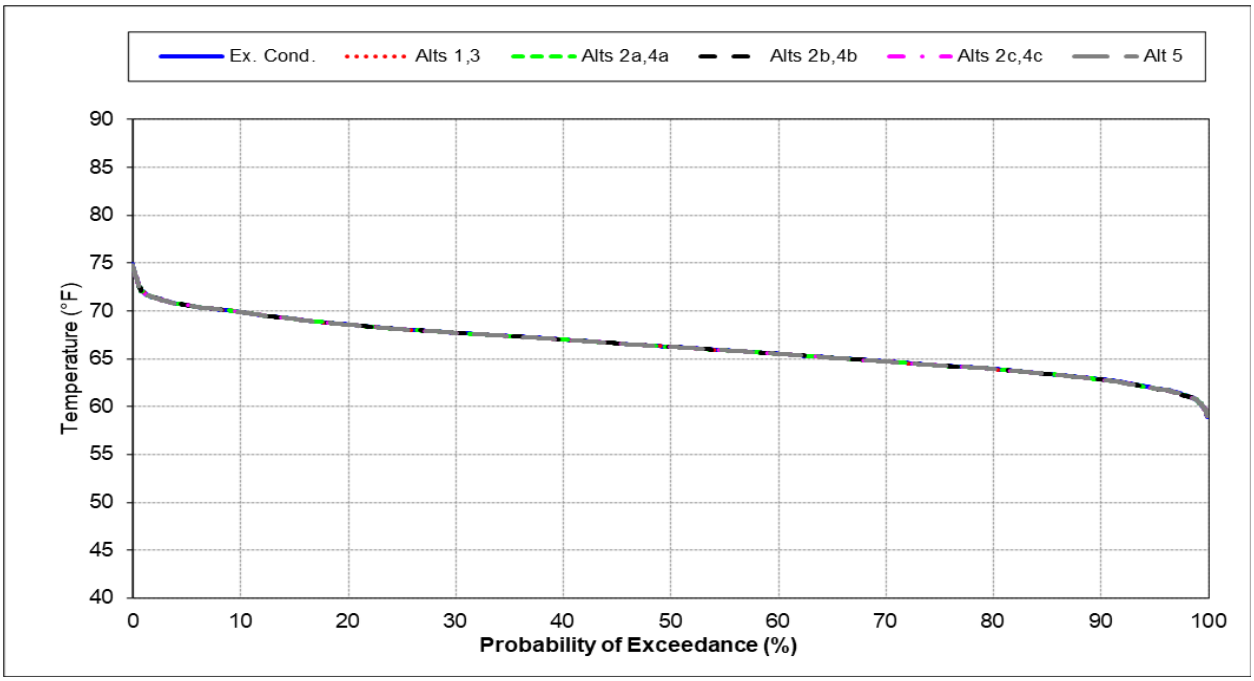



**Figure 6B.1-4. Brannan Island, Daily Average Temperature (in degrees Fahrenheit), September**

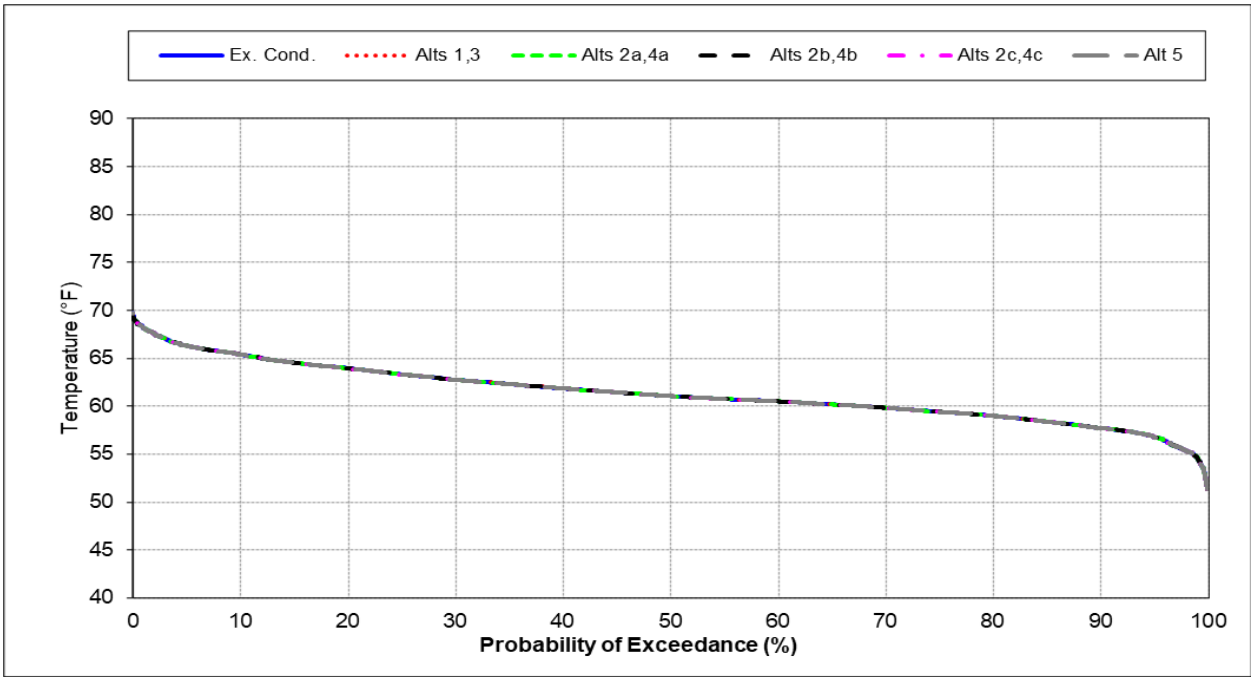



**Figure 6B.1-5. Brannan Island, Daily Average Temperature (in degrees Fahrenheit), October**

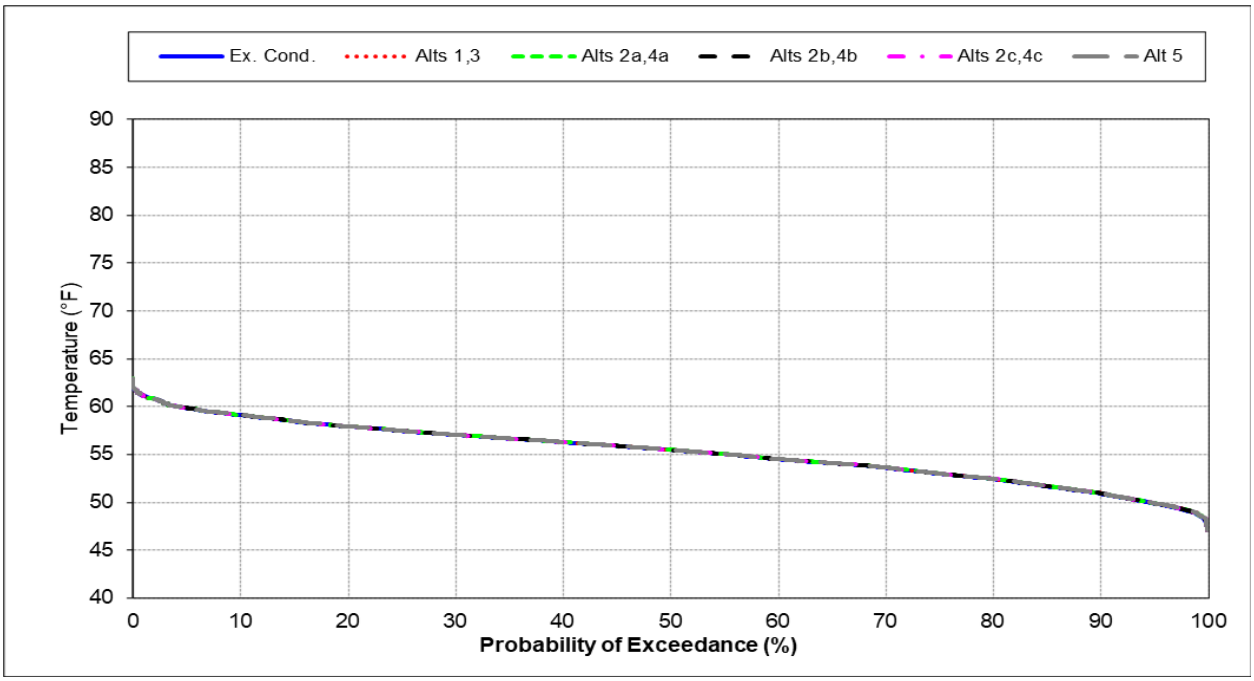



**Figure 6B.1-6. Brannan Island, Daily Average Temperature (in degrees Fahrenheit), November**

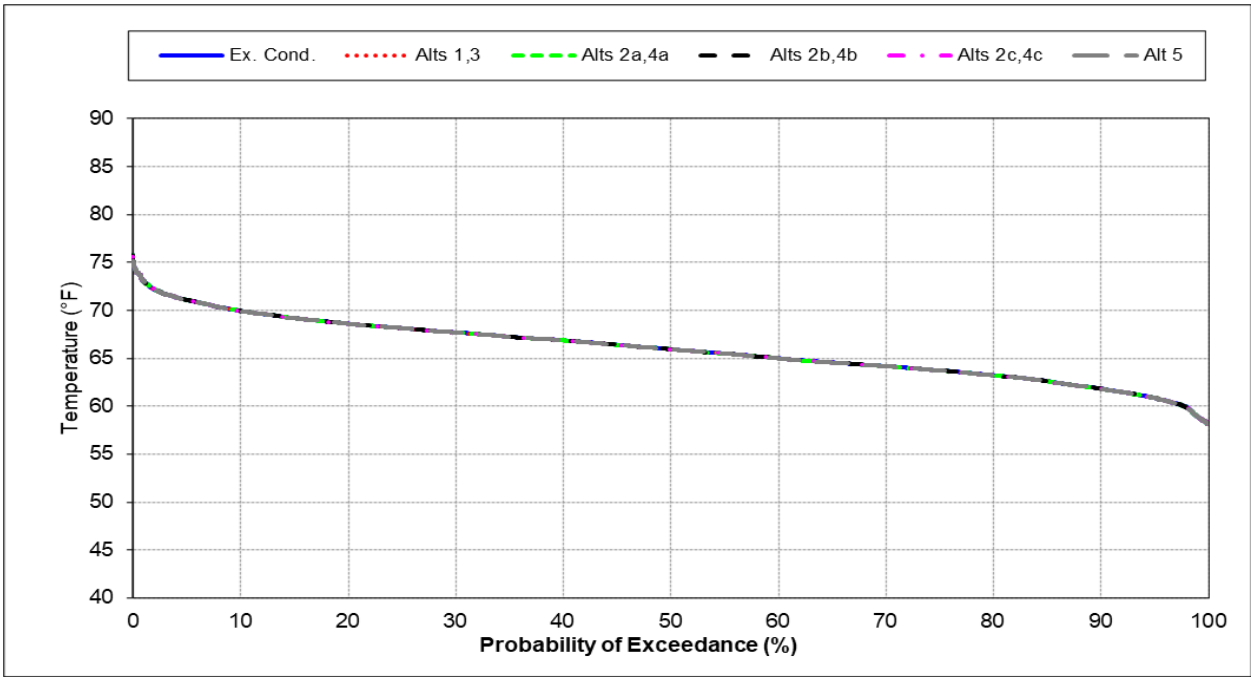



**Figure 6B.1-7. San Joaquin River at Jersey Point, Daily Average Temperature (in degrees Fahrenheit), June**

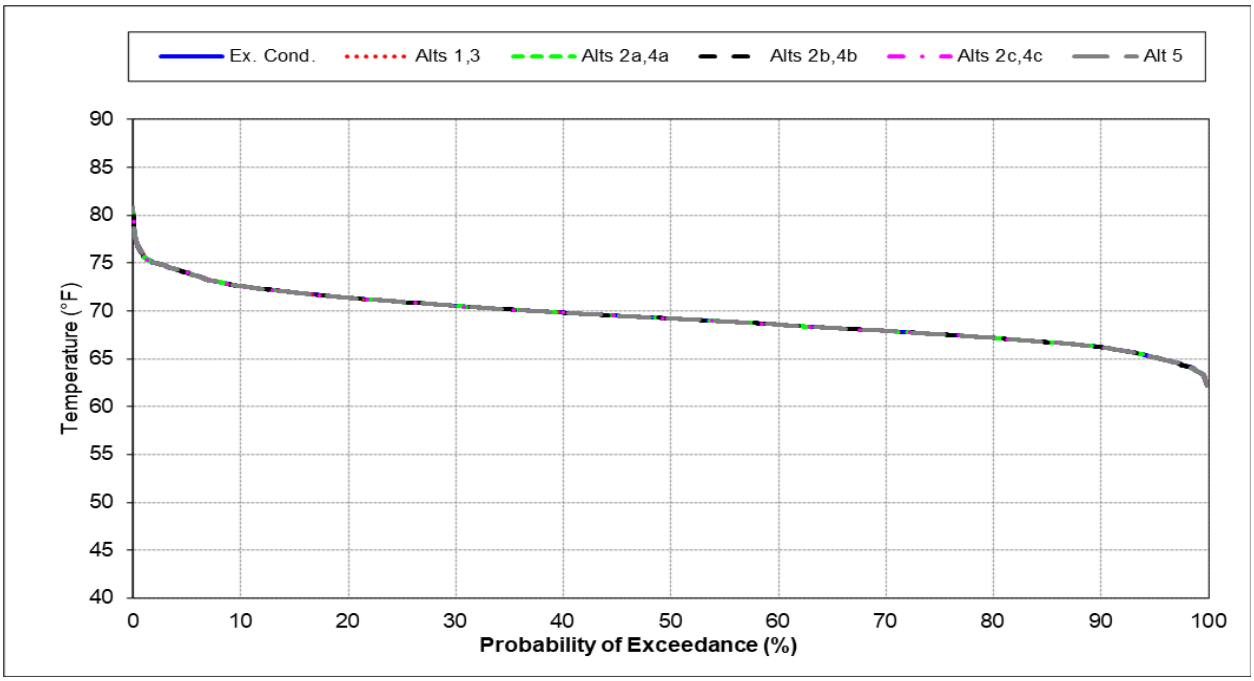



**Figure 6B.1-8. San Joaquin River at Jersey Point, Daily Average Temperature (in degrees Fahrenheit), July**

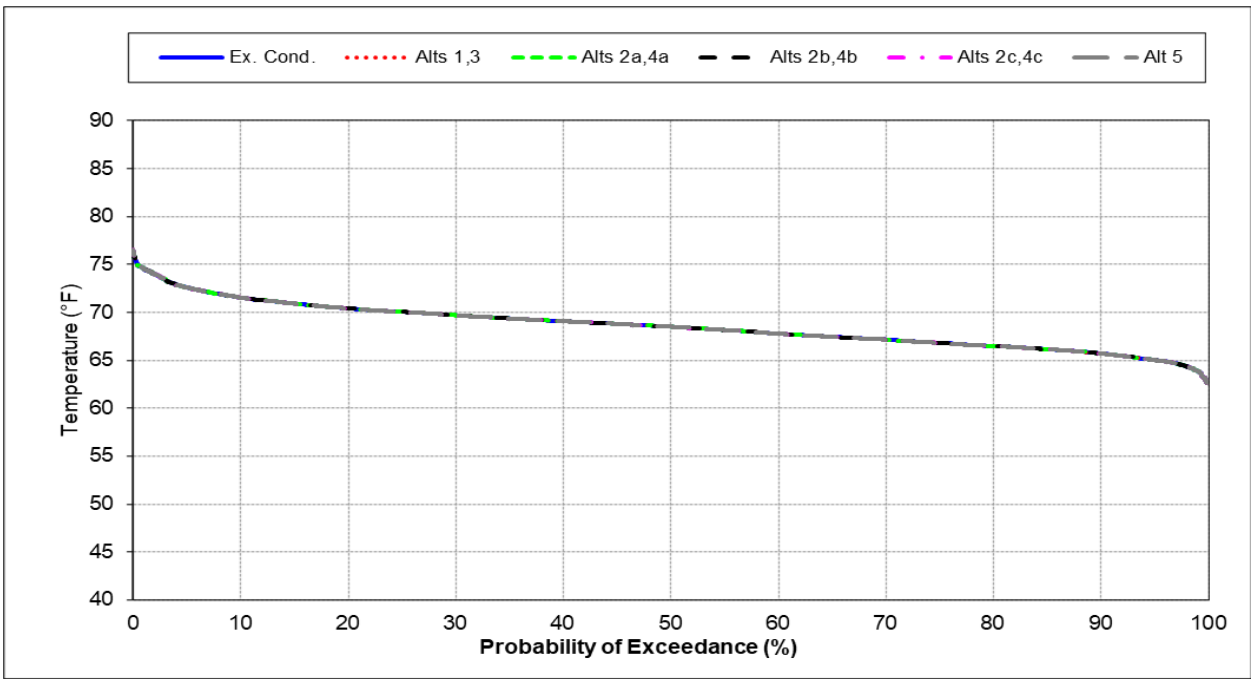



**Figure 6B.1-9. San Joaquin River at Jersey Point, Daily Average Temperature (in degrees Fahrenheit), August**

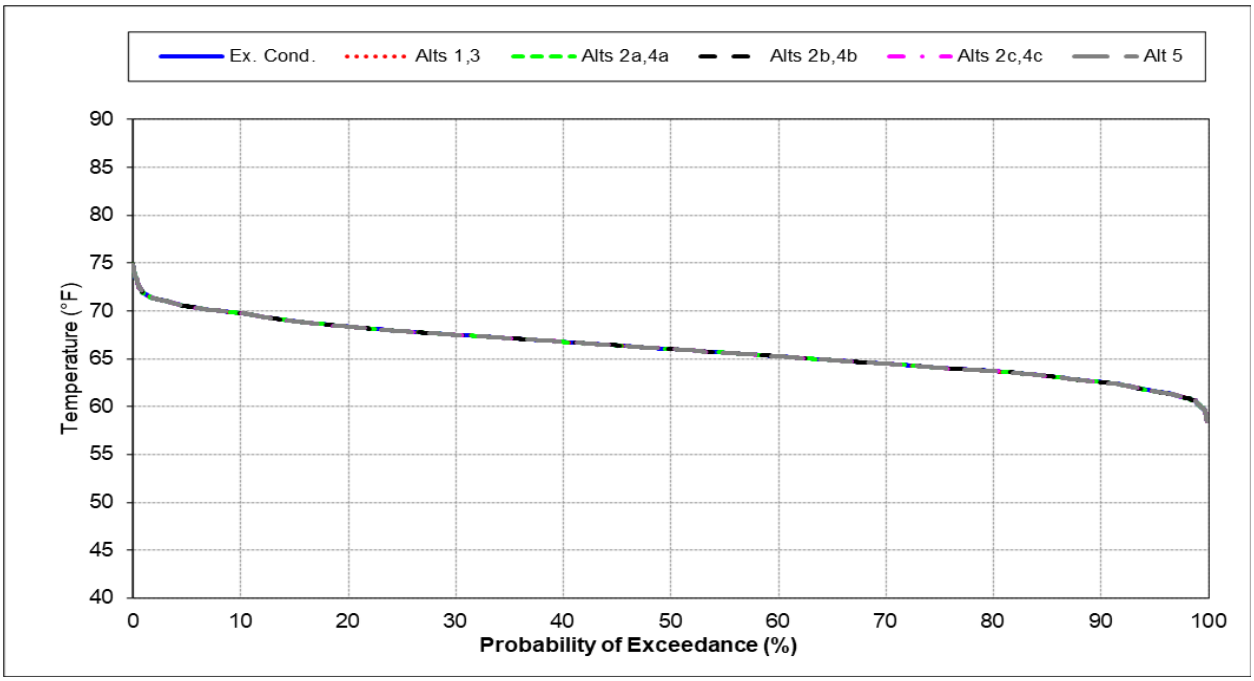



**Figure 6B.1-10. San Joaquin River at Jersey Point, Daily Average Temperature (in degrees Fahrenheit), September**

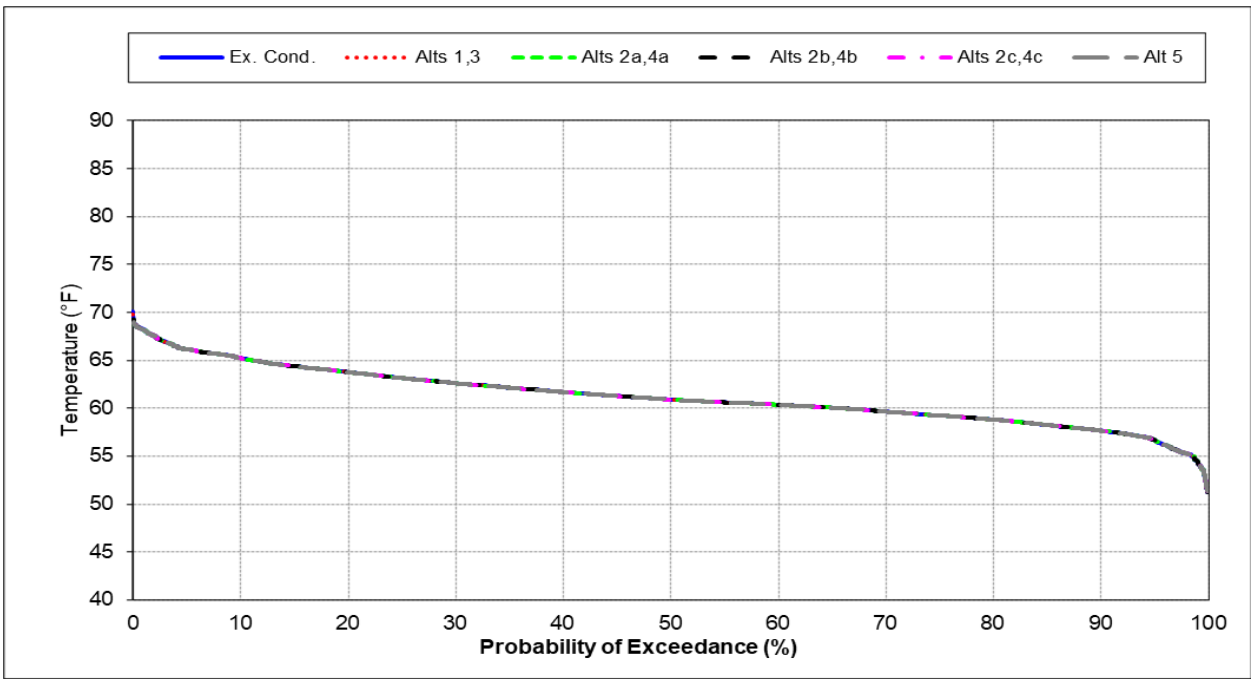



**Figure 6B.1-11. San Joaquin River at Jersey Point, Daily Average Temperature (in degrees Fahrenheit), October**

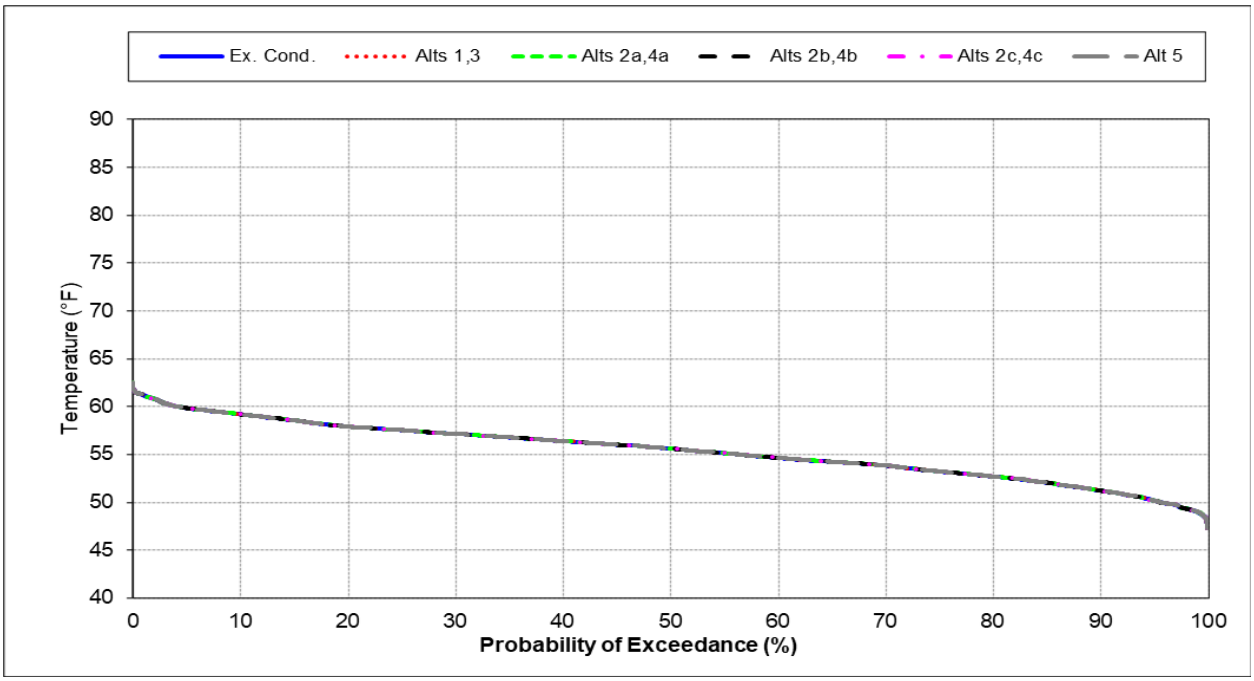



**Figure 6B.1-12. San Joaquin River at Jersey Point, Daily Average Temperature (in degrees Fahrenheit), November**

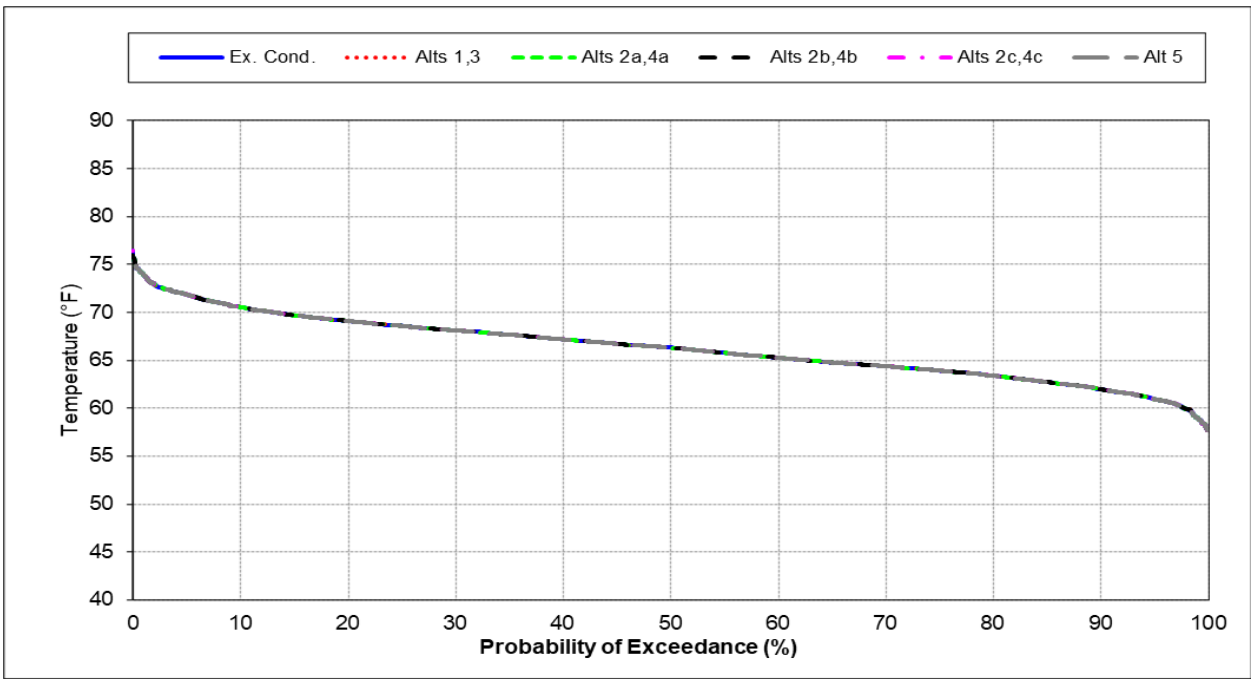



**Figure 6B.1-13. Old River at Rock Slough, Daily Average Temperature (in degrees Fahrenheit), June**

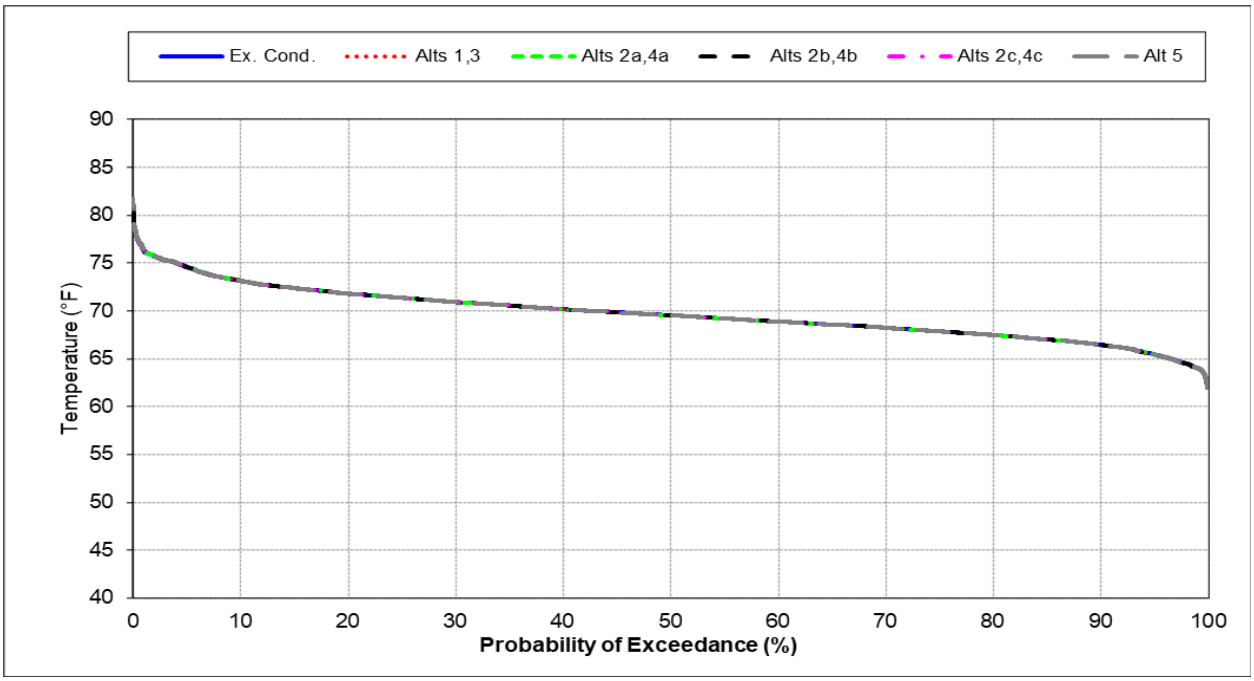



**Figure 6B.1-14. Old River at Rock Slough, Daily Average Temperature (in degrees Fahrenheit), July**

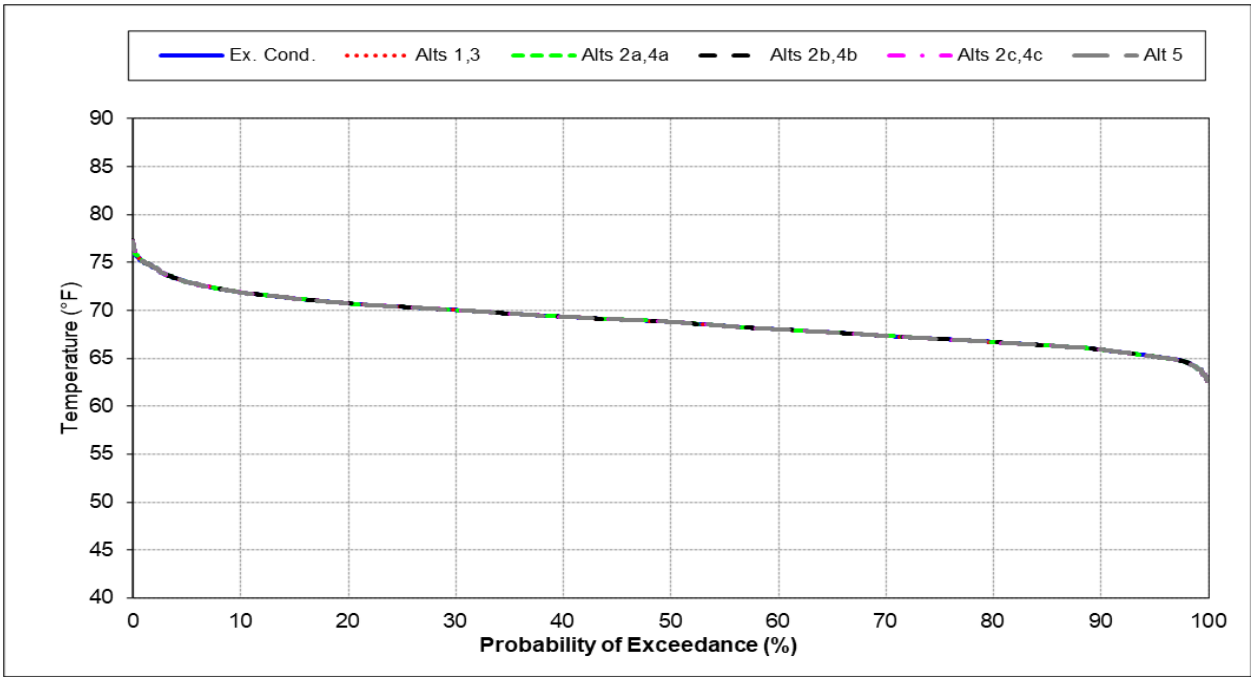



**Figure 6B.1-15. Old River at Rock Slough, Daily Average Temperature (in degrees Fahrenheit), August**

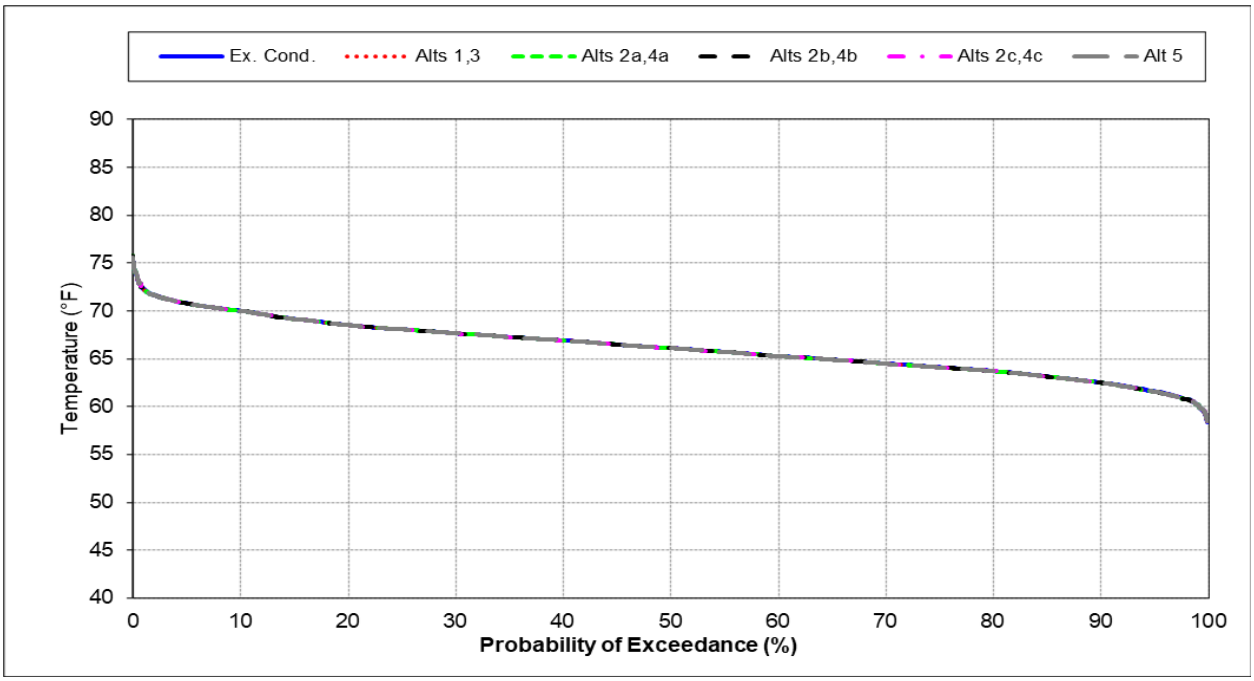



**Figure 6B.1-16. Old River at Rock Slough, Daily Average Temperature (in degrees Fahrenheit), September**

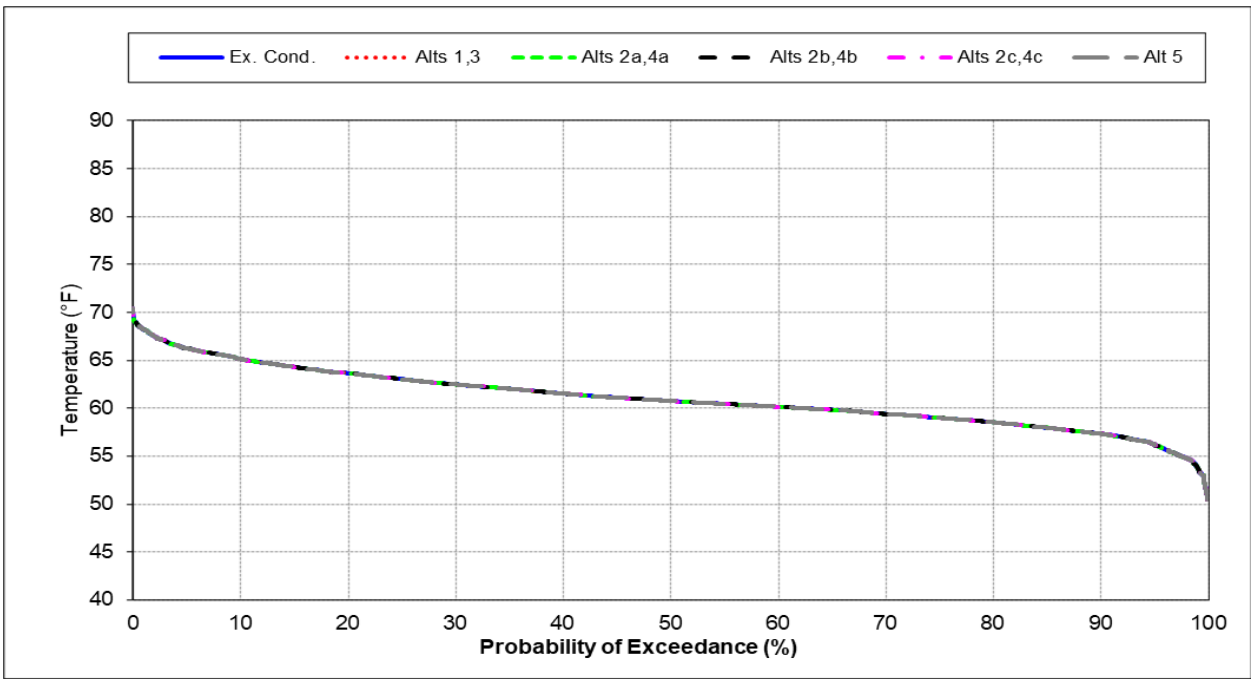



**Figure 6B.1-17. Old River at Rock Slough, Daily Average Temperature (in degrees Fahrenheit), October**

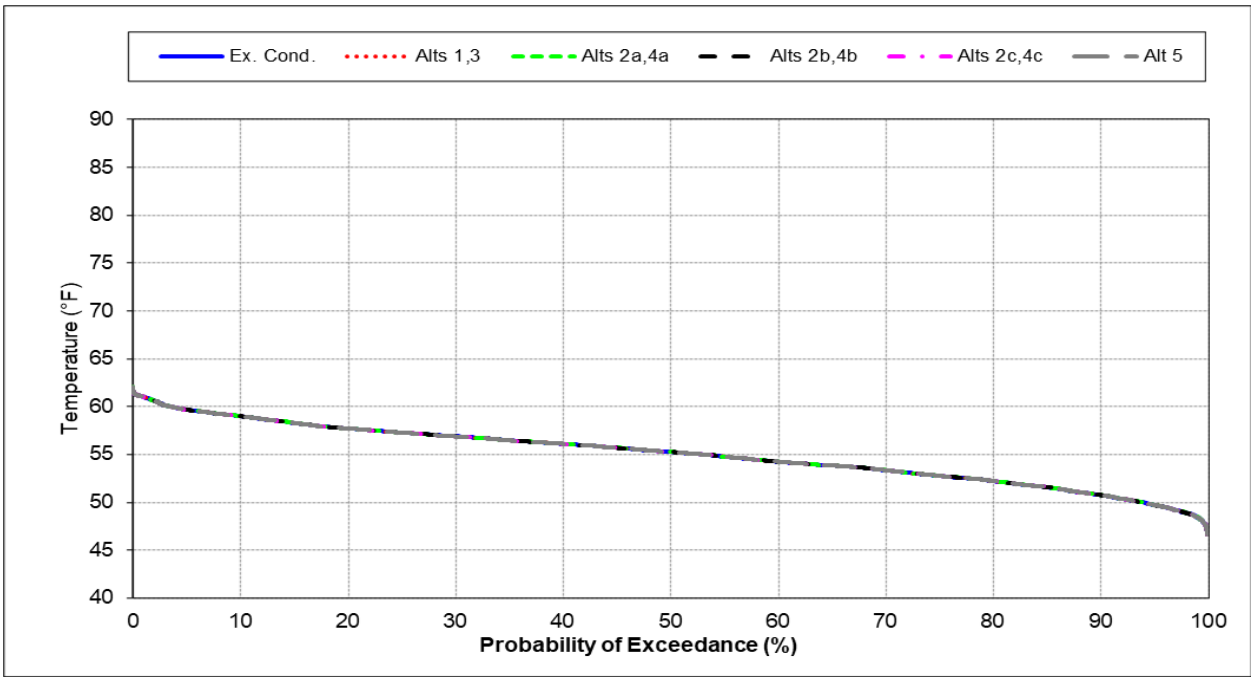



**Figure 6B.1-18. Old River at Rock Slough, Daily Average Temperature (in degrees Fahrenheit), November**

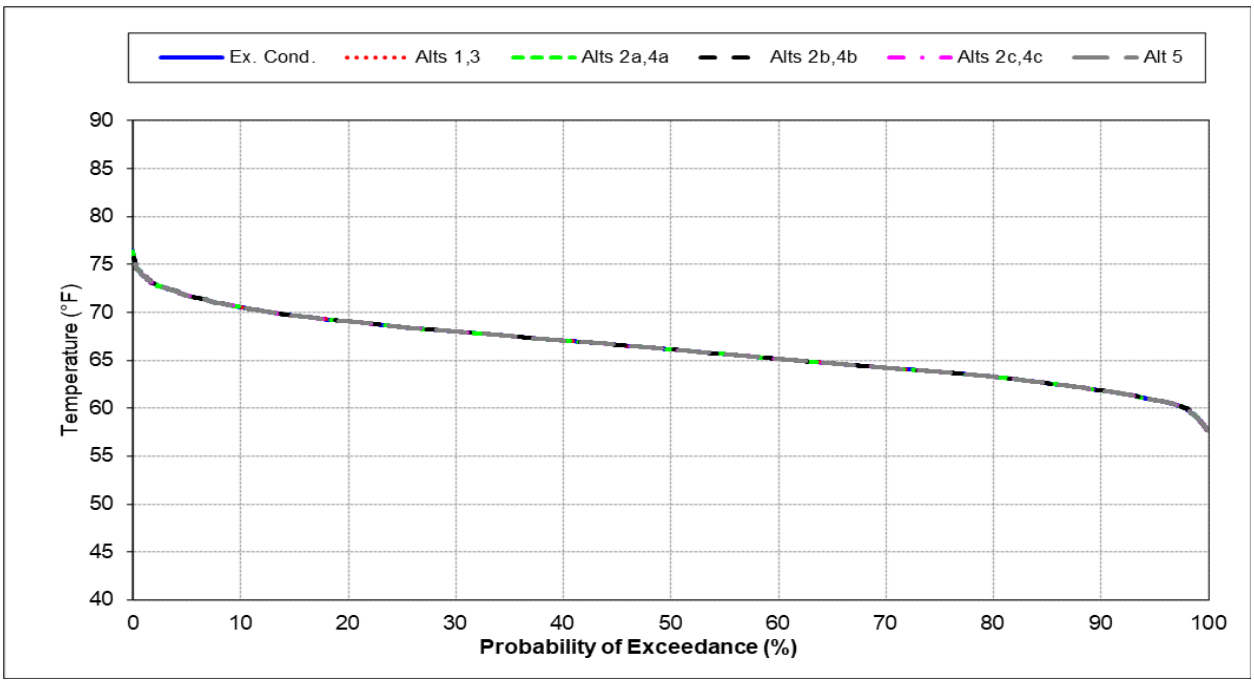



**Figure 6B.1-19. Channels around Franks Tract, Daily Average Temperature (in degrees Fahrenheit), June**

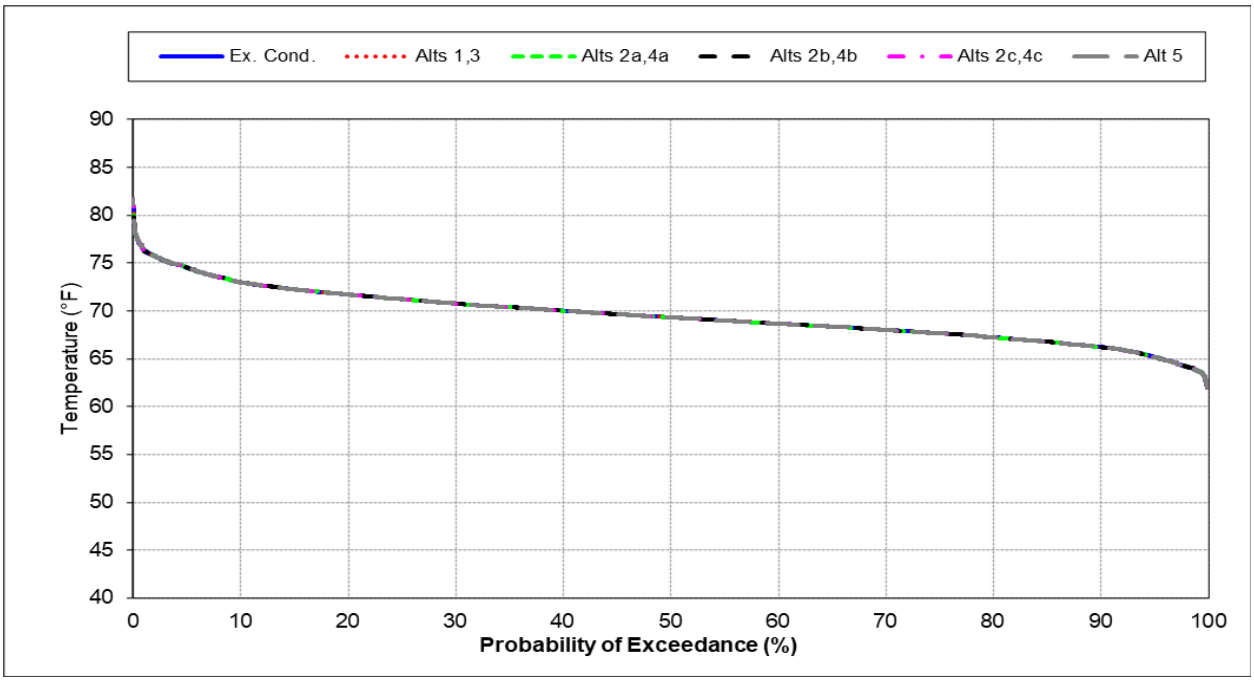



**Figure 6B.1-20. Channels around Franks Tract, Daily Average Temperature (in degrees Fahrenheit), July**

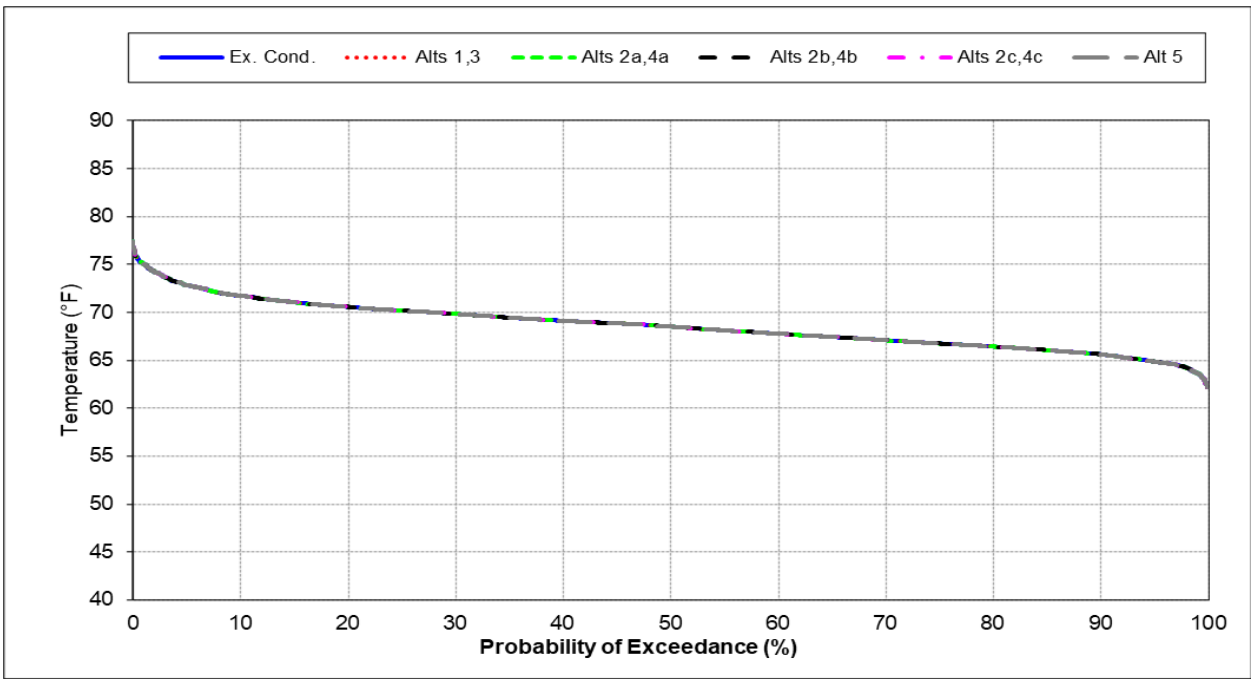



**Figure 6B.1-21. Channels around Franks Tract, Daily Average Temperature (in degrees Fahrenheit), August**

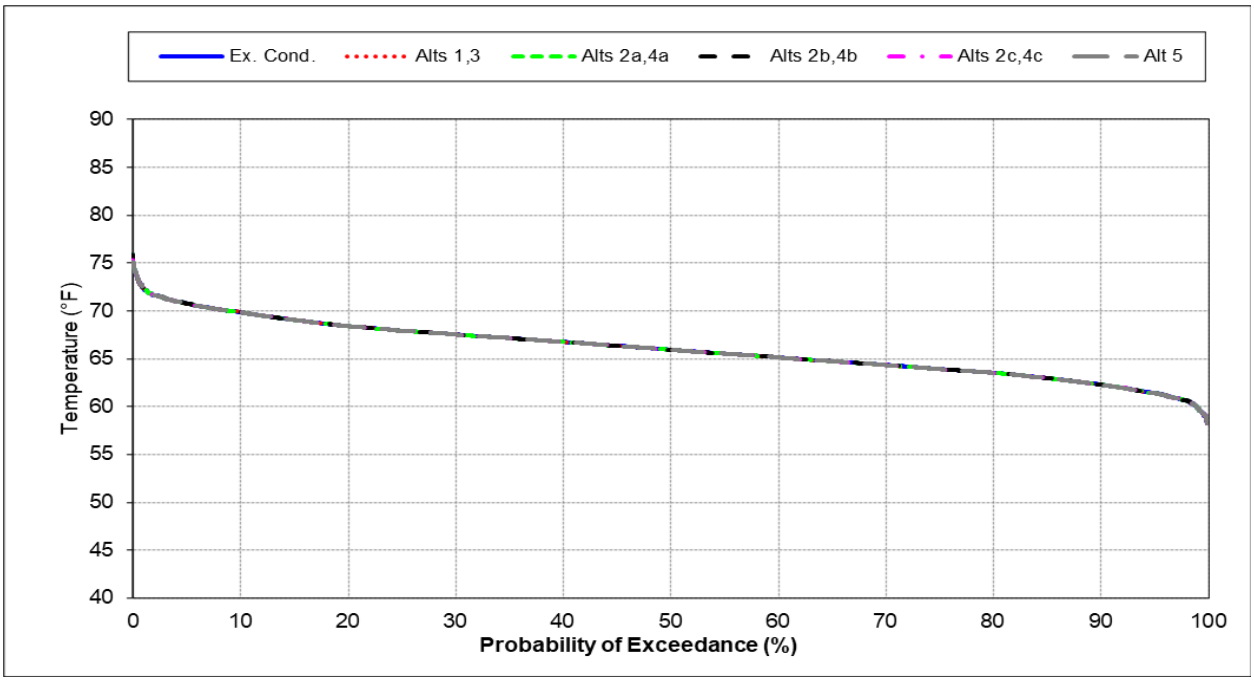



**Figure 6B.1-22. Channels around Franks Tract, Daily Average Temperature (in degrees Fahrenheit), September**

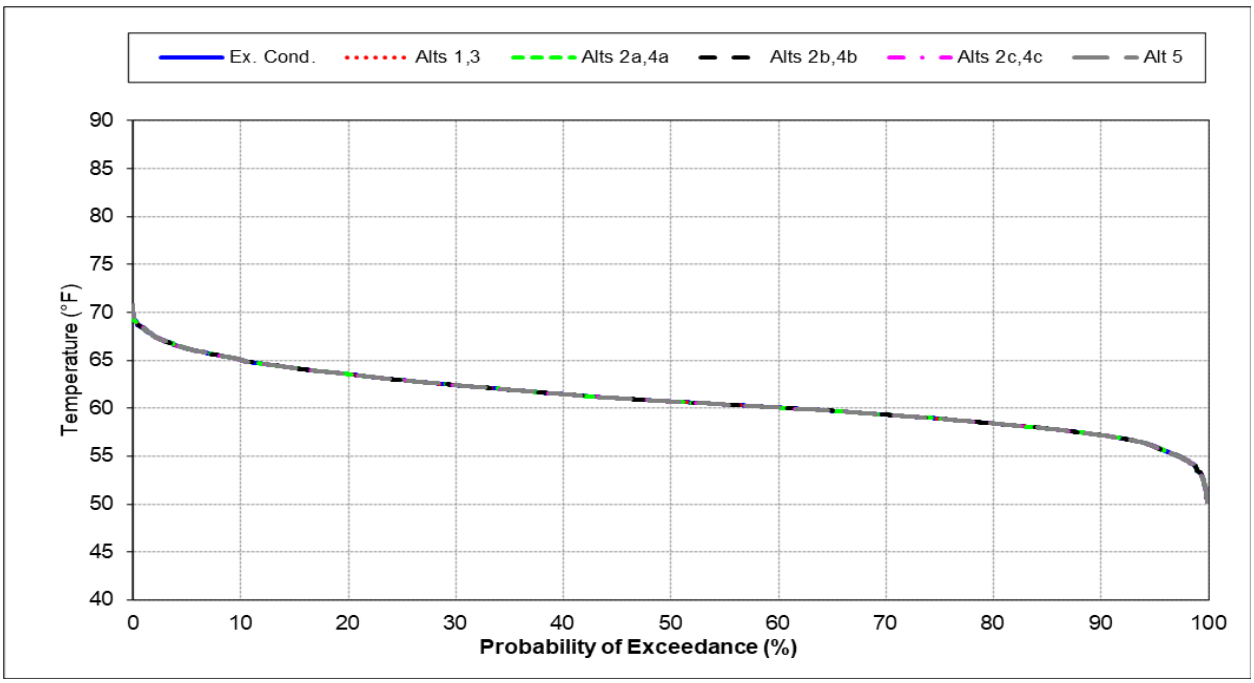



**Figure 6B.1-23. Channels around Franks Tract, Daily Average Temperature (in degrees Fahrenheit), October**

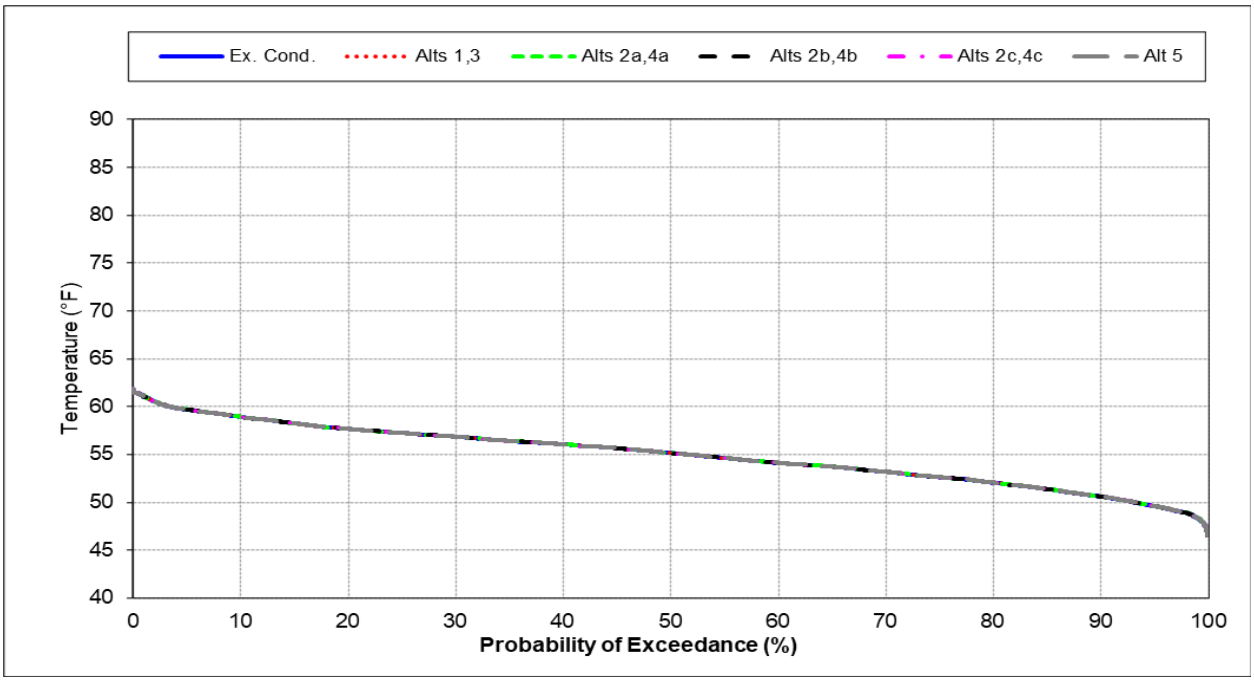



**Figure 6B.1-24. Channels around Franks Tract, Daily Average Temperature (in degrees Fahrenheit), November**

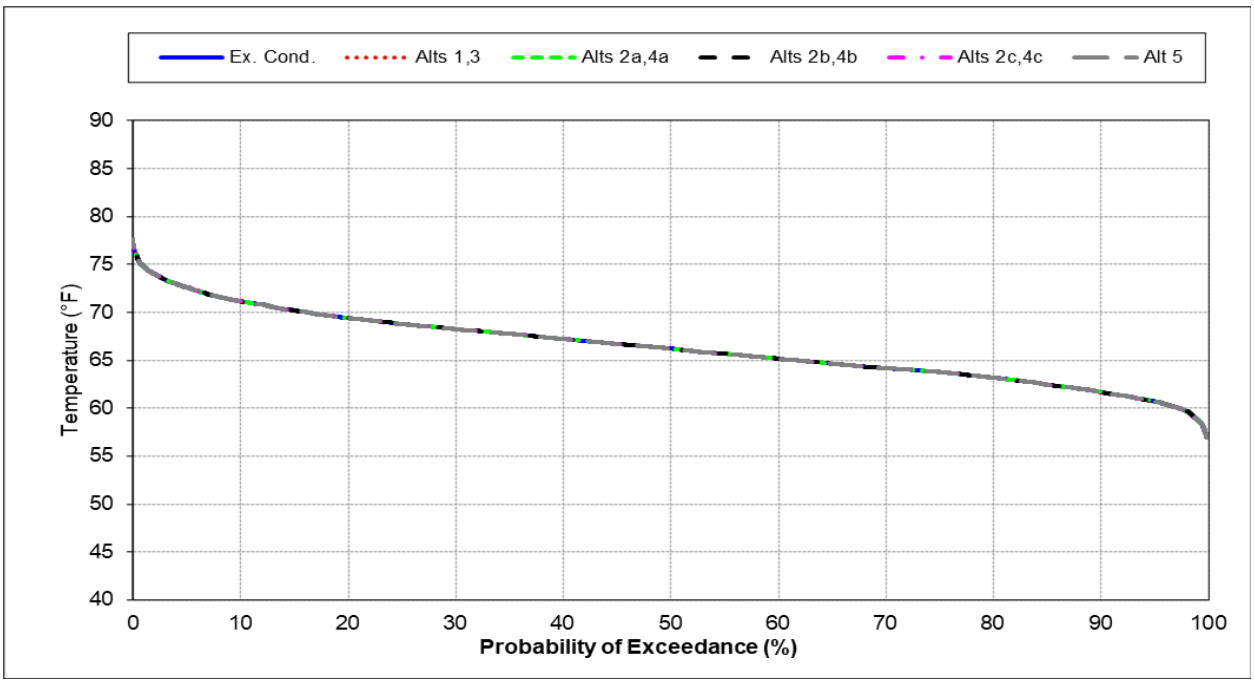



**Figure 6B.1-25. Franks Tract, Daily Average Temperature (in degrees Fahrenheit), June**

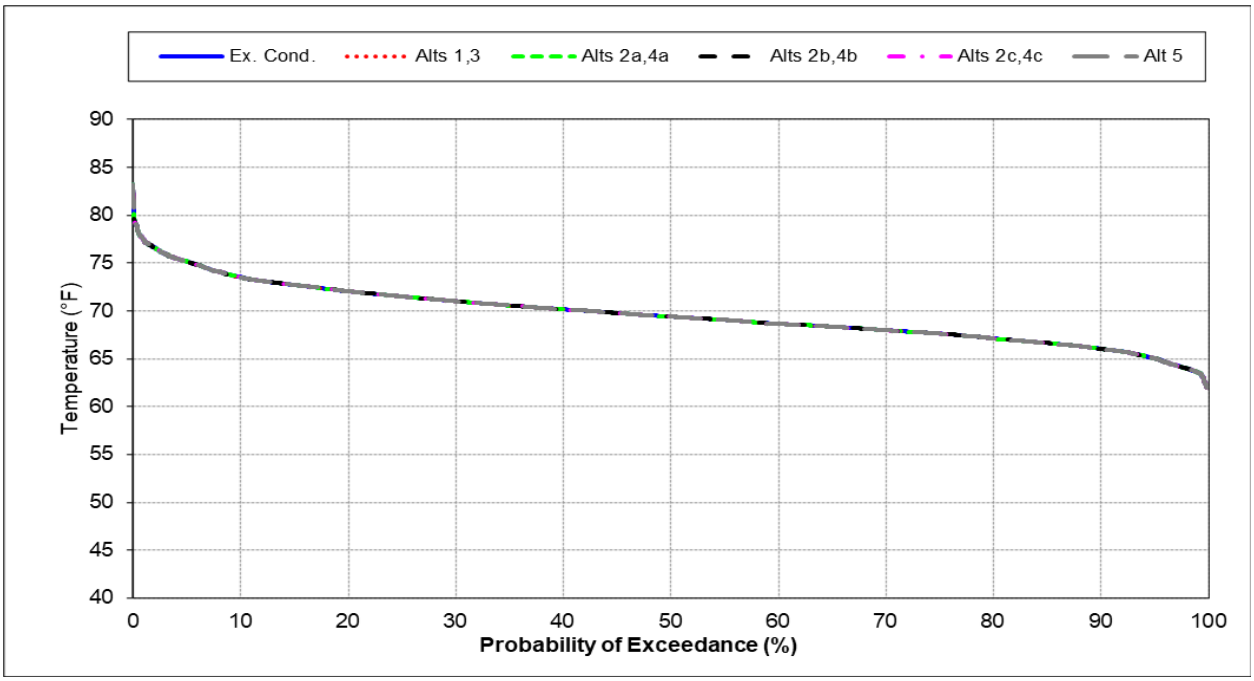



**Figure 6B.1-26. Franks Tract, Daily Average Temperature (in degrees Fahrenheit), July**

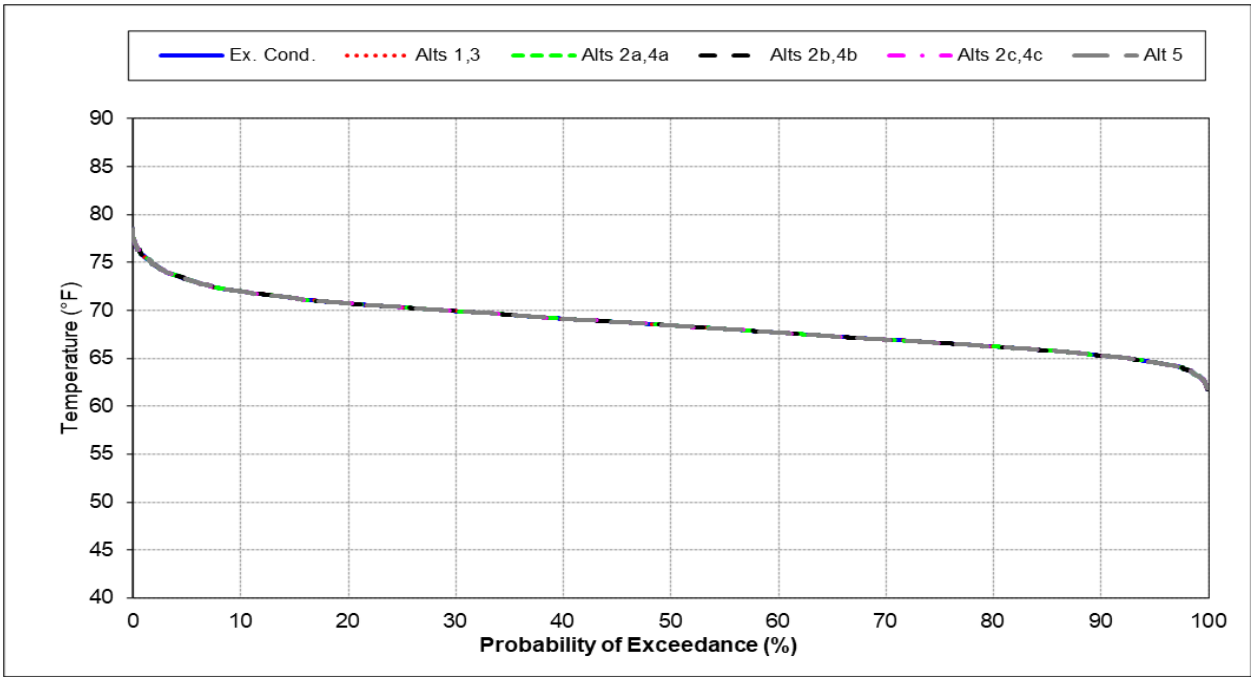



**Figure 6B.1-27. Franks Tract, Daily Average Temperature (in degrees Fahrenheit), August**

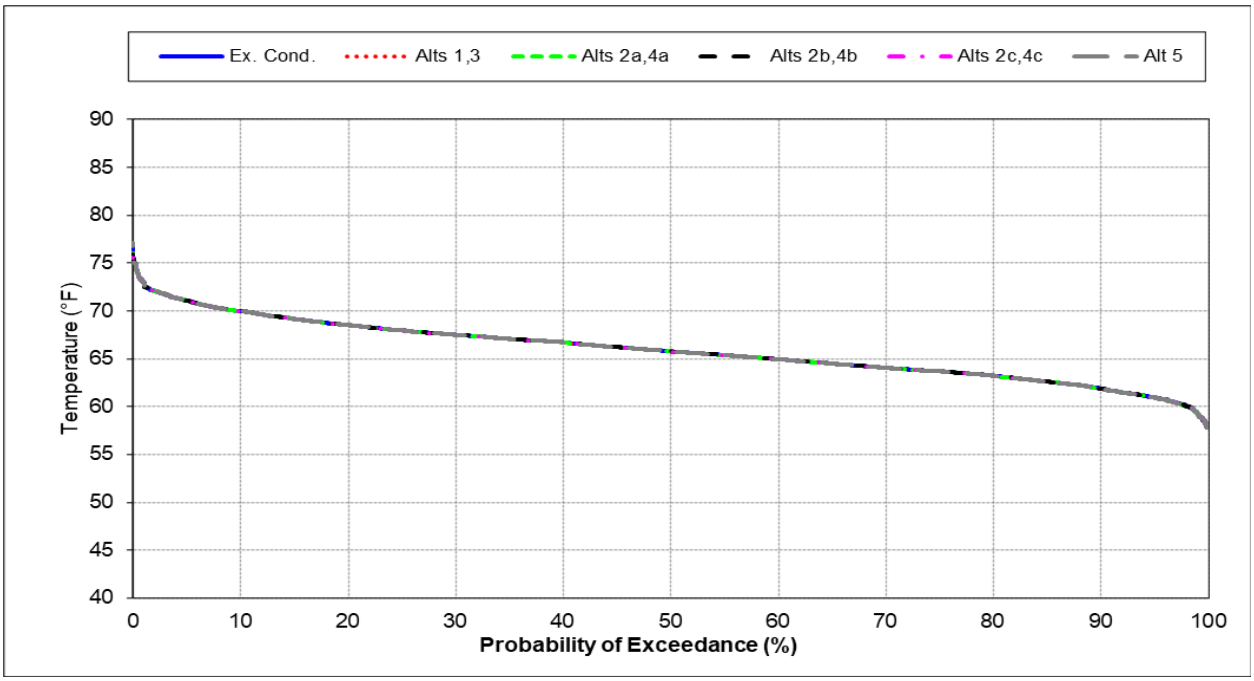



**Figure 6B.1-28. Franks Tract, Daily Average Temperature (in degrees Fahrenheit), September**

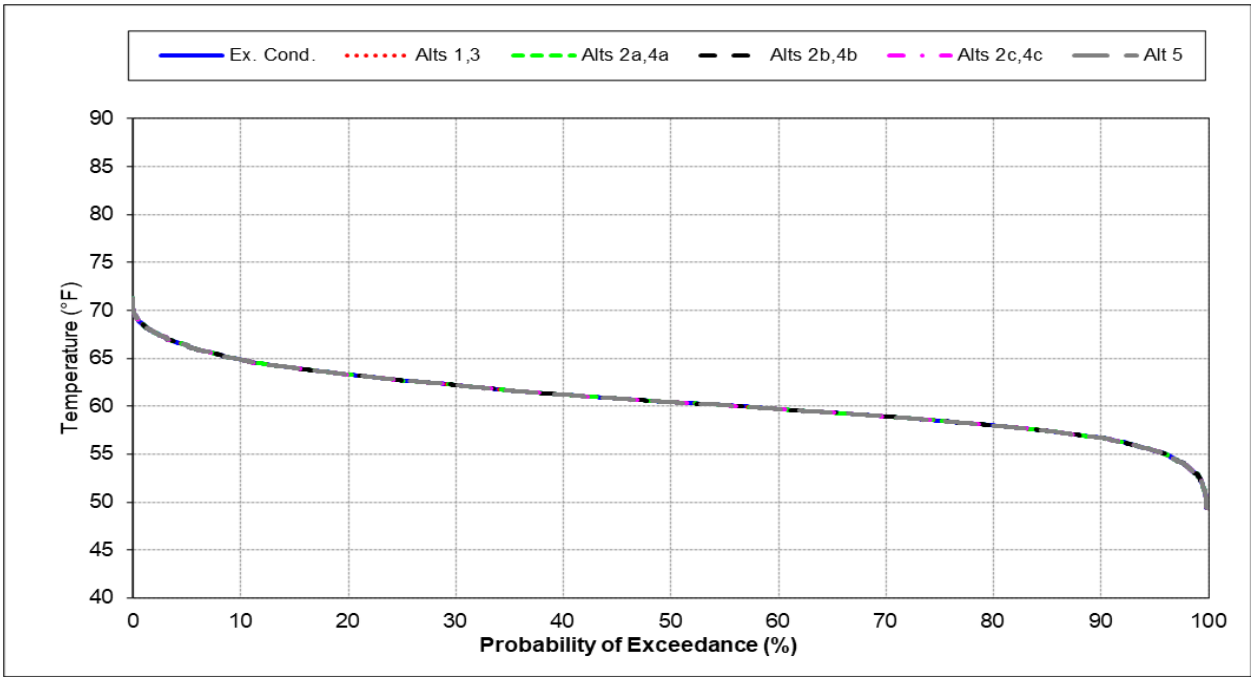



**Figure 6B.1-29. Franks Tract, Daily Average Temperature (in degrees Fahrenheit), October**

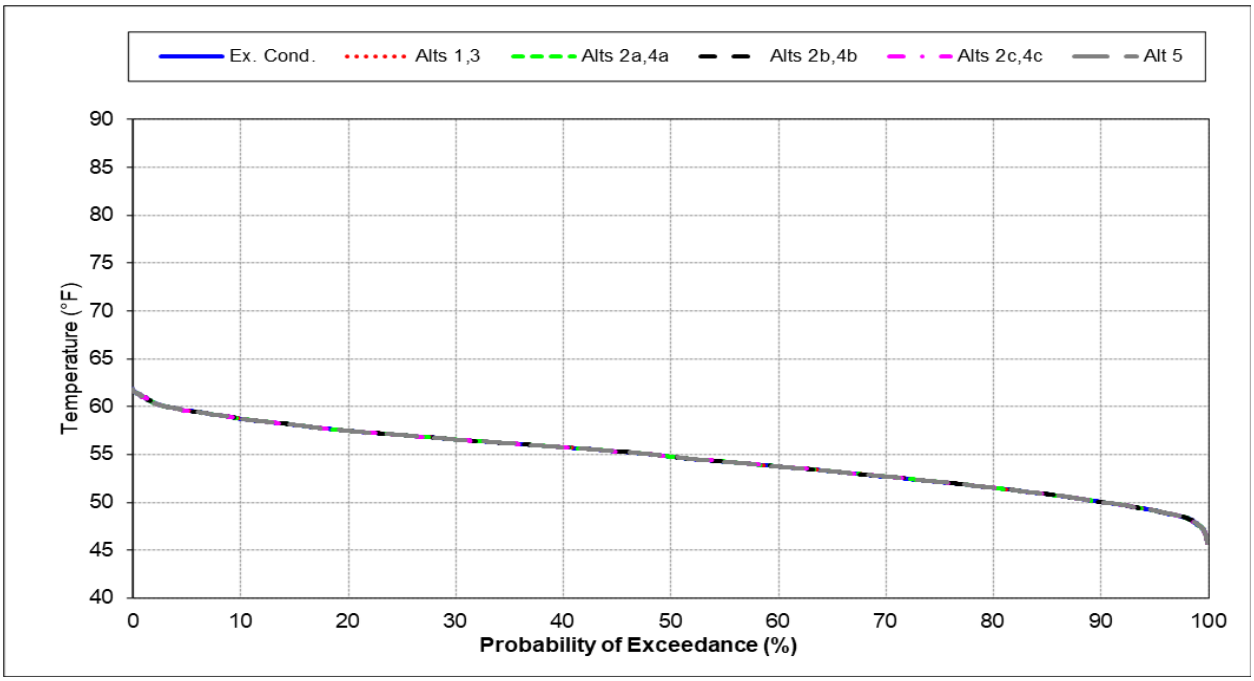



**Figure 6B.1-30. Franks Tract, Daily Average Temperature (in degrees Fahrenheit), November**

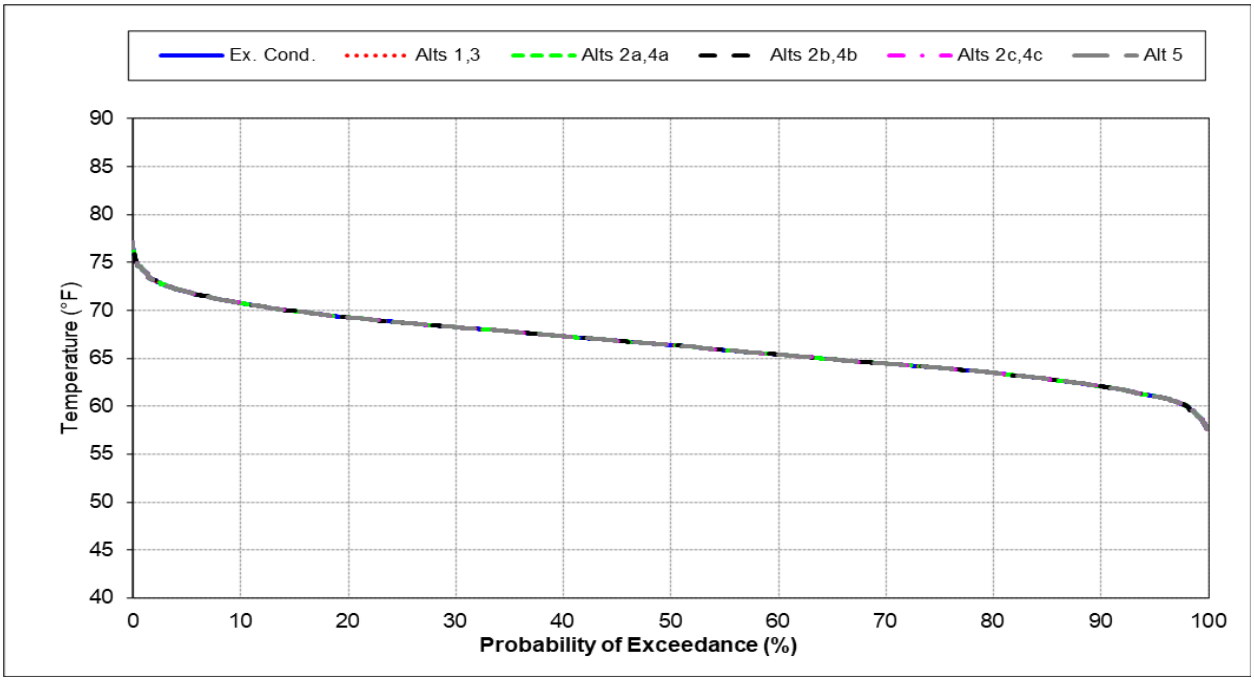



**Figure 6B.1-31. Victoria Canal, Daily Average Temperature (in degrees Fahrenheit), June**

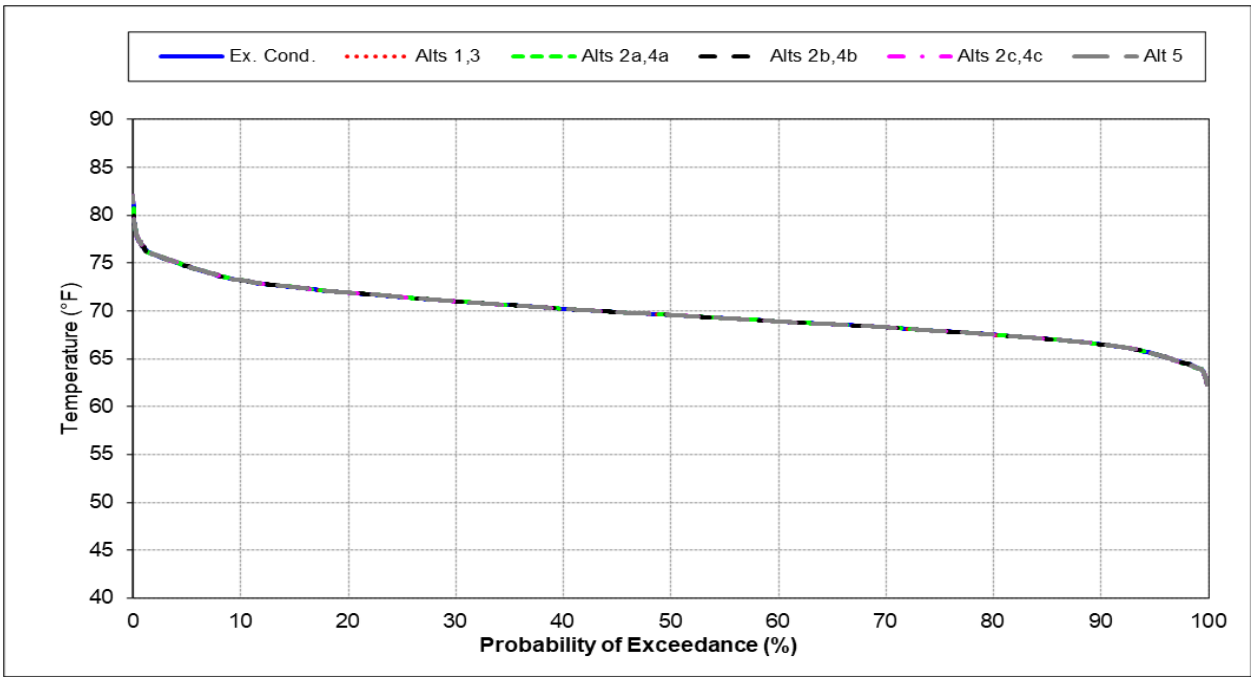



**Figure 6B.1-32. Victoria Canal, Daily Average Temperature (in degrees Fahrenheit), July**

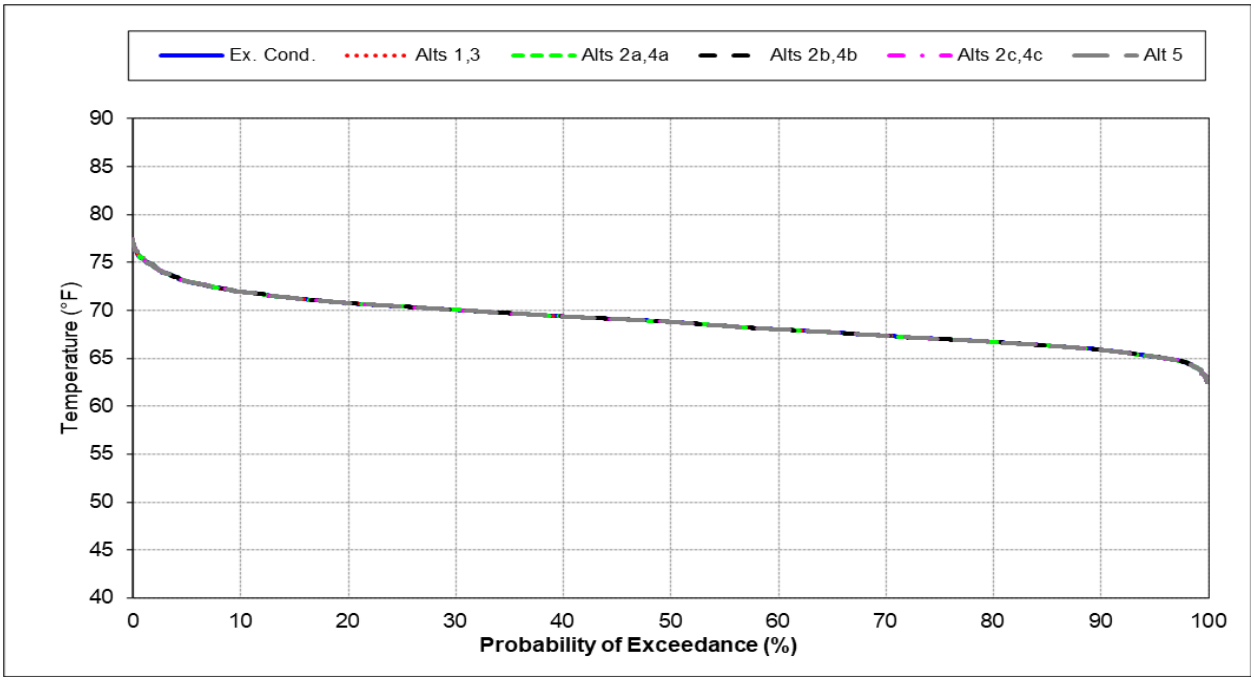



**Figure 6B.1-33. Victoria Canal, Daily Average Temperature (in degrees Fahrenheit), August**

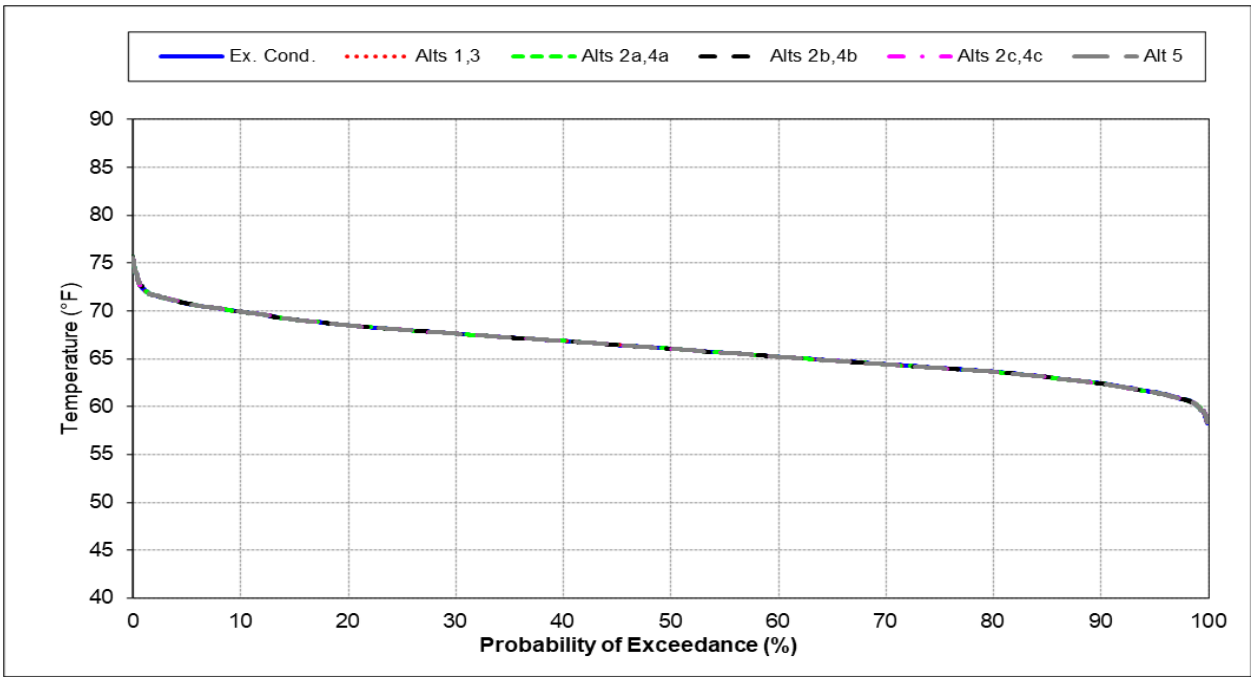



**Figure 6B.1-34. Victoria Canal, Daily Average Temperature (in degrees Fahrenheit), September**

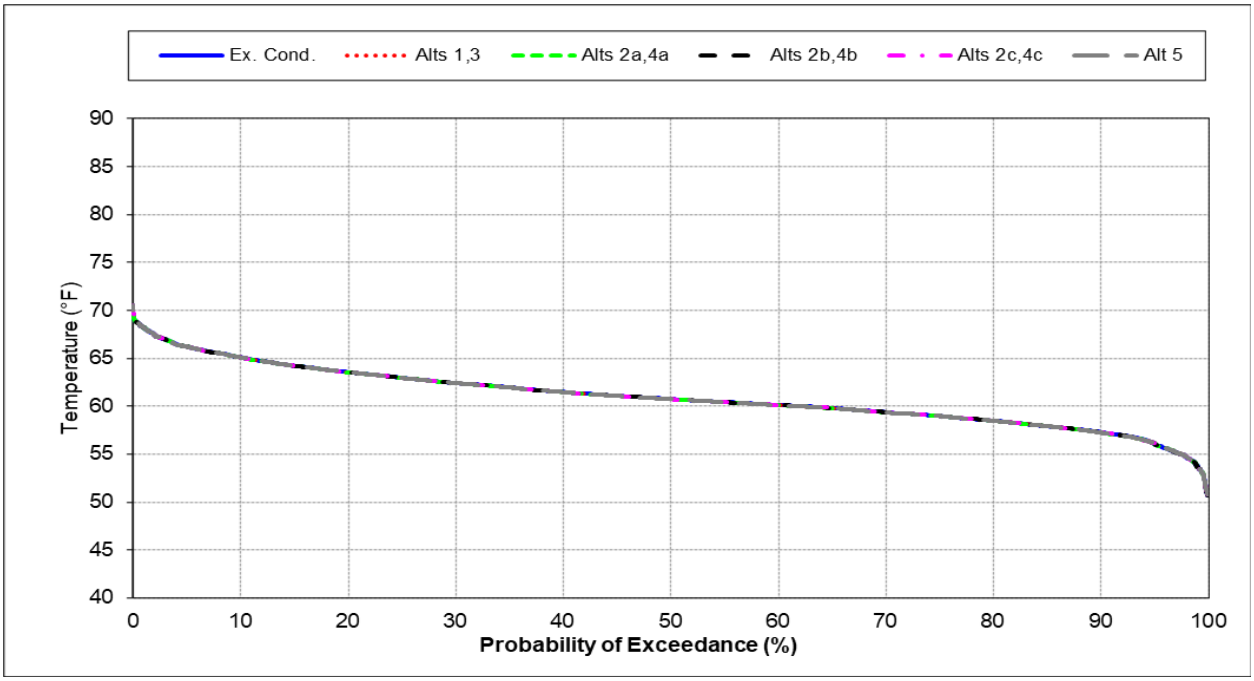



**Figure 6B.1-35. Victoria Canal, Daily Average Temperature (in degrees Fahrenheit), October**

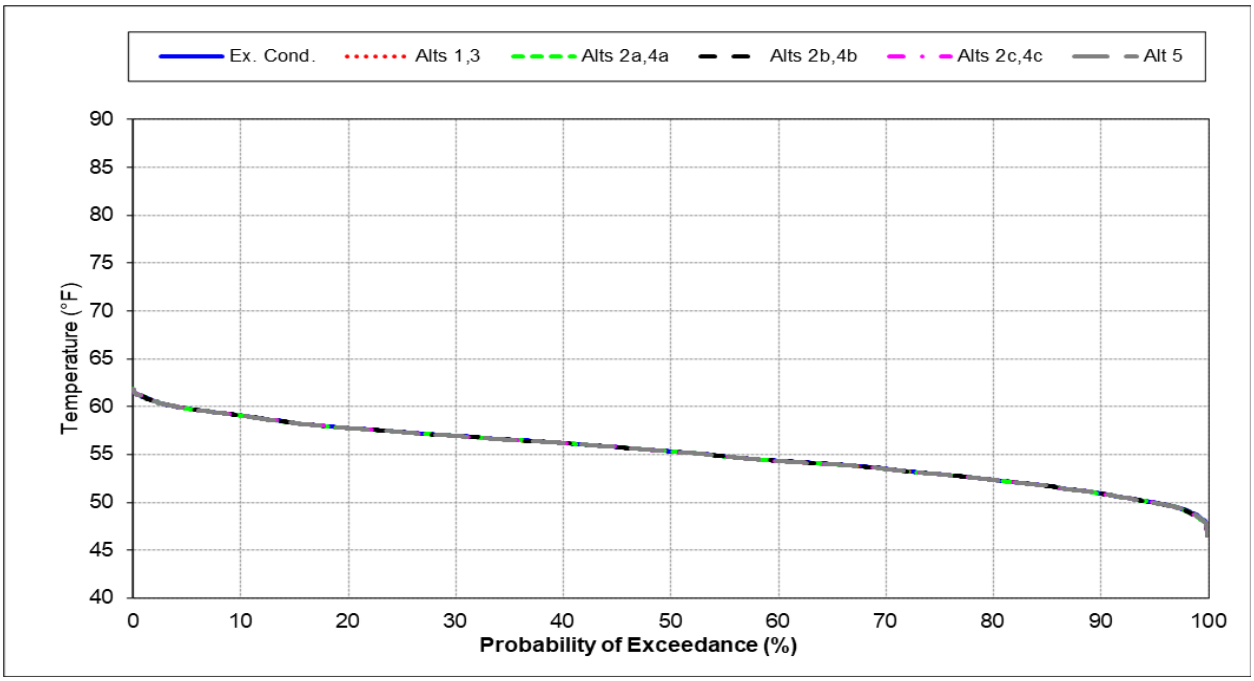



**Figure 6B.1-36. Victoria Canal, Daily Average Temperature (in degrees Fahrenheit), November**

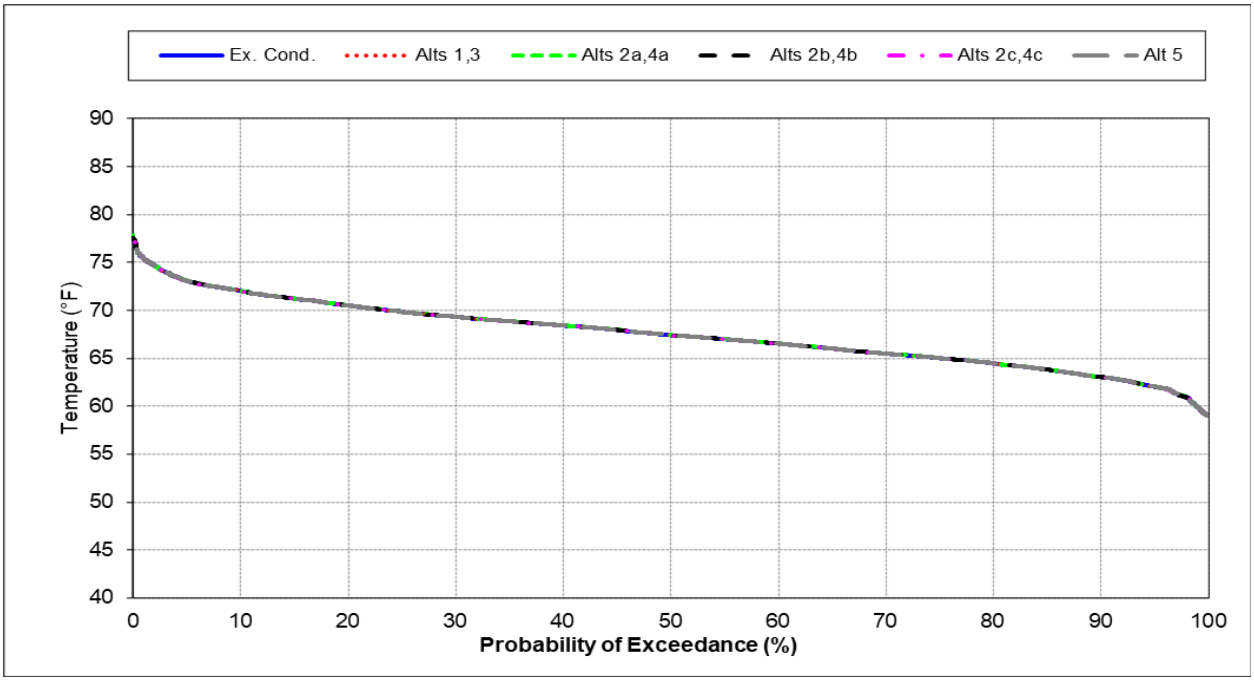



**Figure 6B.1-37. Stockton Deep Water Ship Channel, Daily Average Temperature (in degrees Fahrenheit), June**

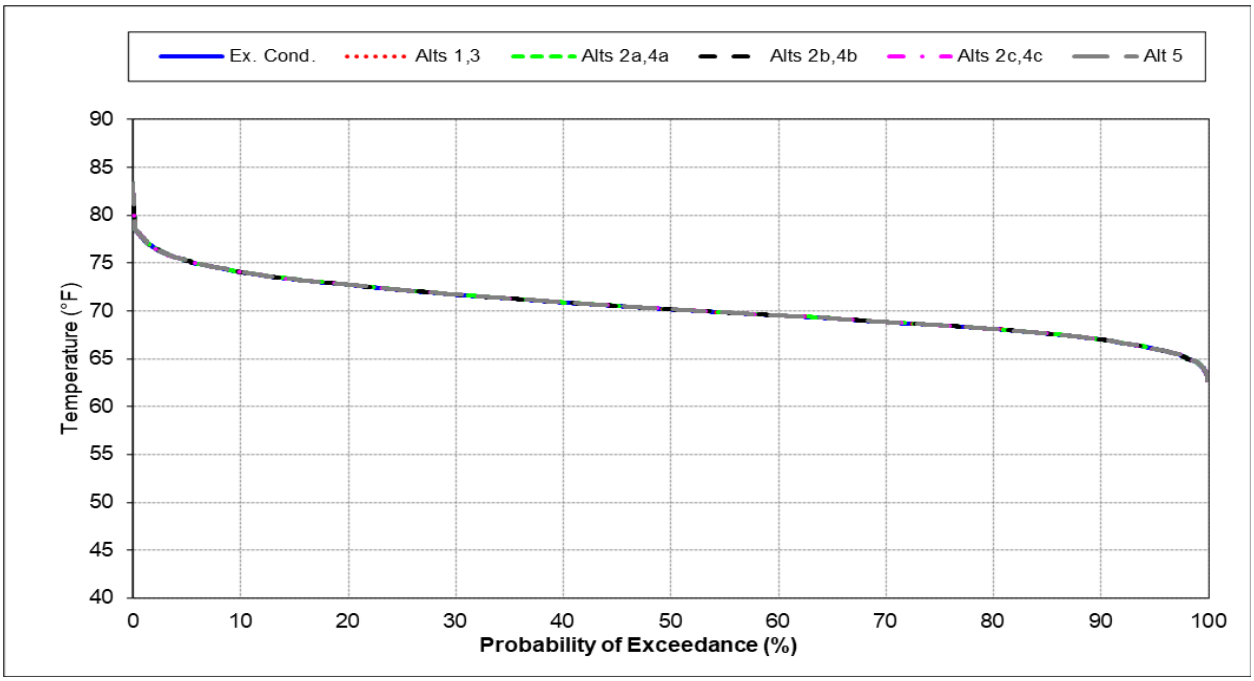



**Figure 6B.1-38. Stockton Deep Water Ship Channel, Daily Average Temperature (in degrees Fahrenheit), July**

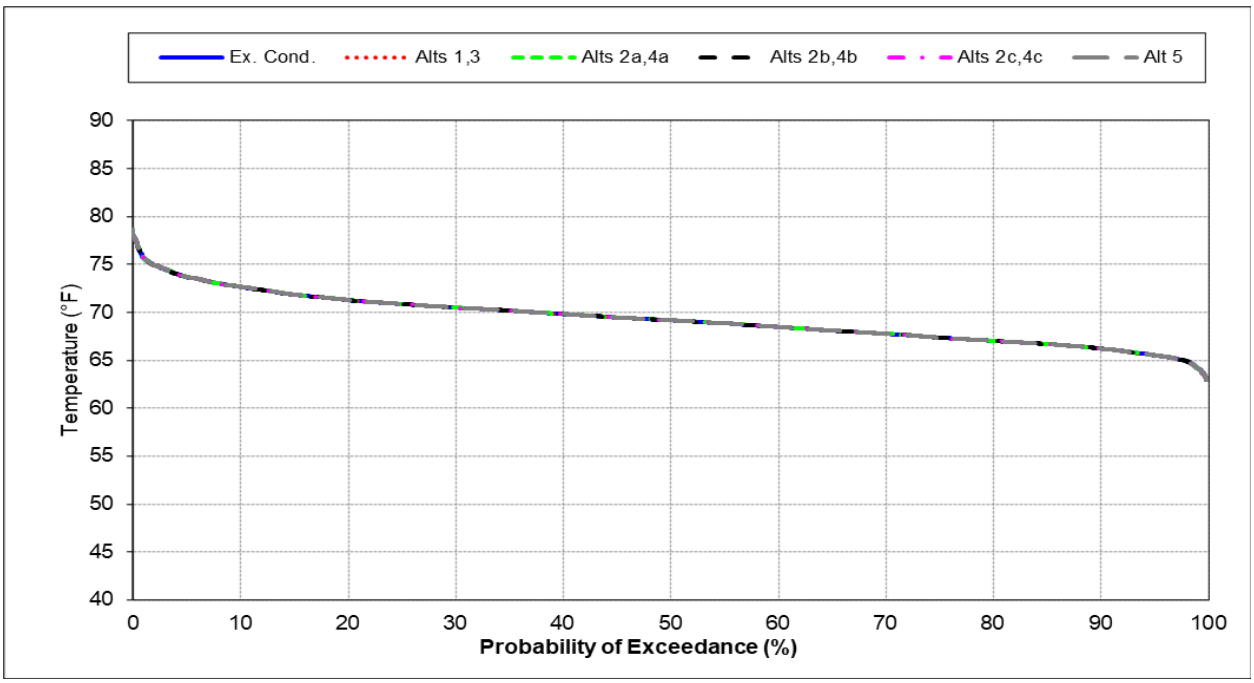



**Figure 6B.1-39. Stockton Deep Water Ship Channel, Daily Average Temperature (in degrees Fahrenheit), August**

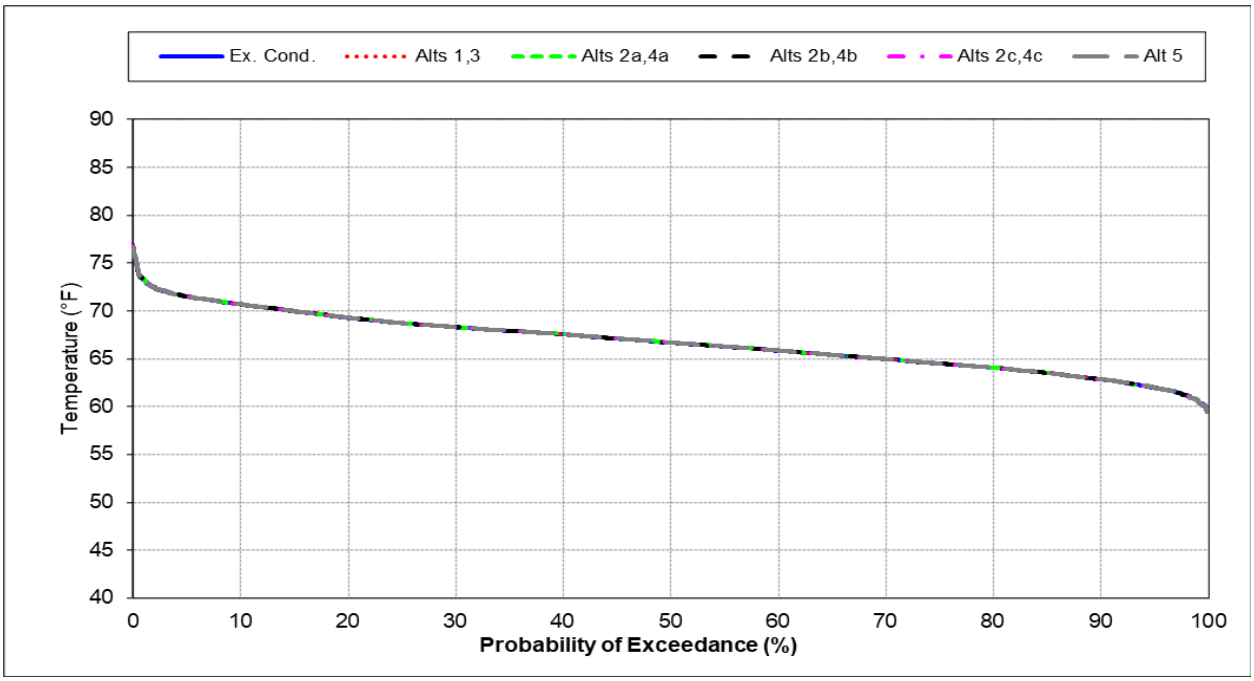



**Figure 6B.1-40. Stockton Deep Water Ship Channel, Daily Average Temperature (in degrees Fahrenheit), September**

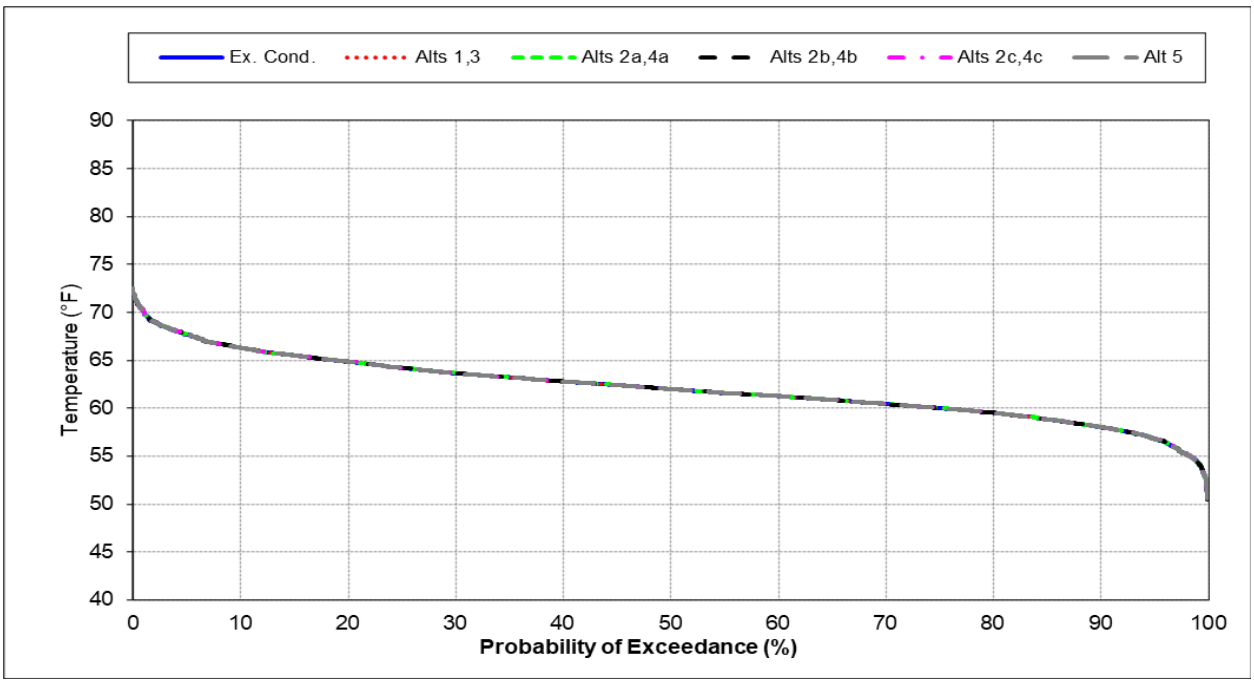



**Figure 6B.1-41. Stockton Deep Water Ship Channel, Daily Average Temperature (in degrees Fahrenheit), October**

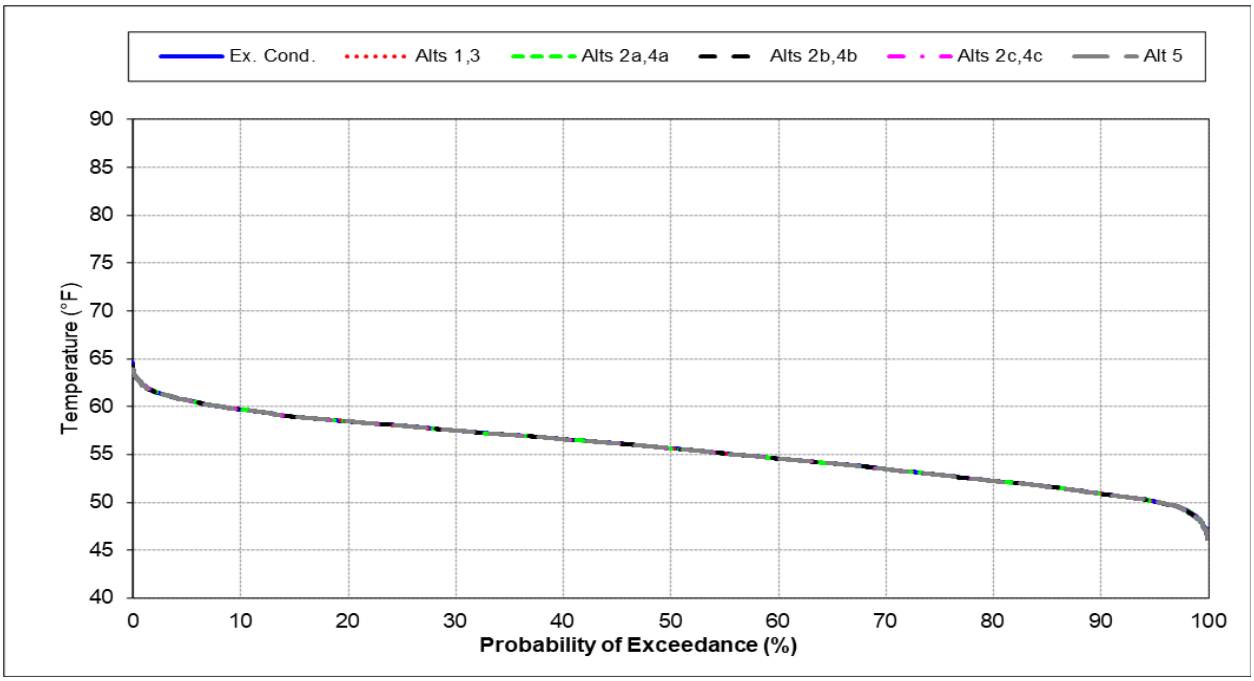



**Figure 6B.1-42. Stockton Deep Water Ship Channel, Daily Average Temperature (in degrees Fahrenheit), November**

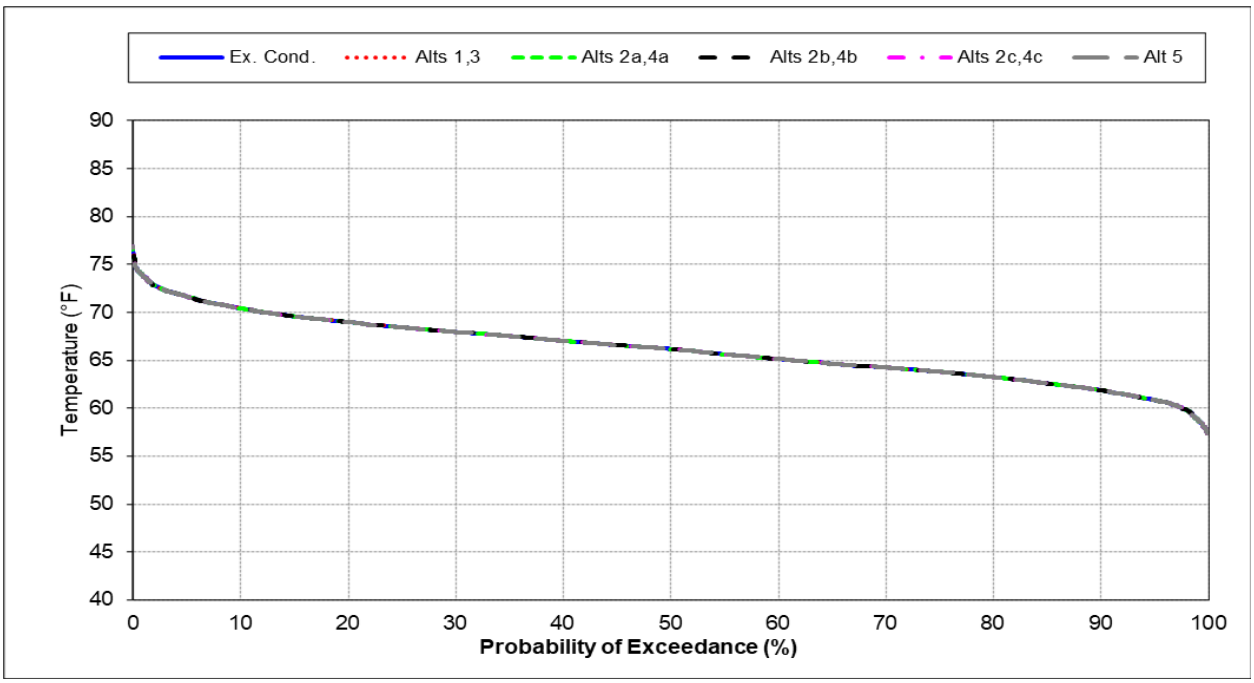



**Figure 6B.1-43. Mildred Island, Daily Average Temperature (in degrees Fahrenheit), June**

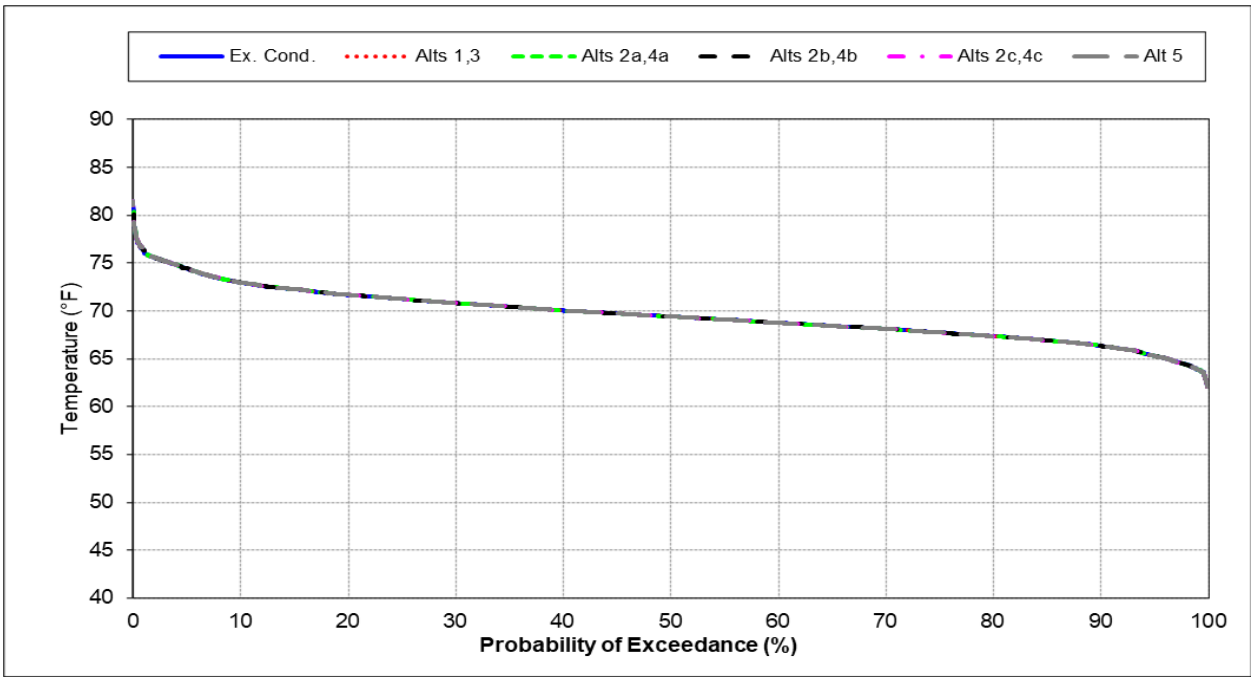



**Figure 6B.1-44. Mildred Island, Daily Average Temperature (in degrees Fahrenheit), July**

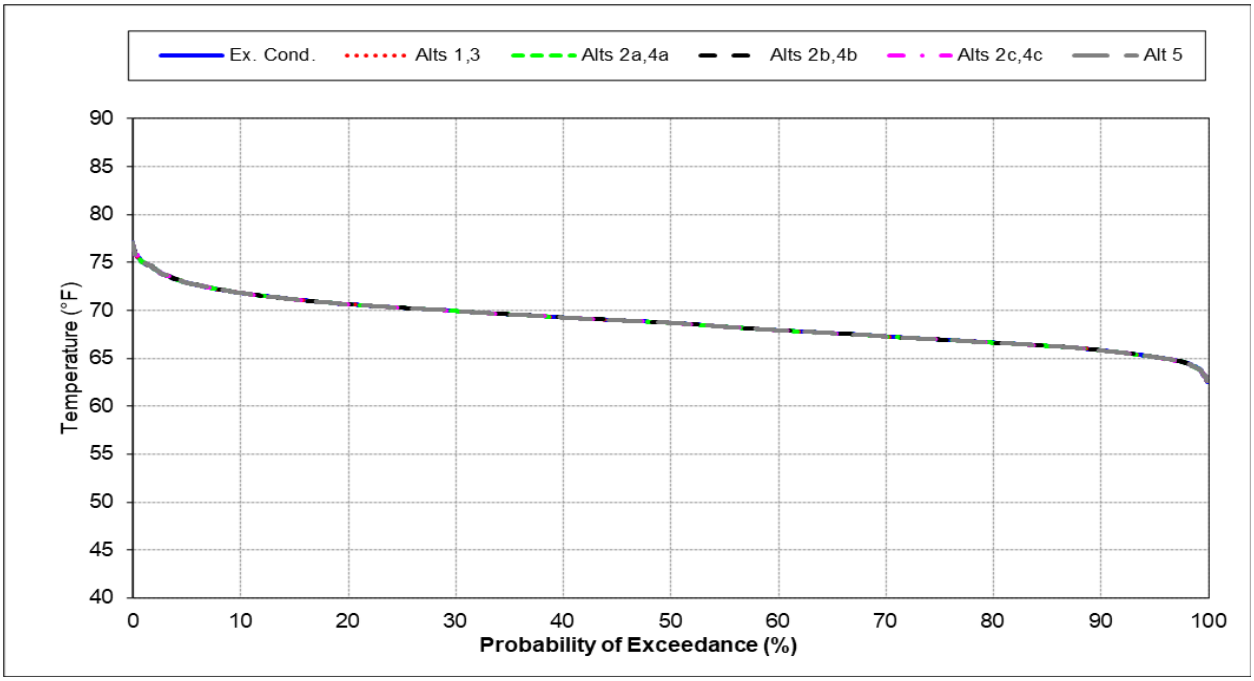



**Figure 6B.1-45. Mildred Island, Daily Average Temperature (in degrees Fahrenheit), August**

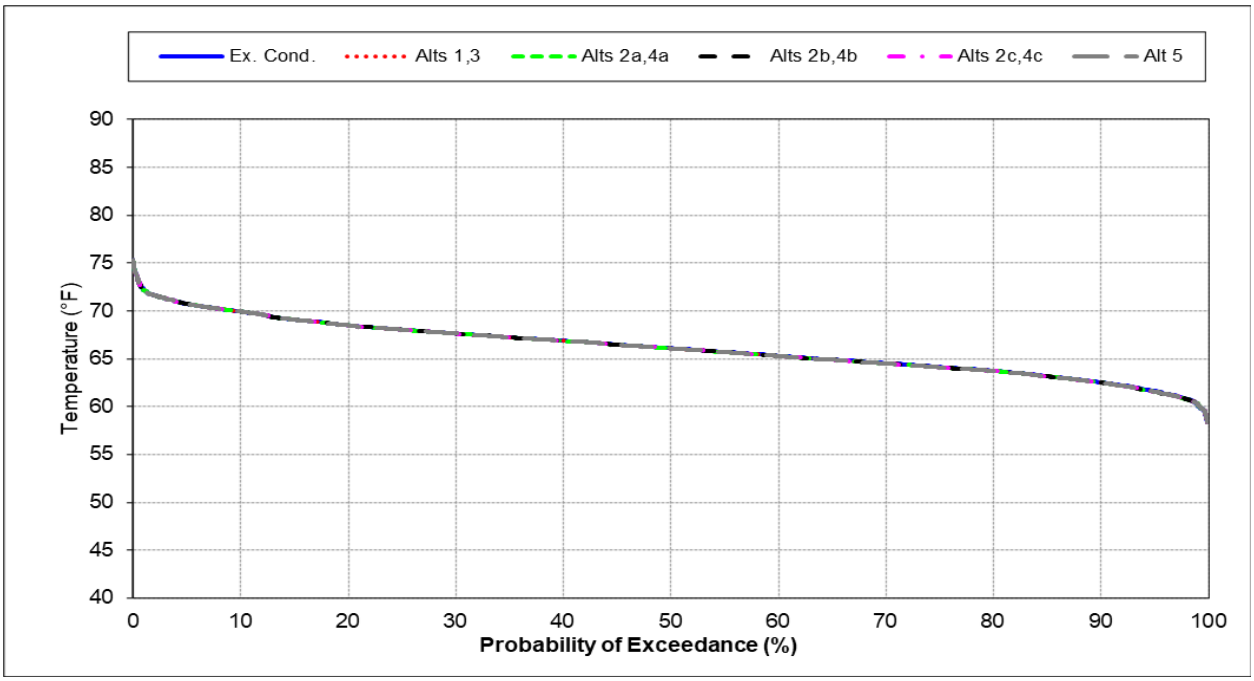



**Figure 6B.1-46. Mildred Island, Daily Average Temperature (in degrees Fahrenheit), September**

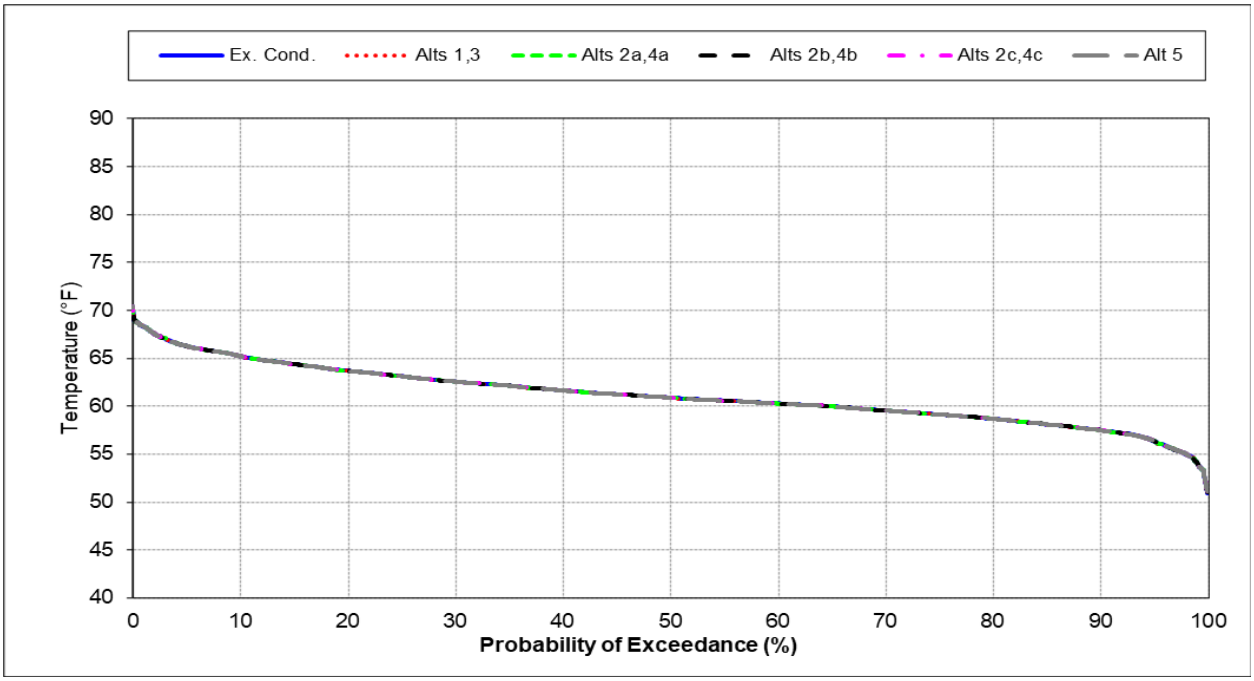



**Figure 6B.1-47. Mildred Island, Daily Average Temperature (in degrees Fahrenheit), October**

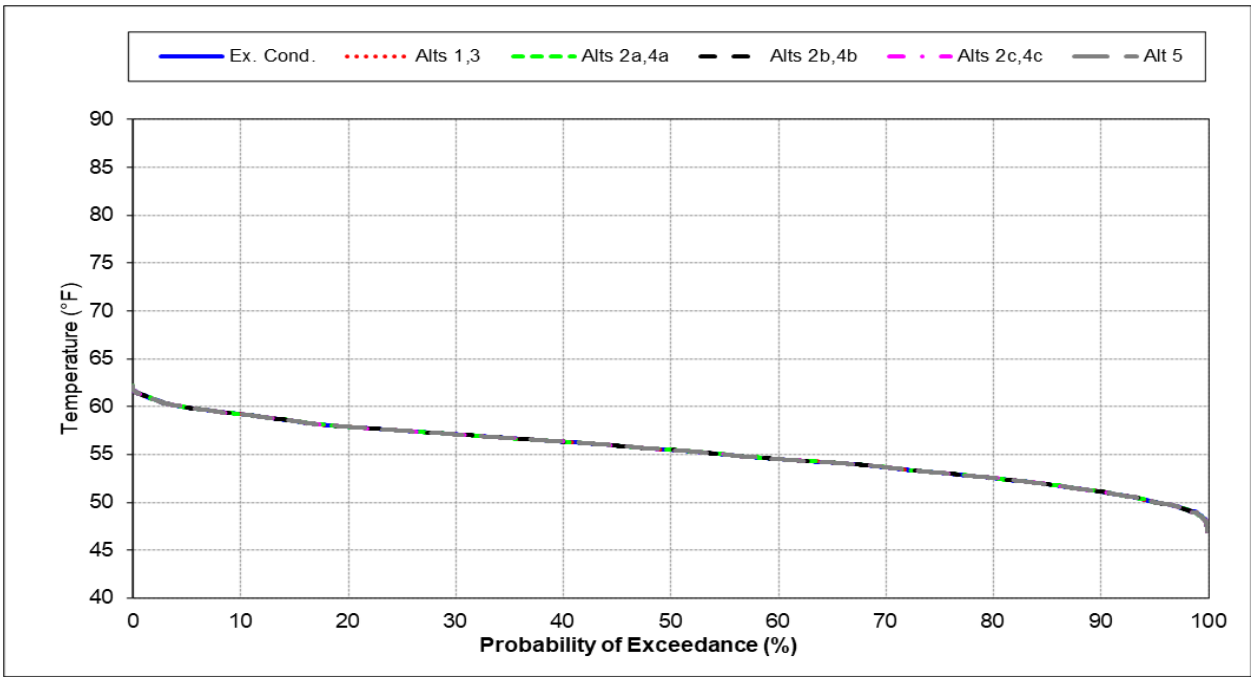



**Figure 6B.1-48. Mildred Island, Daily Average Temperature (in degrees Fahrenheit), November**

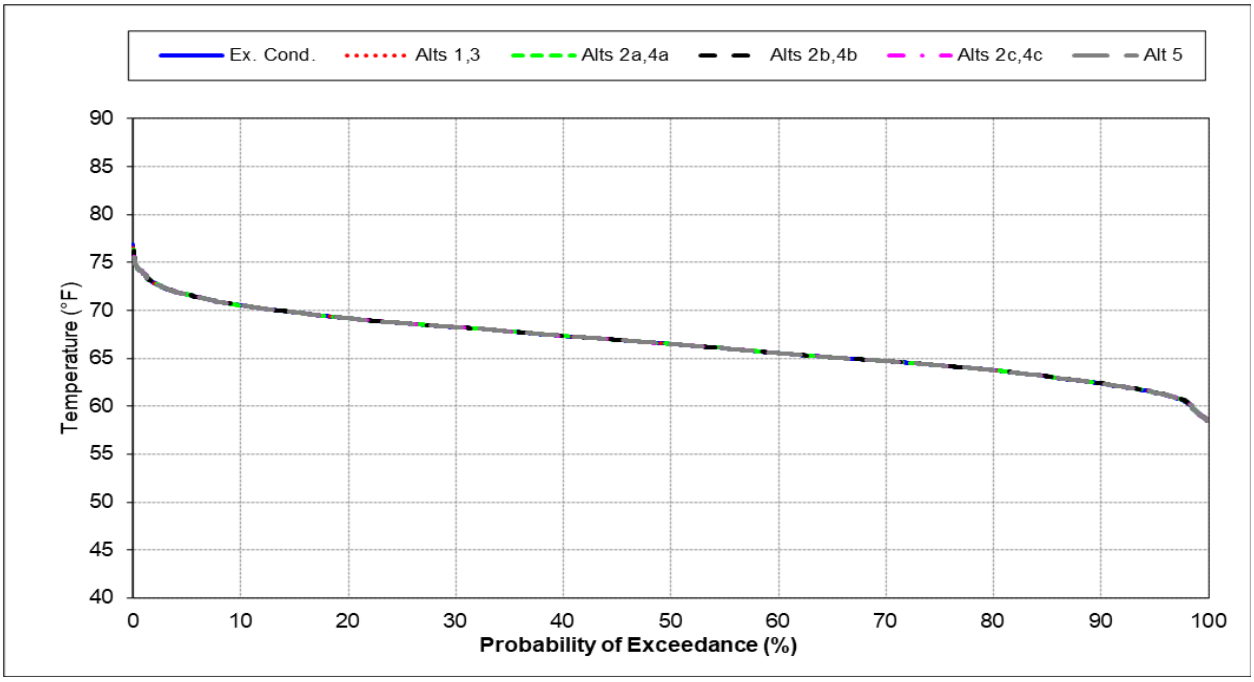



**Figure 6B.1-49. San Joaquin River near Venice Cut, Daily Average Temperature (in degrees Fahrenheit), June**

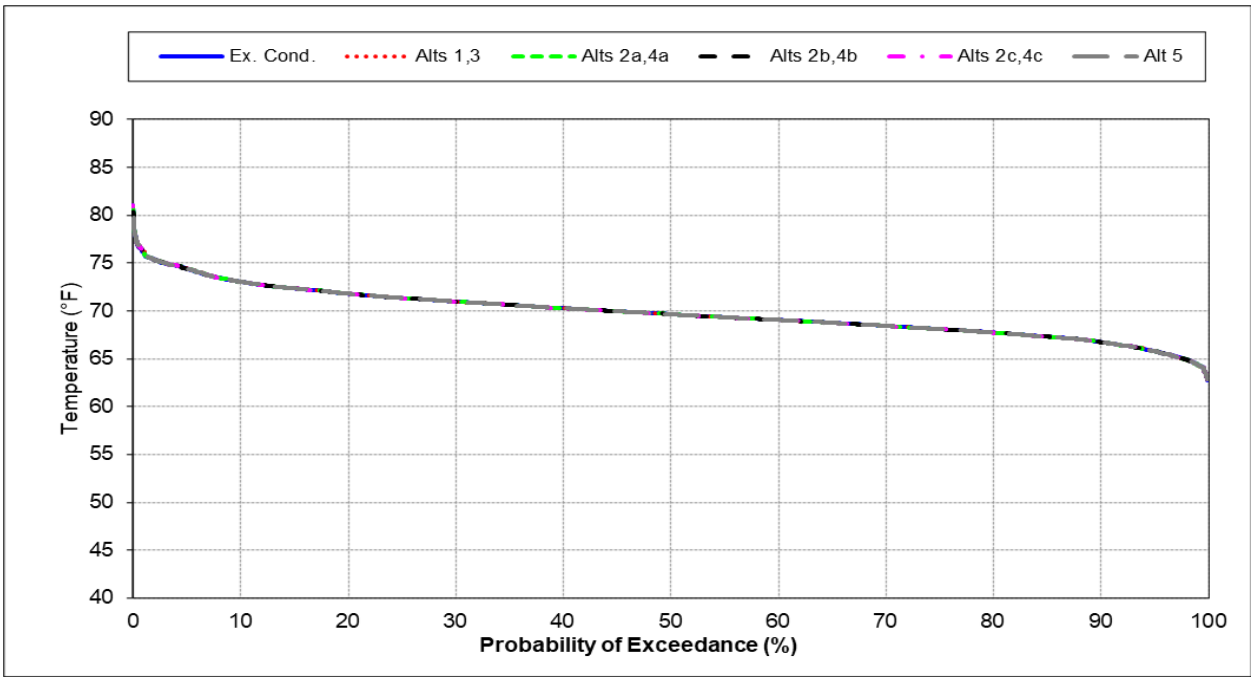



**Figure 6B.1-50. San Joaquin River near Venice Cut, Daily Average Temperature (in degrees Fahrenheit), July**

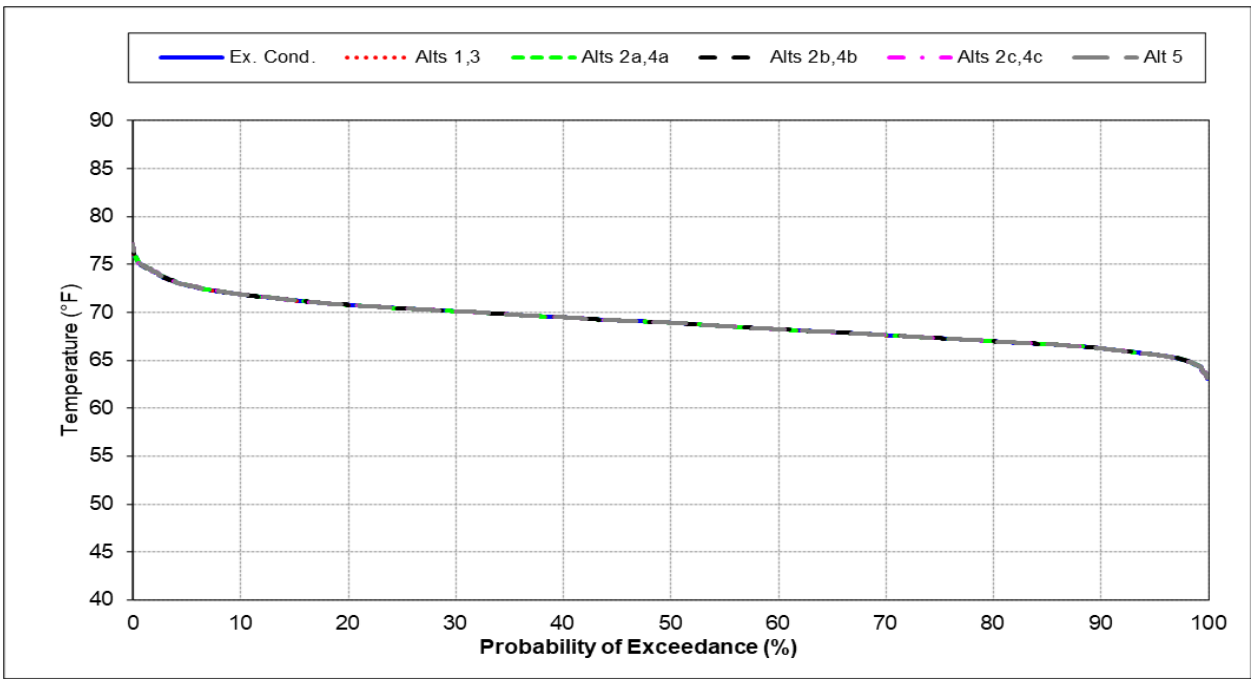



**Figure 6B.1-51. San Joaquin River near Venice Cut, Daily Average Temperature (in degrees Fahrenheit), August**

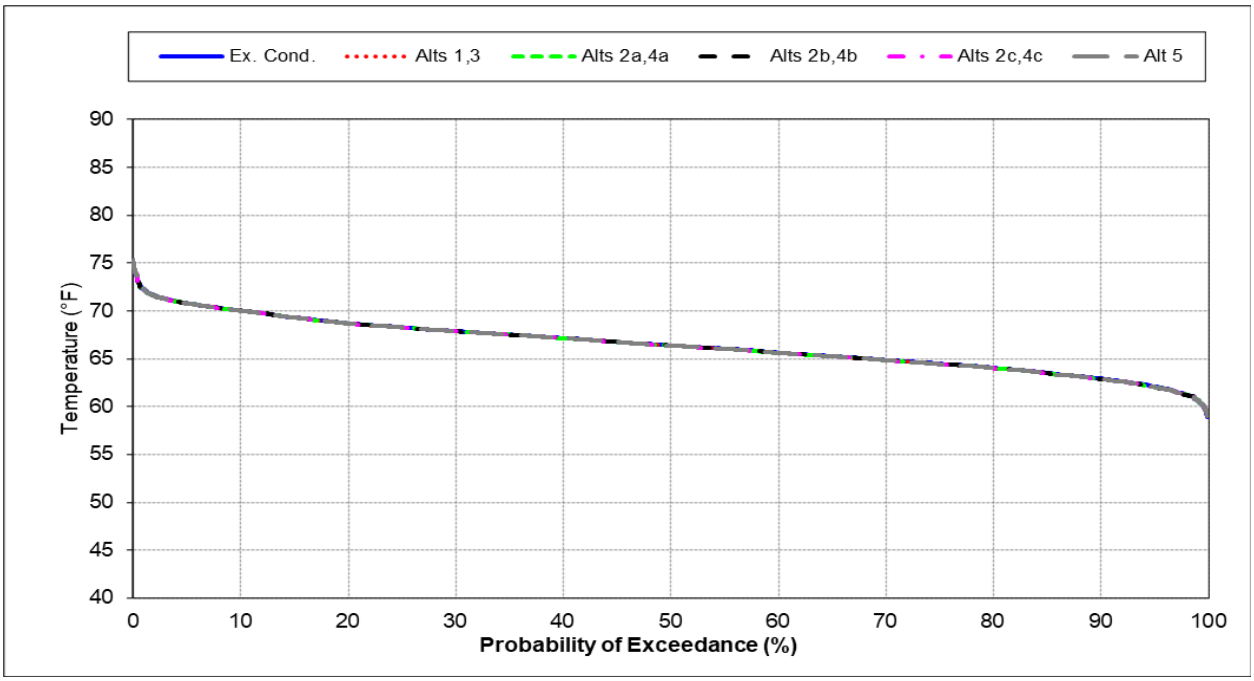



**Figure 6B.1-52. San Joaquin River near Venice Cut, Daily Average Temperature (in degrees Fahrenheit), September**

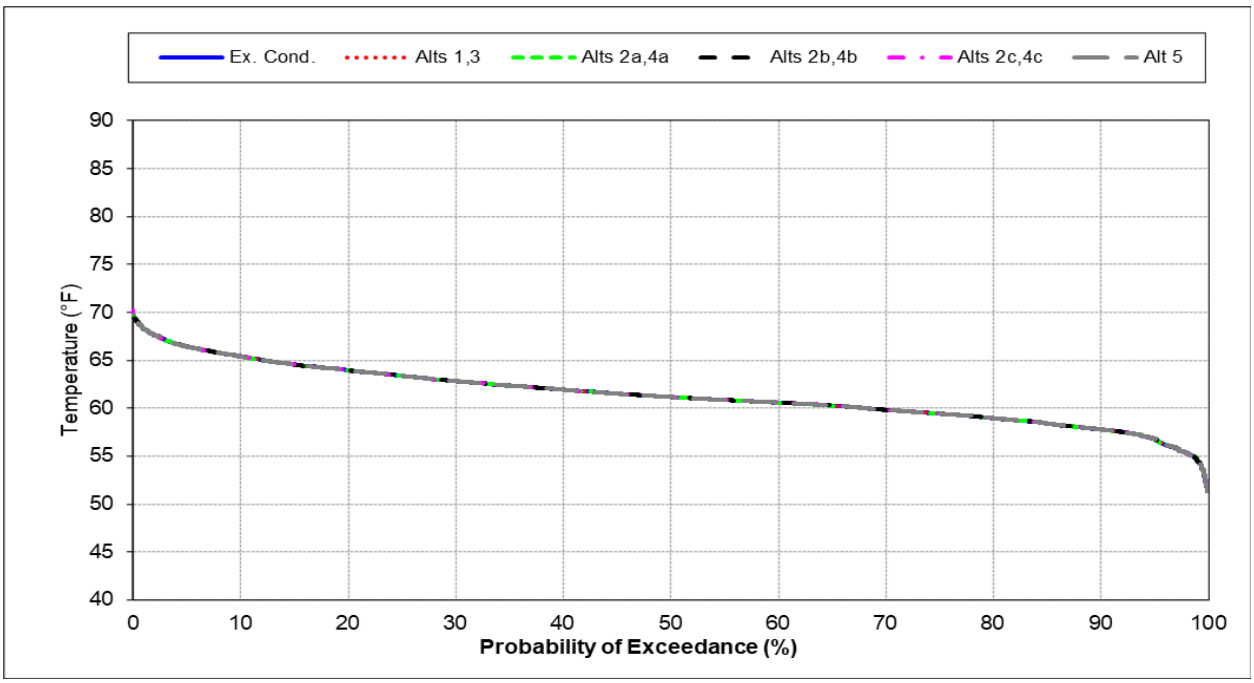



**Figure 6B.1-53. San Joaquin River near Venice Cut, Daily Average Temperature (in degrees Fahrenheit), October**

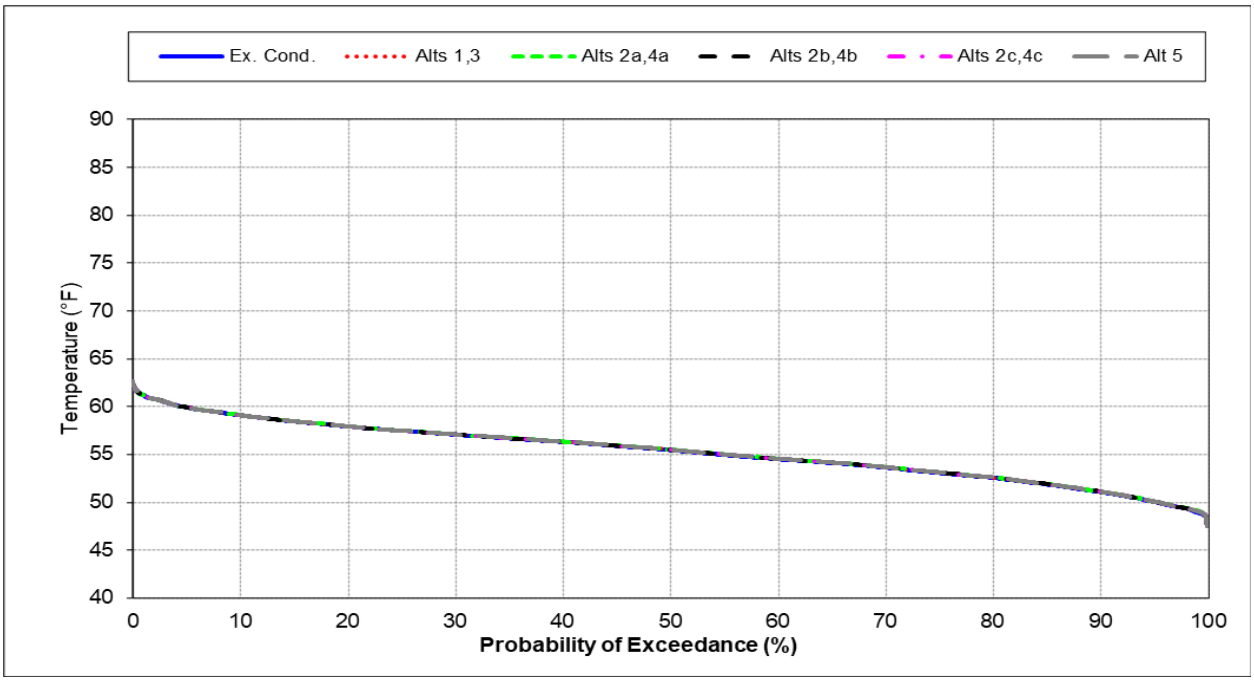



**Figure 6B.1-54. San Joaquin River near Venice Cut, Daily Average Temperature (in degrees Fahrenheit), November**

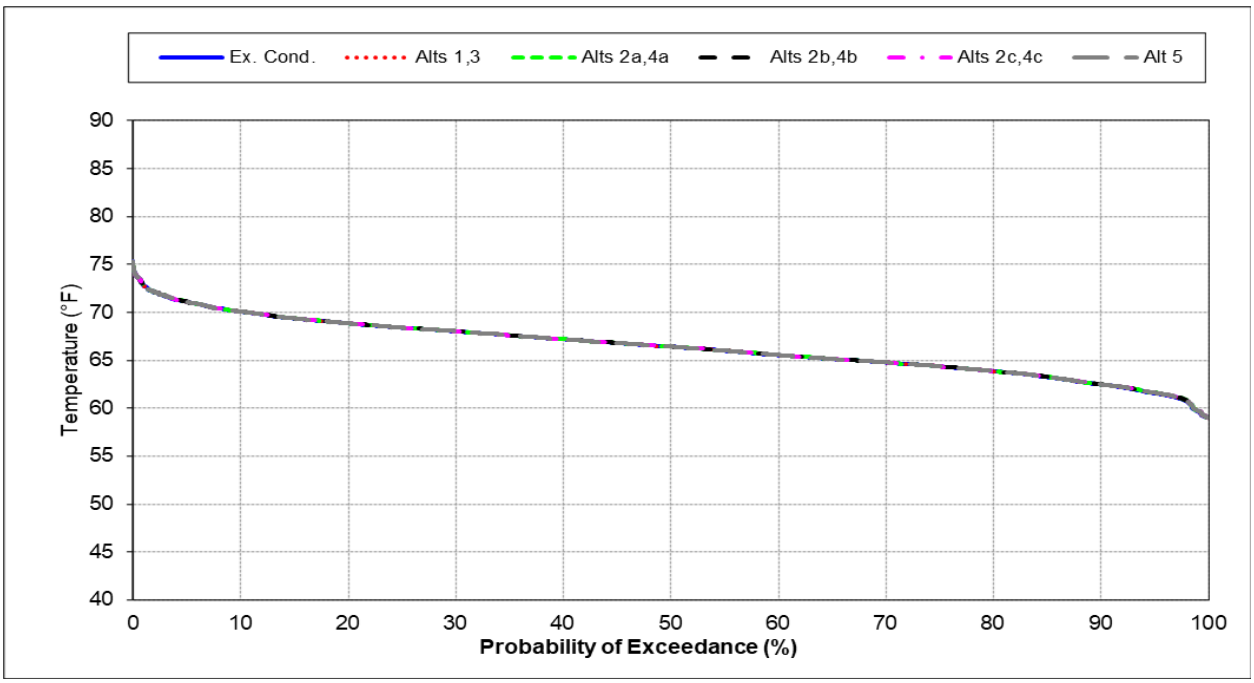



**Figure 6B.1-55. Mokelumne River, Daily Average Temperature (in degrees Fahrenheit), June**

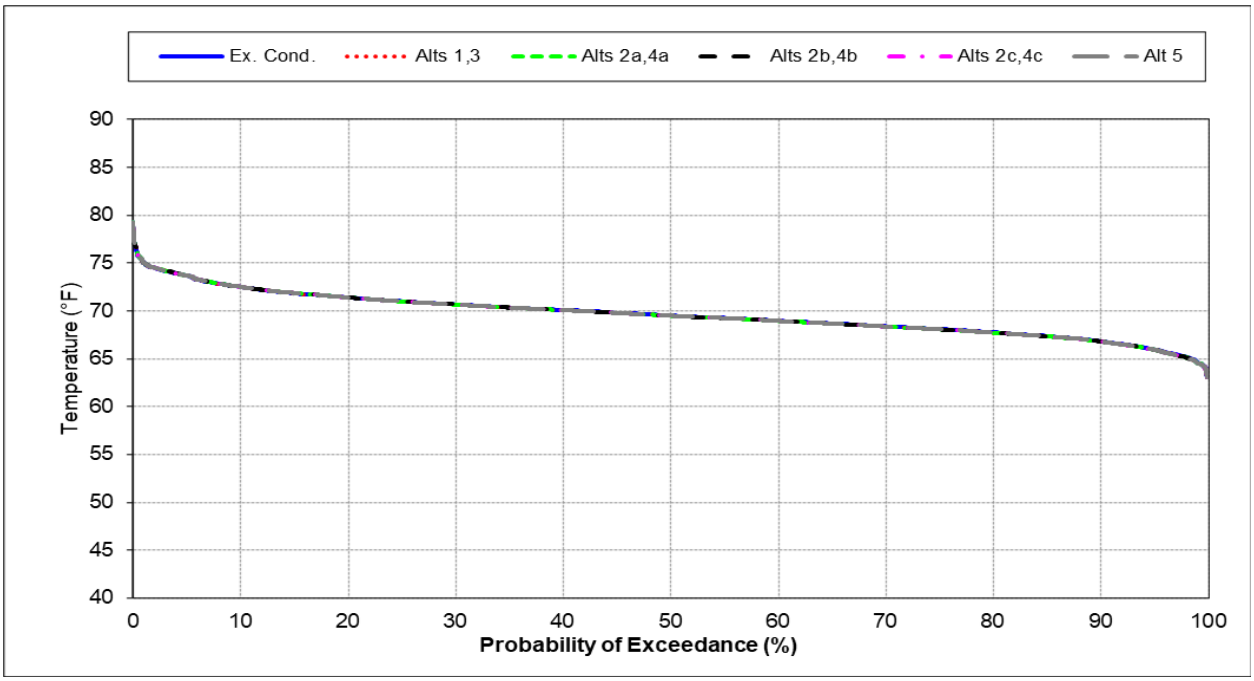



**Figure 6B.1-56. Mokelumne River, Daily Average Temperature (in degrees Fahrenheit), July**

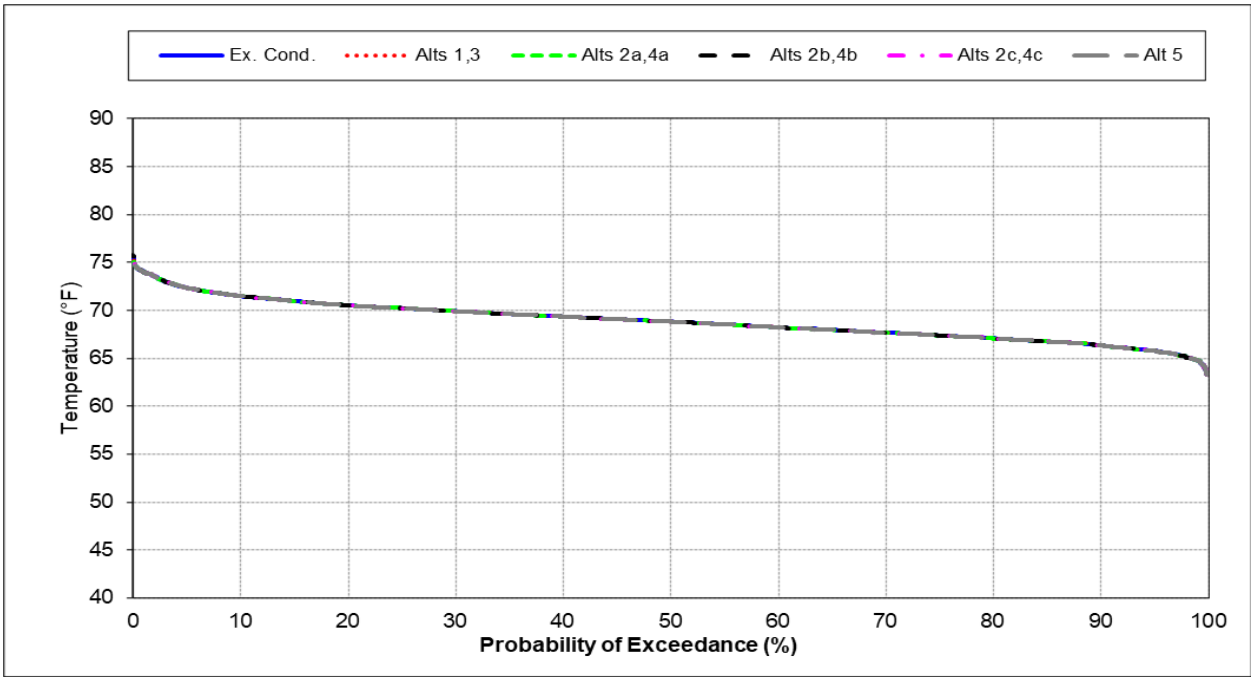



**Figure 6B.1-57. Mokelumne River, Daily Average Temperature (in degrees Fahrenheit), August**

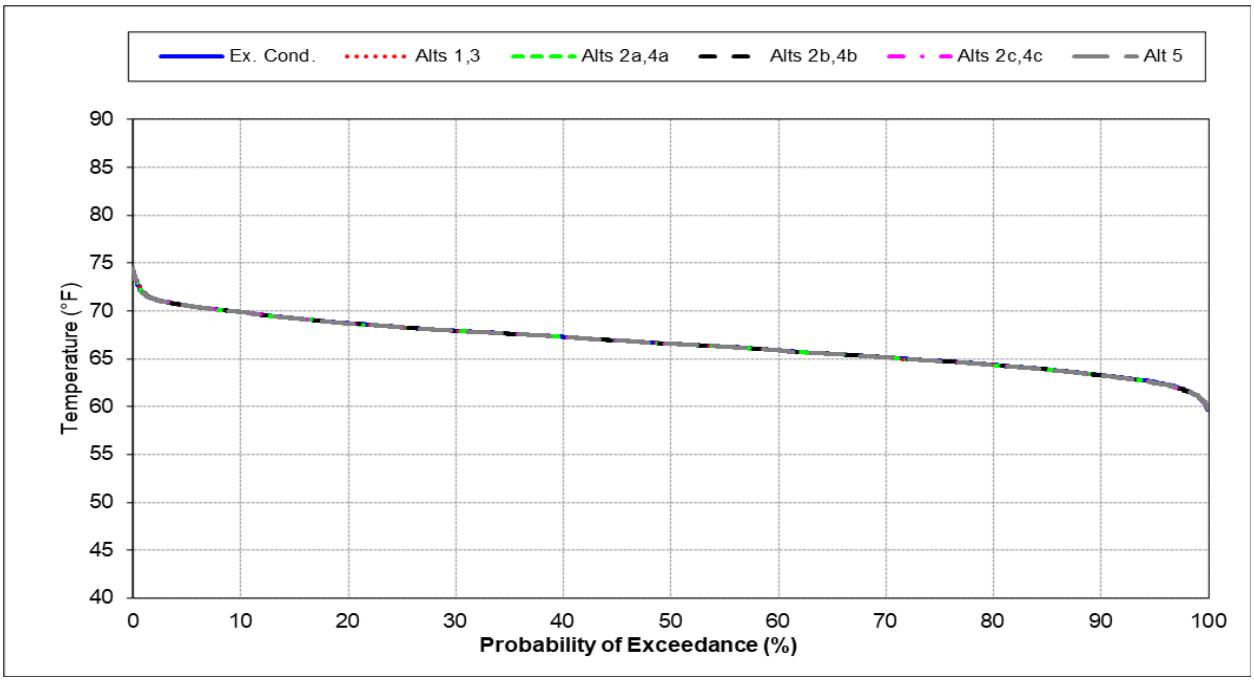



**Figure 6B.1-58. Mokelumne River, Daily Average Temperature (in degrees Fahrenheit), September**

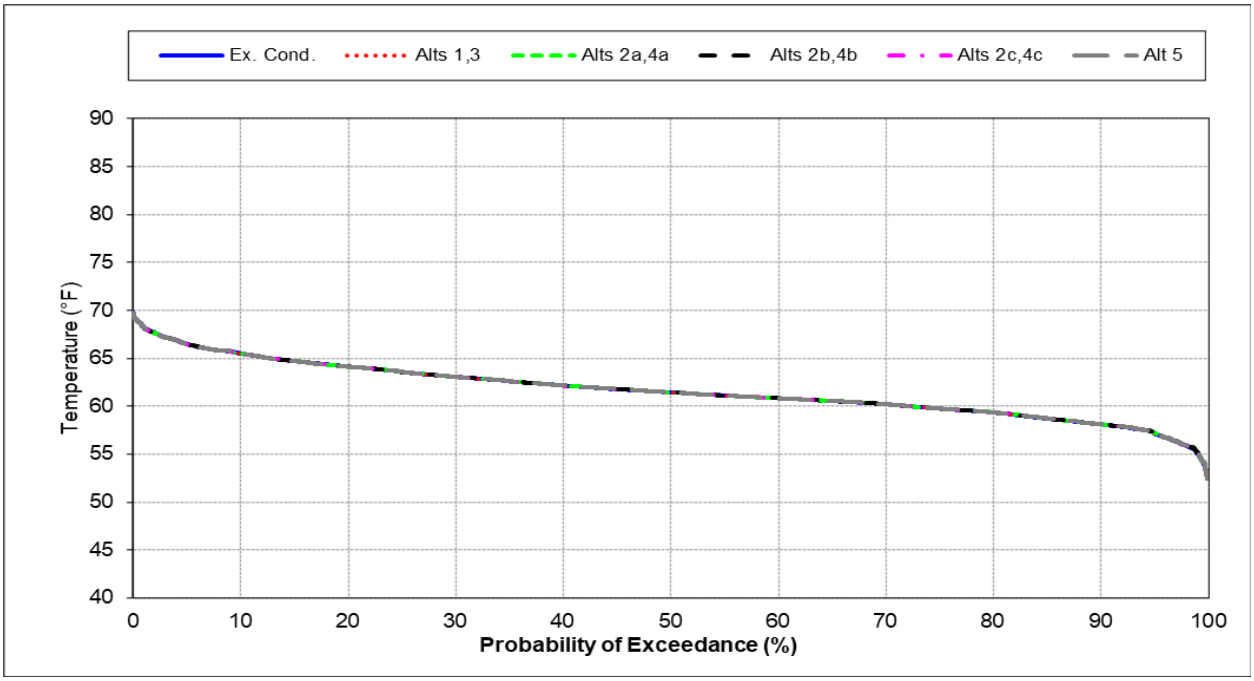



**Figure 6B.1-59. Mokelumne River, Daily Average Temperature (in degrees Fahrenheit), October**

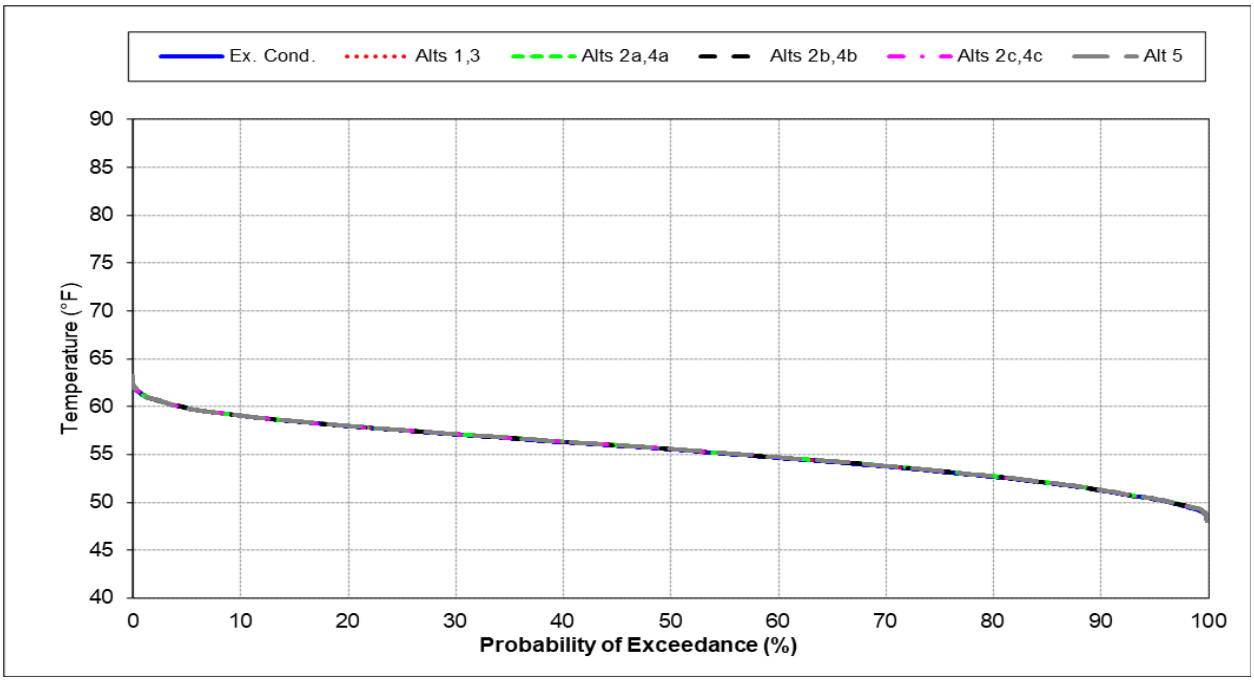



**Figure 6B.1-60. Mokelumne River, Daily Average Temperature (in degrees Fahrenheit), November**

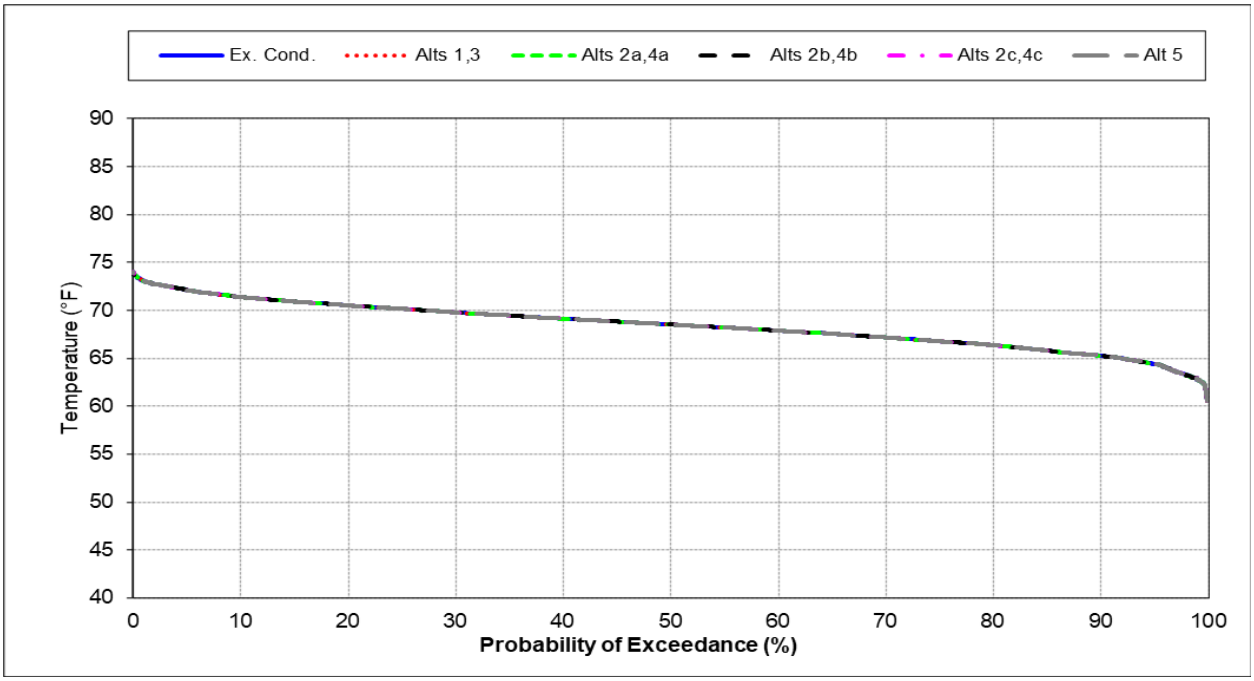



**Figure 6B.1-61. Sacramento River at I Street Bridge, Daily Average Temperature (in degrees Fahrenheit), June**

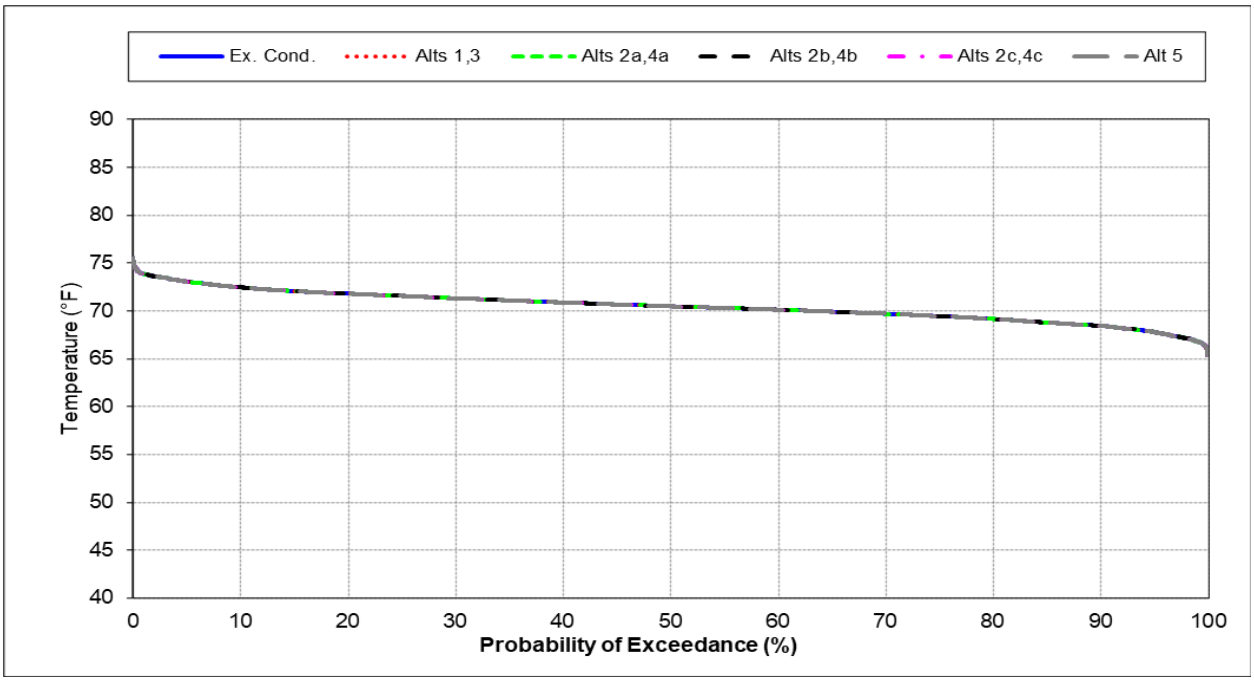



**Figure 6B.1-62. Sacramento River at I Street Bridge, Daily Average Temperature (in degrees Fahrenheit), July**

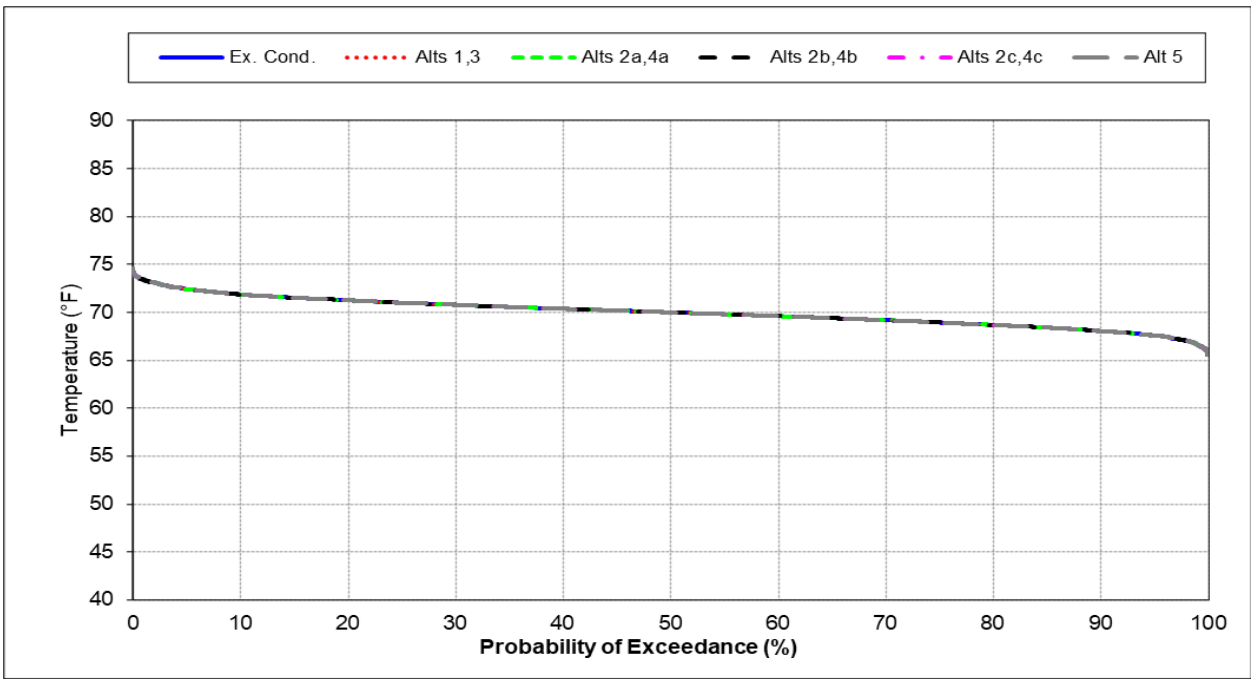



**Figure 6B.1-63. Sacramento River at I Street Bridge, Daily Average Temperature (in degrees Fahrenheit), August**

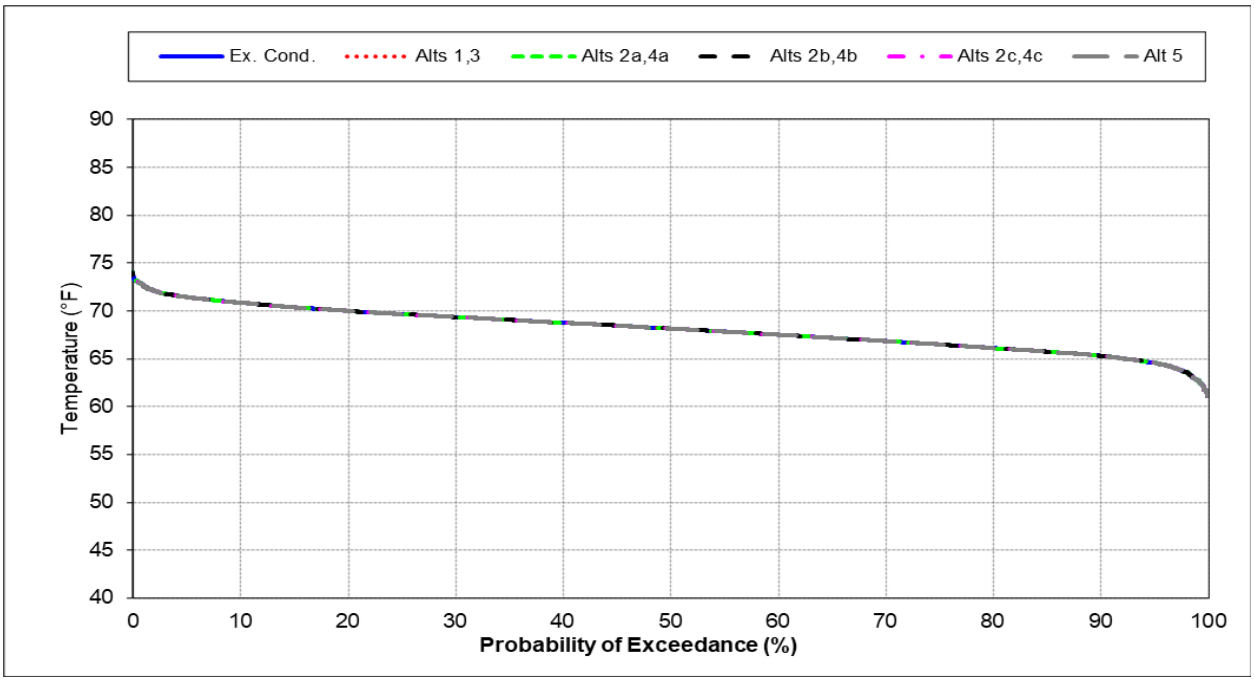



**Figure 6B.1-64. Sacramento River at I Street Bridge, Daily Average Temperature (in degrees Fahrenheit), September**

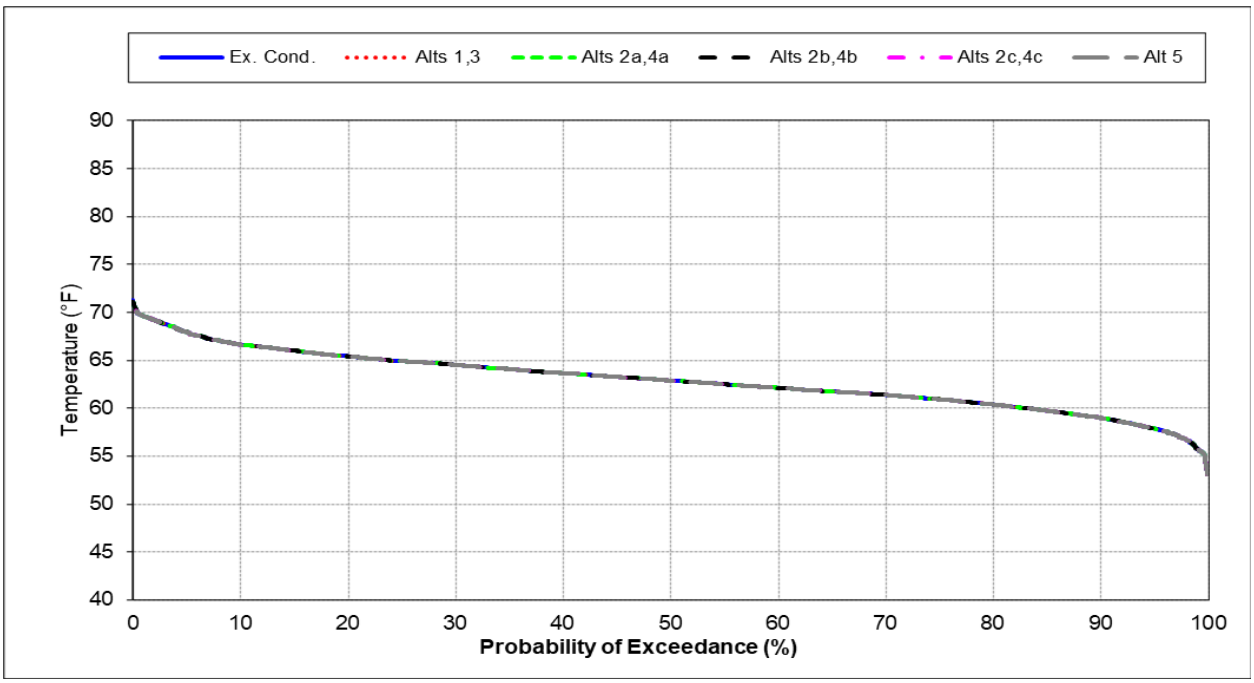



**Figure 6B.1-65. Sacramento River at I Street Bridge, Daily Average Temperature (in degrees Fahrenheit), October**

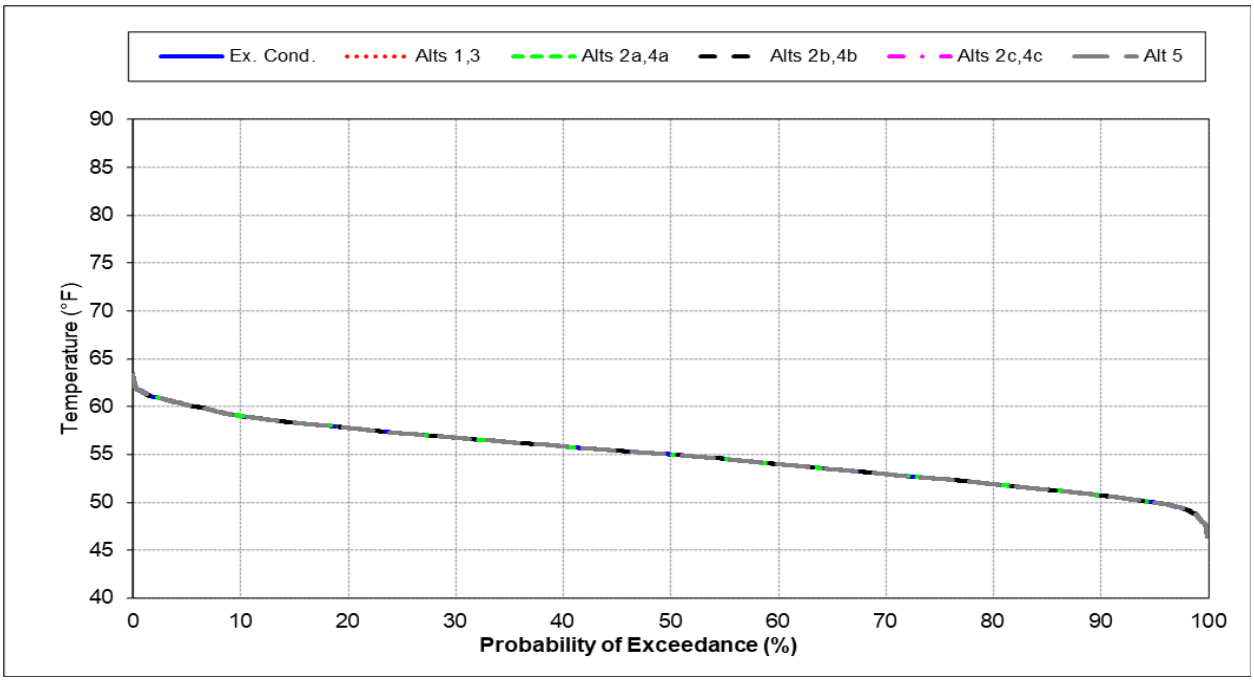



**Figure 6B.1-66. Sacramento River at I Street Bridge, Daily Average Temperature (in degrees Fahrenheit), November**

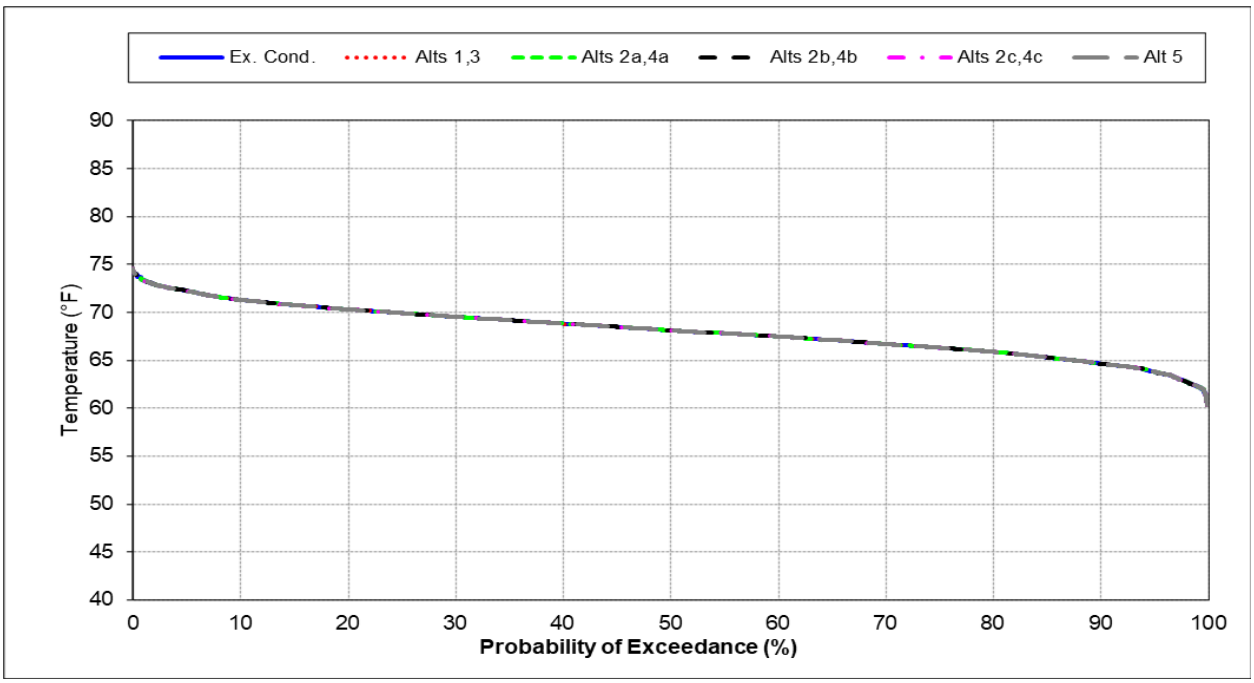



**Figure 6B.1-67. Sacramento River at Freeport, Daily Average Temperature (in degrees Fahrenheit), June**

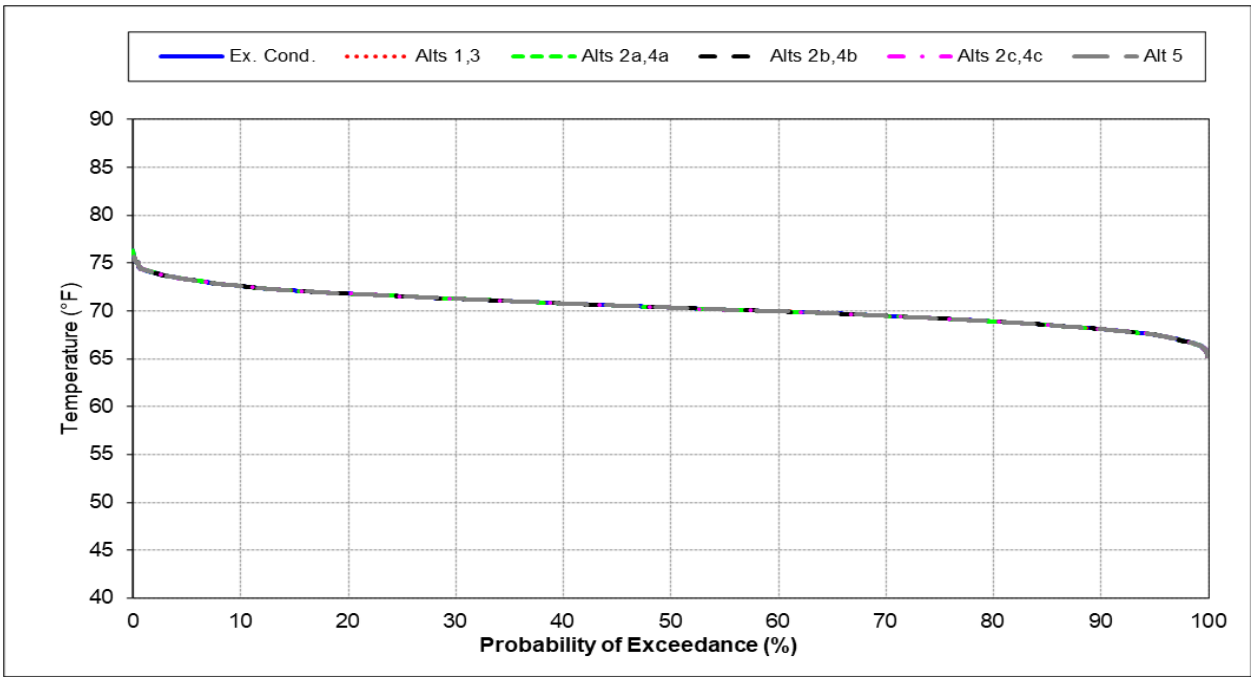



**Figure 6B.1-68. Sacramento River at Freeport, Daily Average Temperature (in degrees Fahrenheit), July**

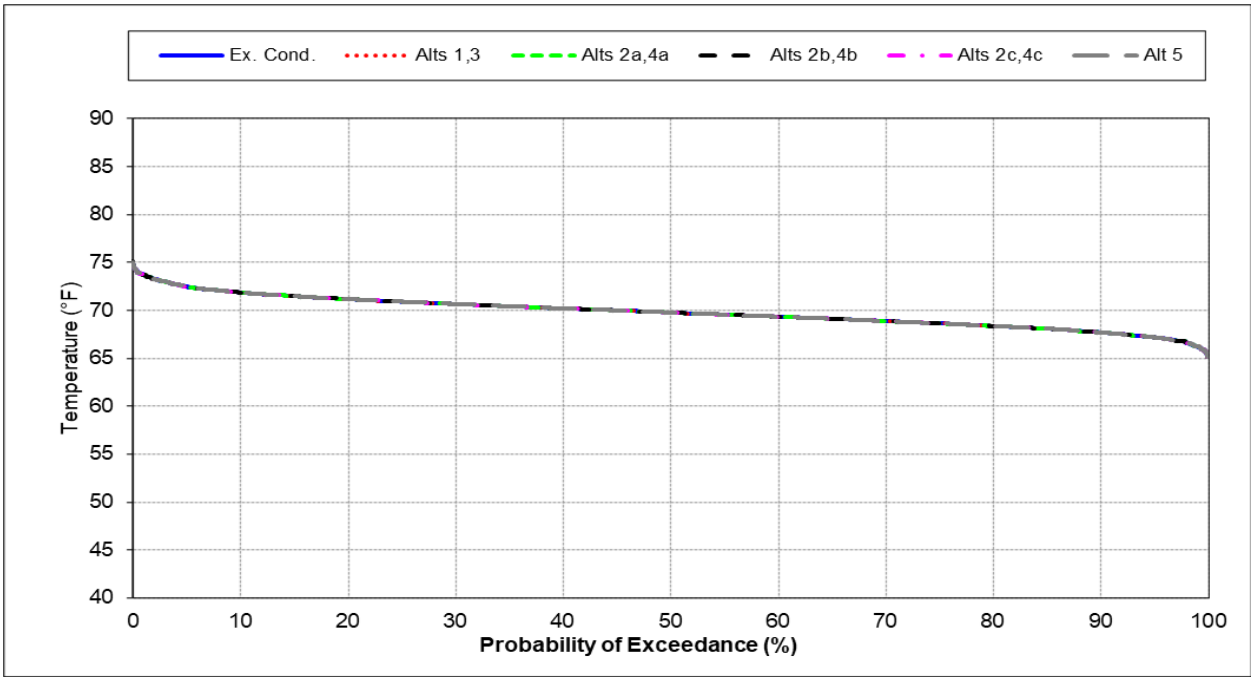



**Figure 6B.1-69. Sacramento River at Freeport, Daily Average Temperature (in degrees Fahrenheit), August**

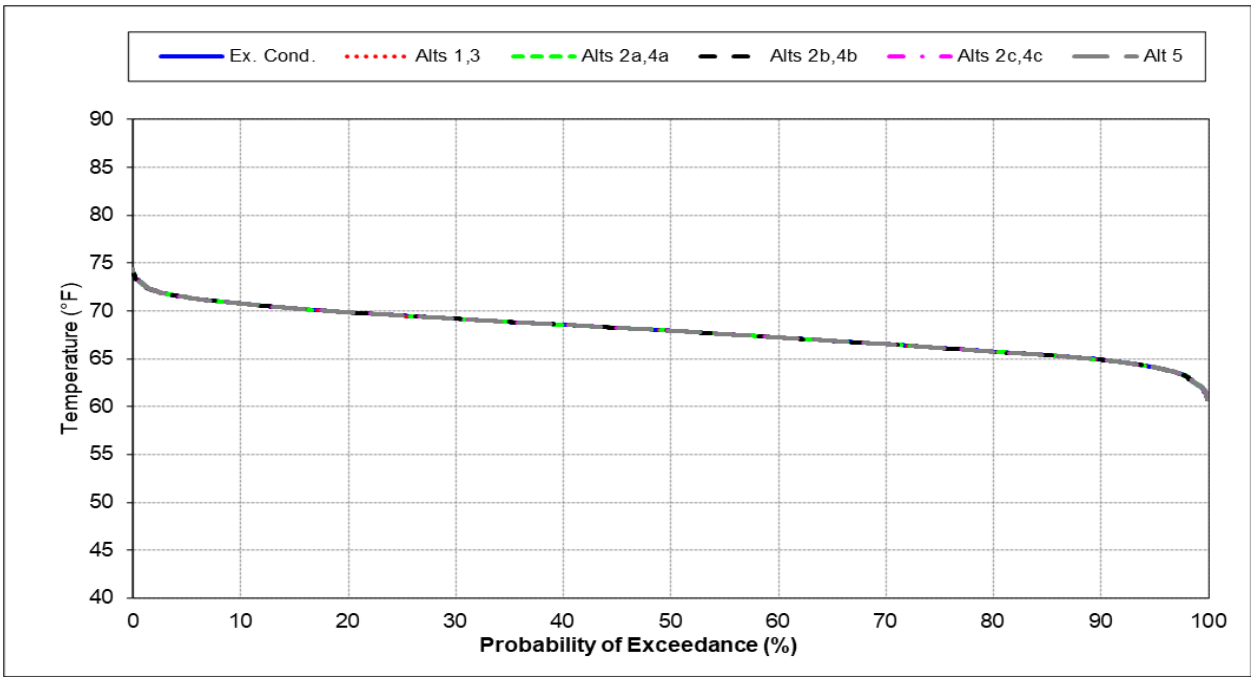



**Figure 6B.1-70. Sacramento River at Freeport, Daily Average Temperature (in degrees Fahrenheit), September**

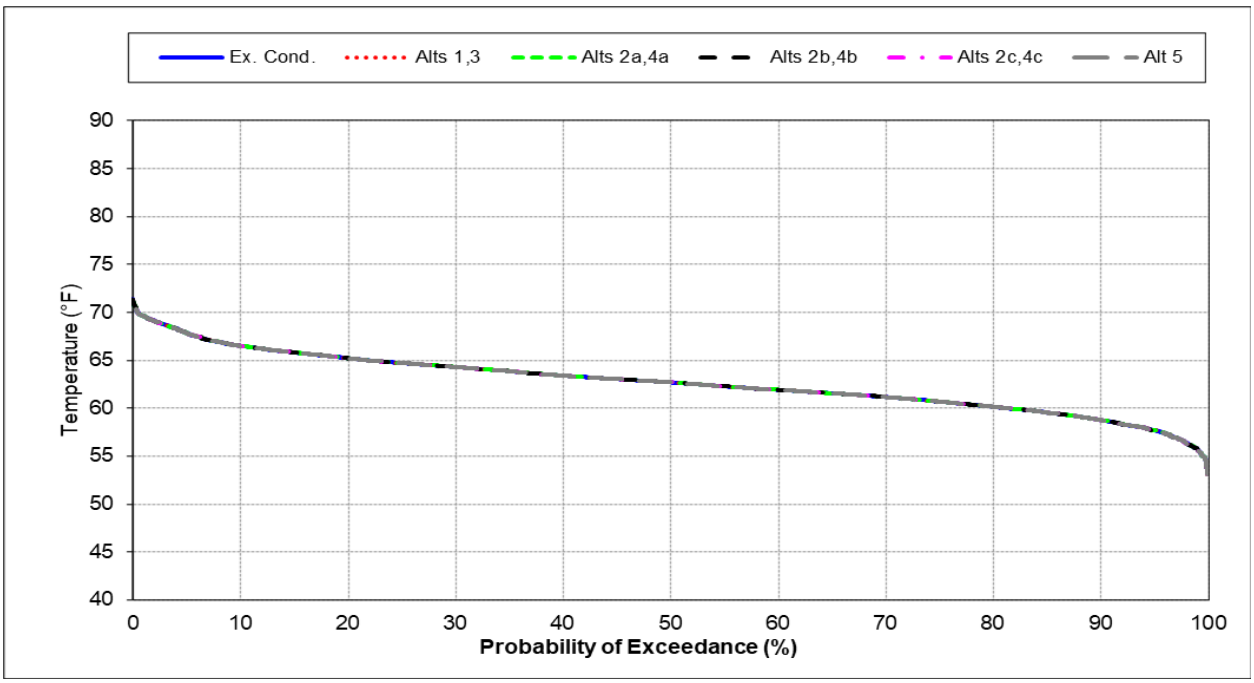



**Figure 6B.1-71. Sacramento River at Freeport, Daily Average Temperature (in degrees Fahrenheit), October**

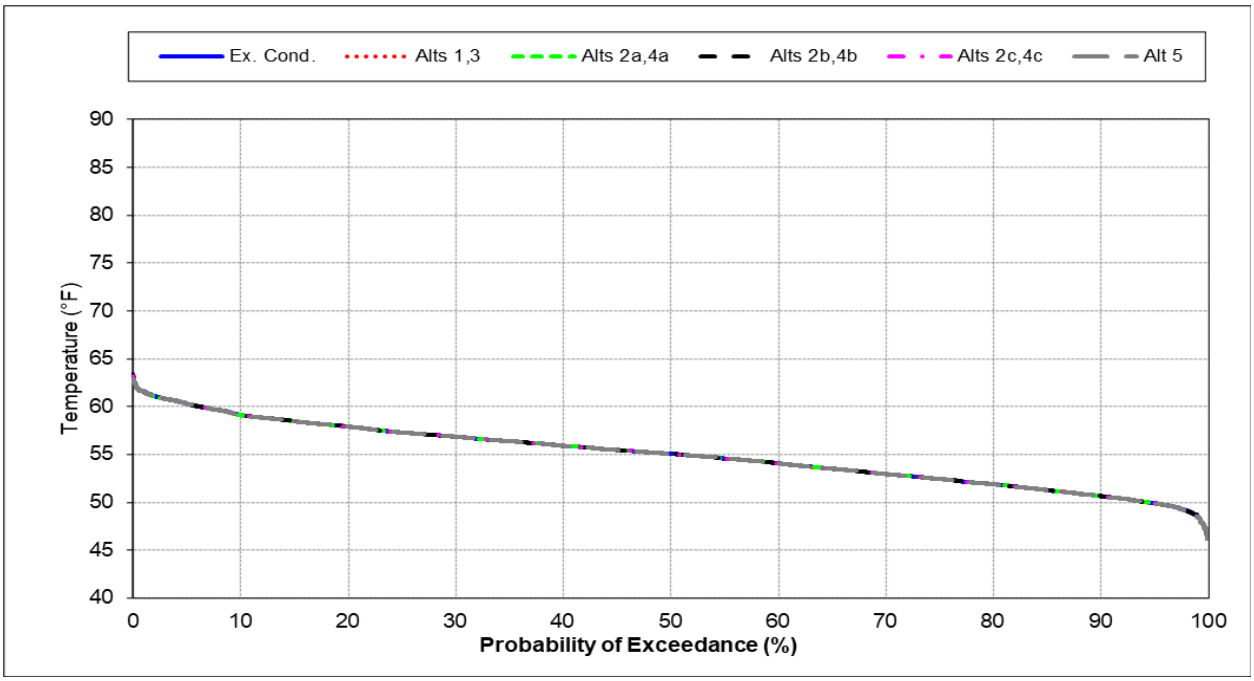



**Figure 6B.1-72. Sacramento River at Freeport, Daily Average Temperature (in degrees Fahrenheit), November**

#### 6B.1.1.1.2 Velocity

Figure 6B.1-73 through Figure 6B.1-138 show monthly 15-minute absolute velocity (in feet per second) for existing conditions and the proposed action (Alt 5) for 9 Delta assessment locations.

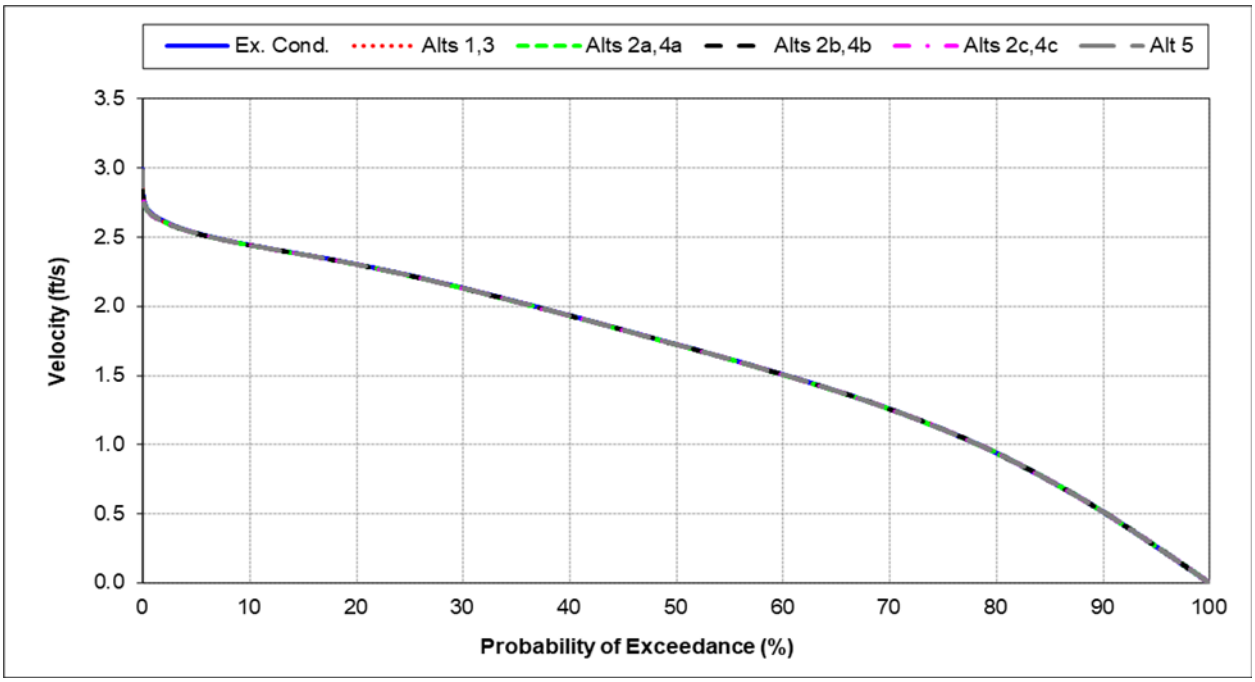



**Figure 6B.1-73. Brannan Island, 15-Minute Absolute Velocity (in feet per second), June**

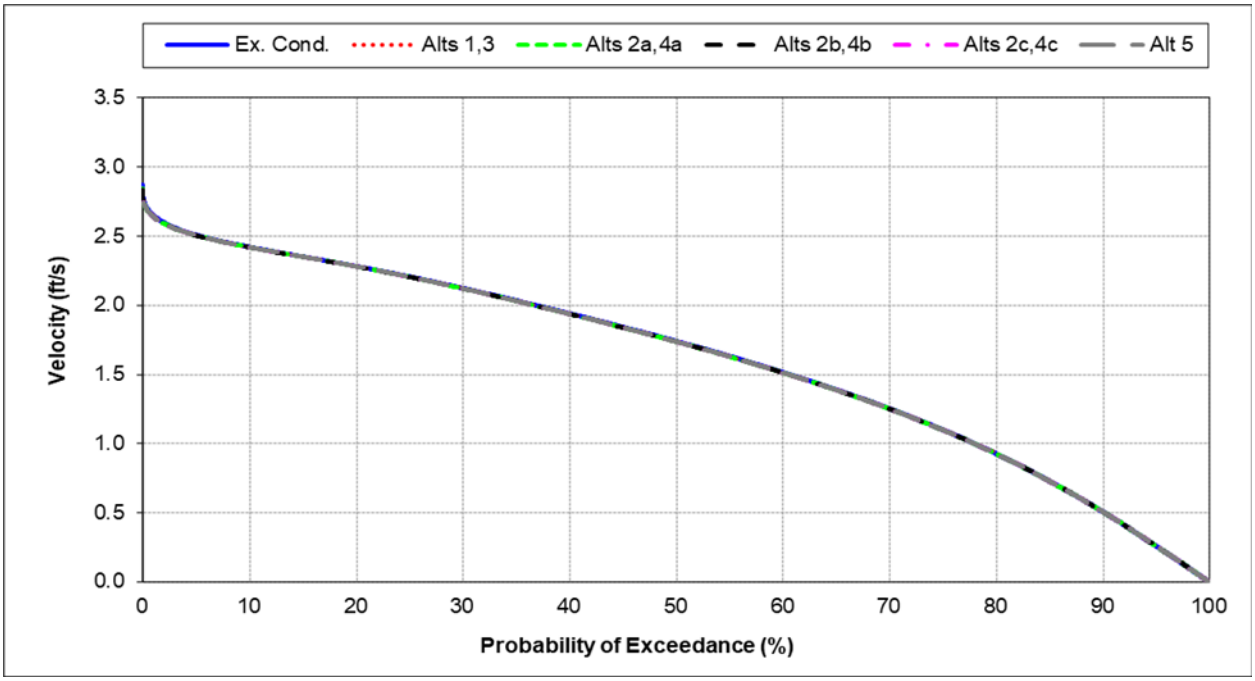



**Figure 6B.1-74. Brannan Island, 15-Minute Absolute Velocity (in feet per second), July**

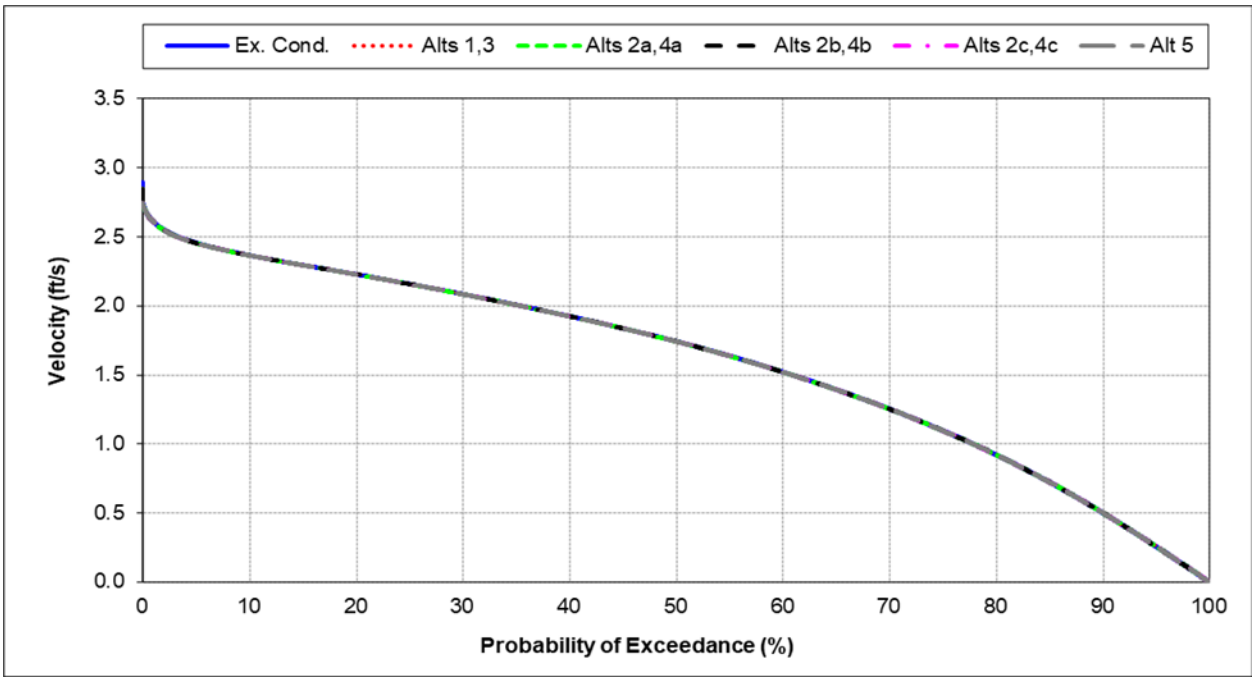



**Figure 6B.1-75. Brannan Island, 15-Minute Absolute Velocity (in feet per second), August**

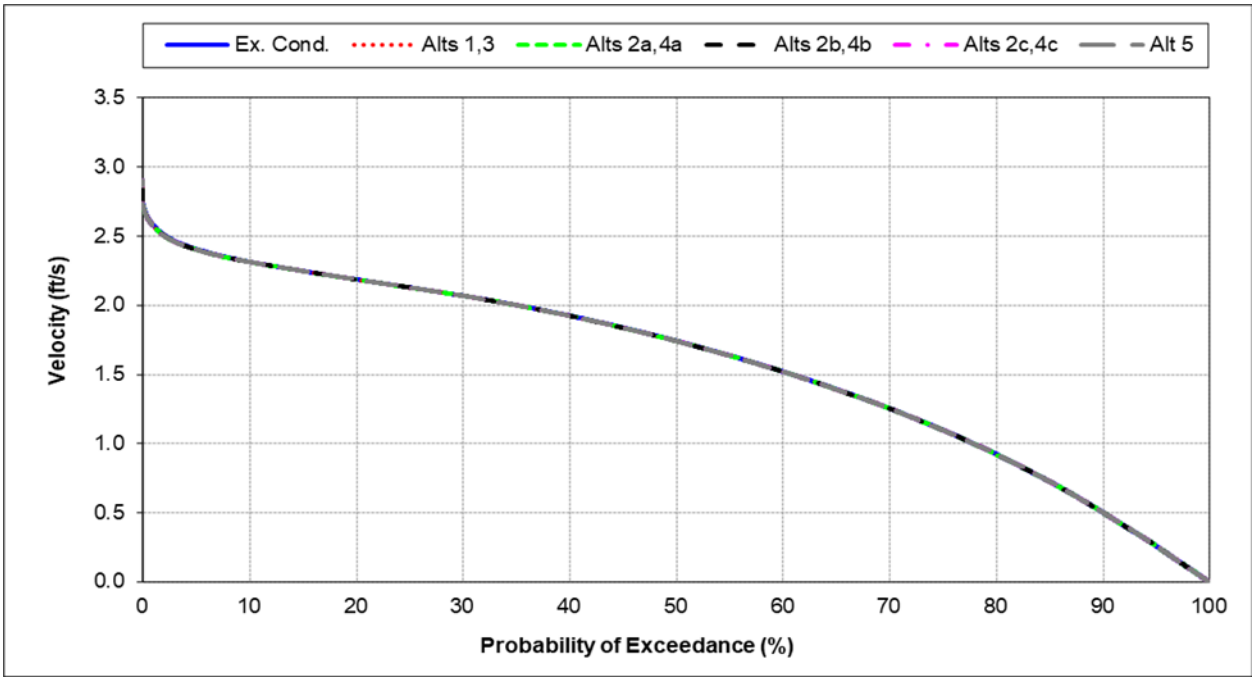



**Figure 6B.1-76. Brannan Island, 15-Minute Absolute Velocity (in feet per second), September**

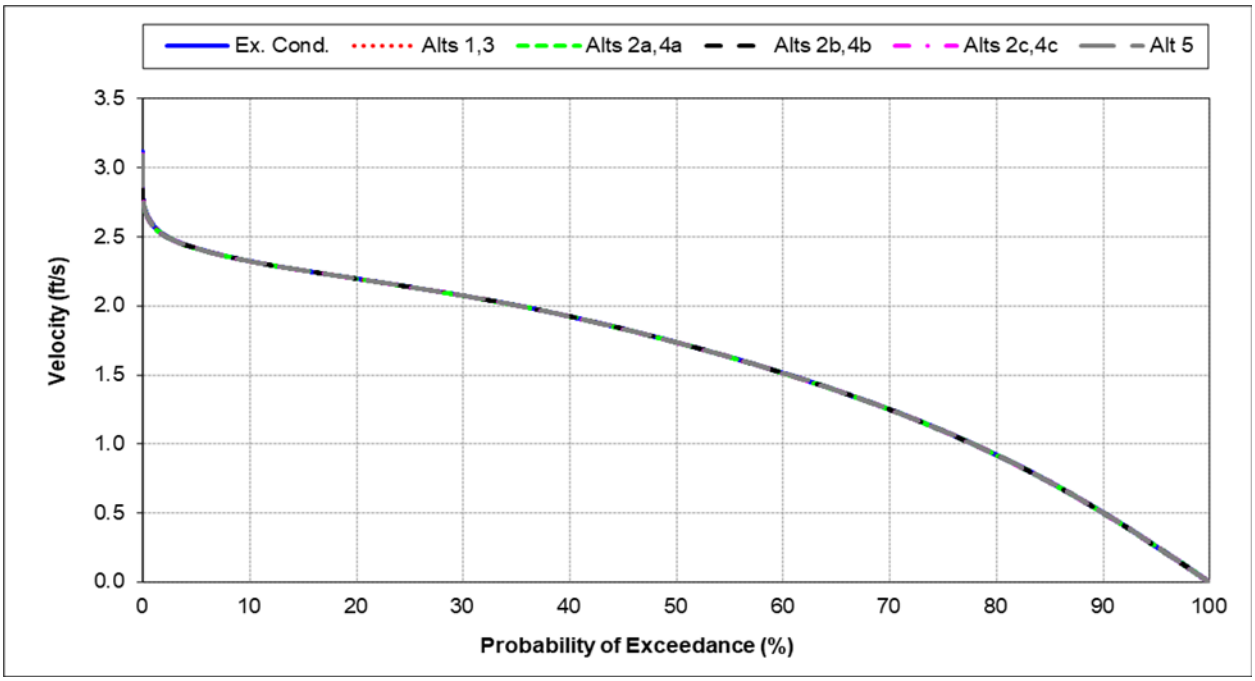



**Figure 6B.1-77. Brannan Island, 15-Minute Absolute Velocity (in feet per second), October**

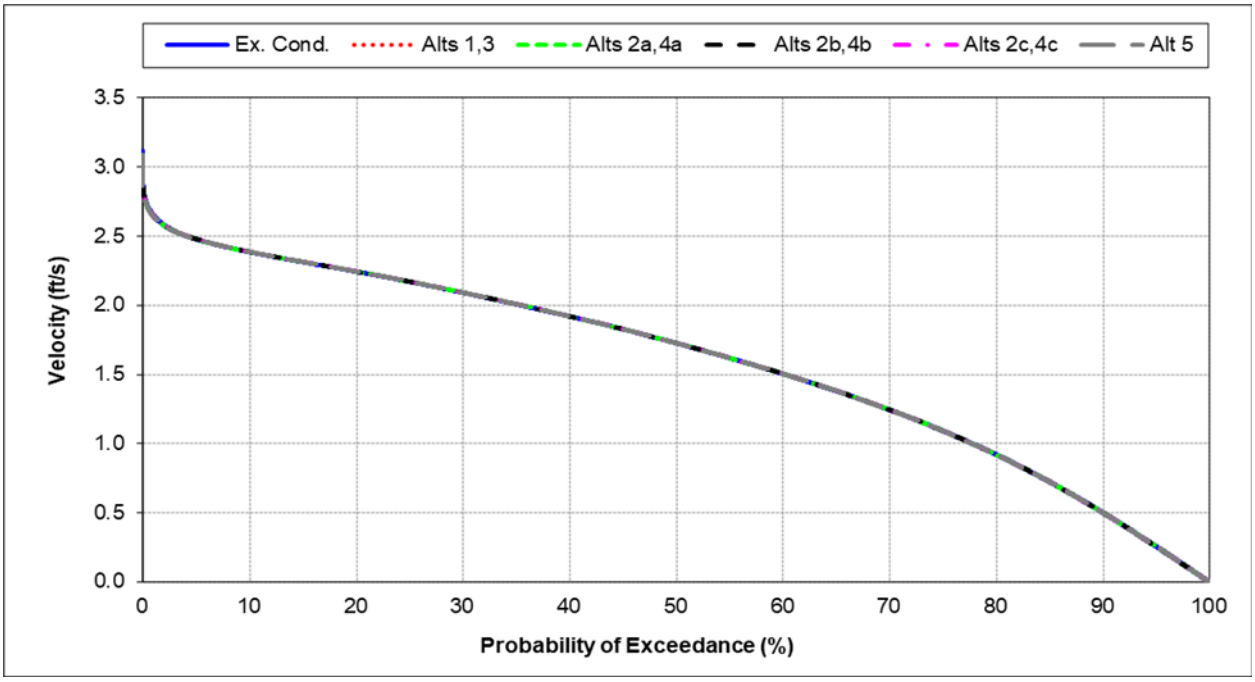



**Figure 6B.1-78. Brannan Island, 15-Minute Absolute Velocity (in feet per second), November**

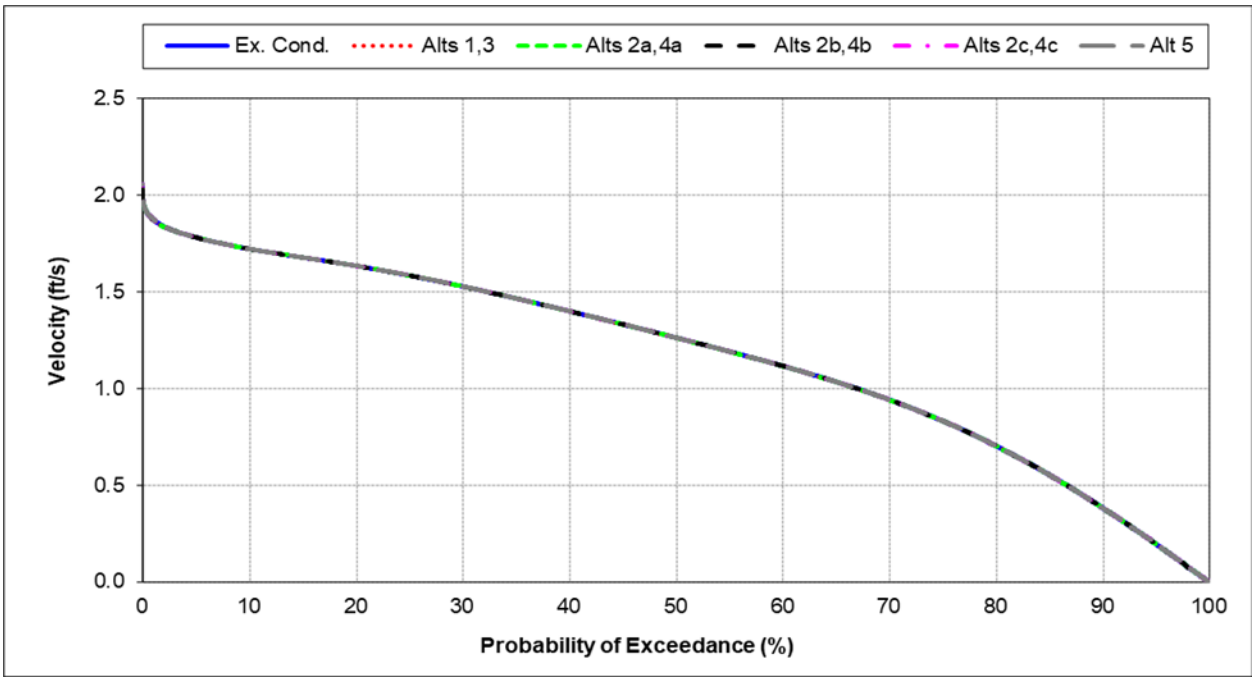



**Figure 6B.1-79. San Joaquin River at Jersey Point, 15-Minute Absolute Velocity (in feet per second), June**

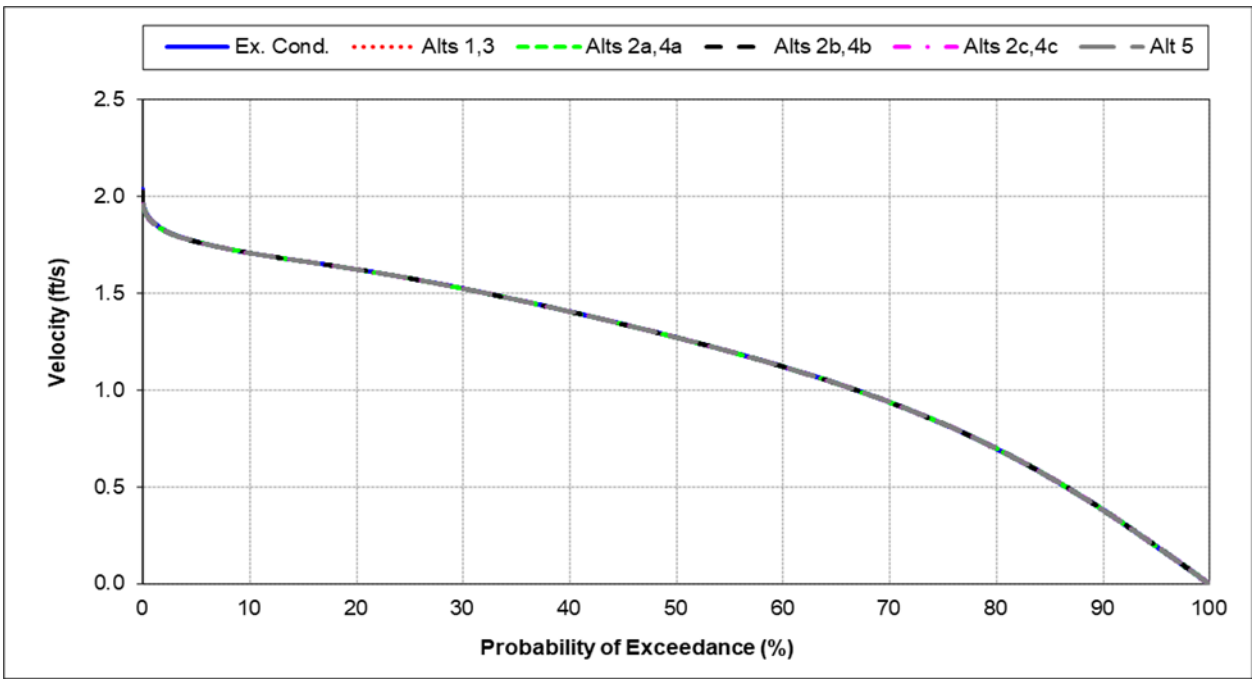



**Figure 6B.1-80. San Joaquin River at Jersey Point, 15-Minute Absolute Velocity (in feet per second), July**

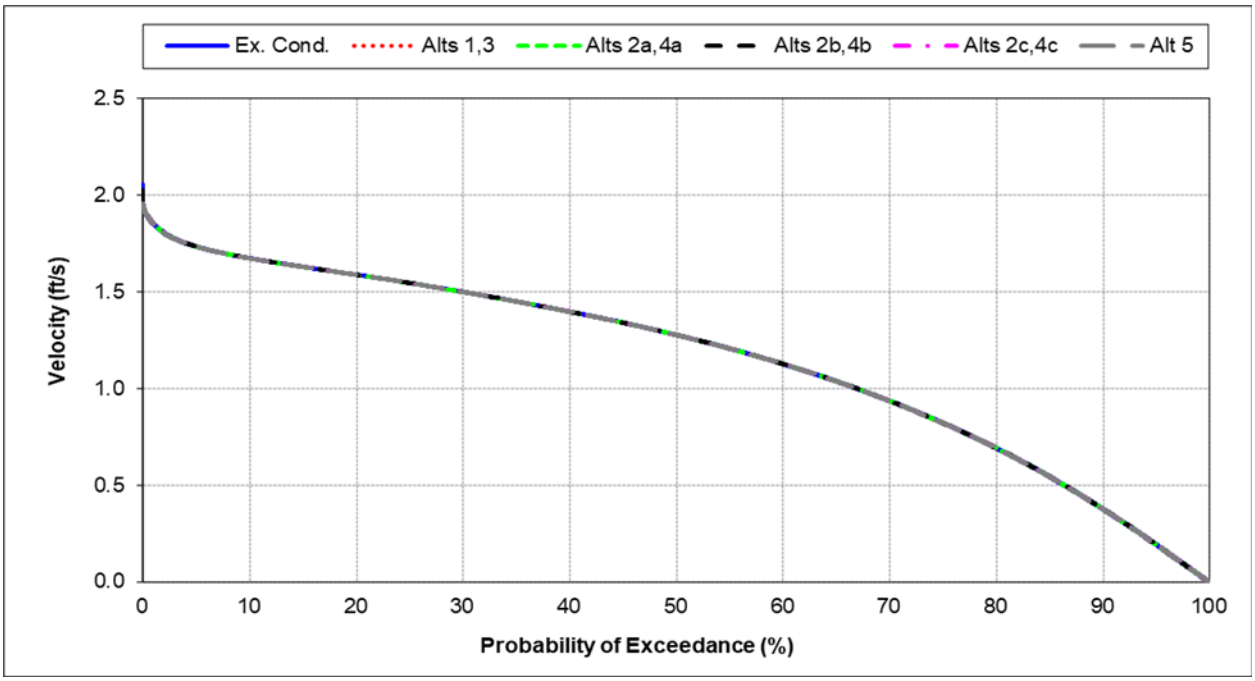



**Figure 6B.1-81. San Joaquin River at Jersey Point, 15-Minute Absolute Velocity (in feet per second), August**

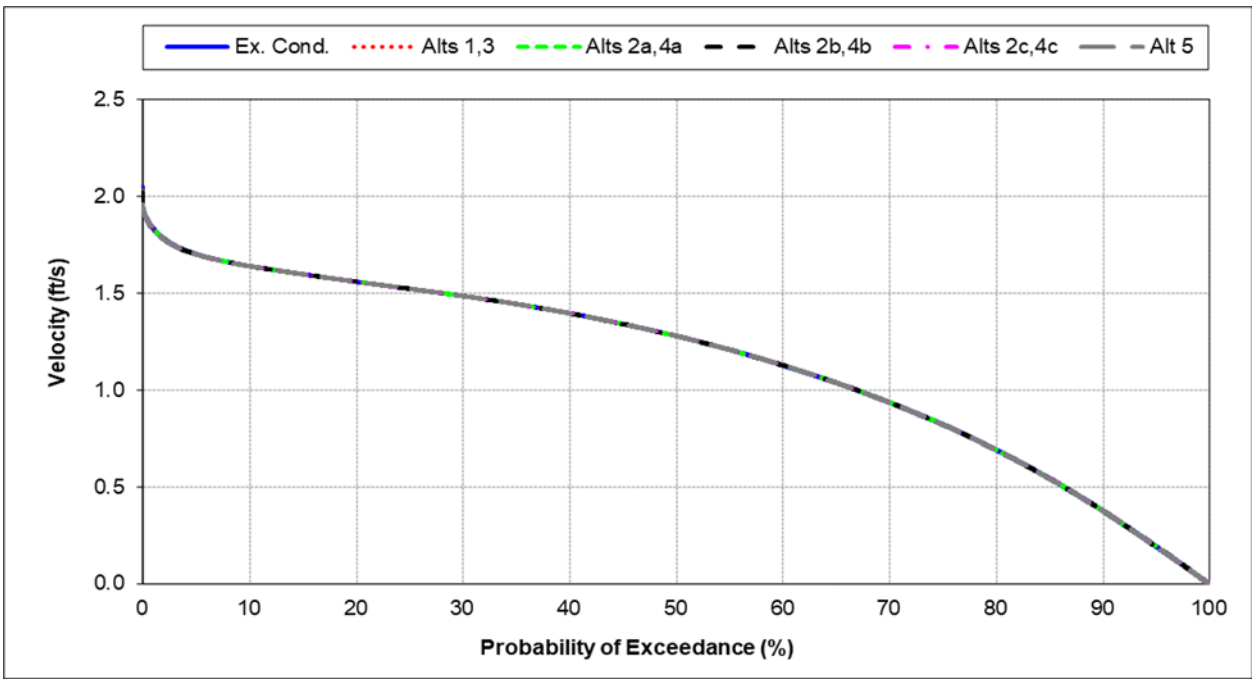



**Figure 6B.1-82. San Joaquin River at Jersey Point, 15-Minute Absolute Velocity (in feet per second), September**

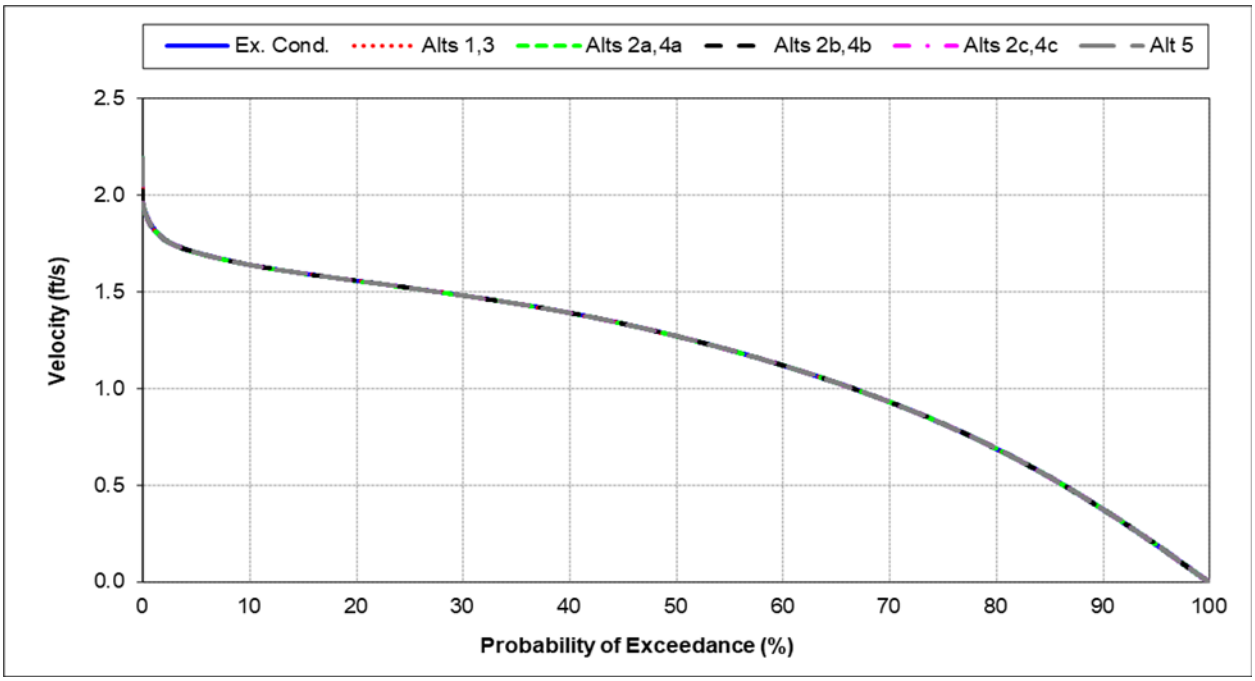



**Figure 6B.1-83. San Joaquin River at Jersey Point, 15-Minute Absolute Velocity (in feet per second), October**

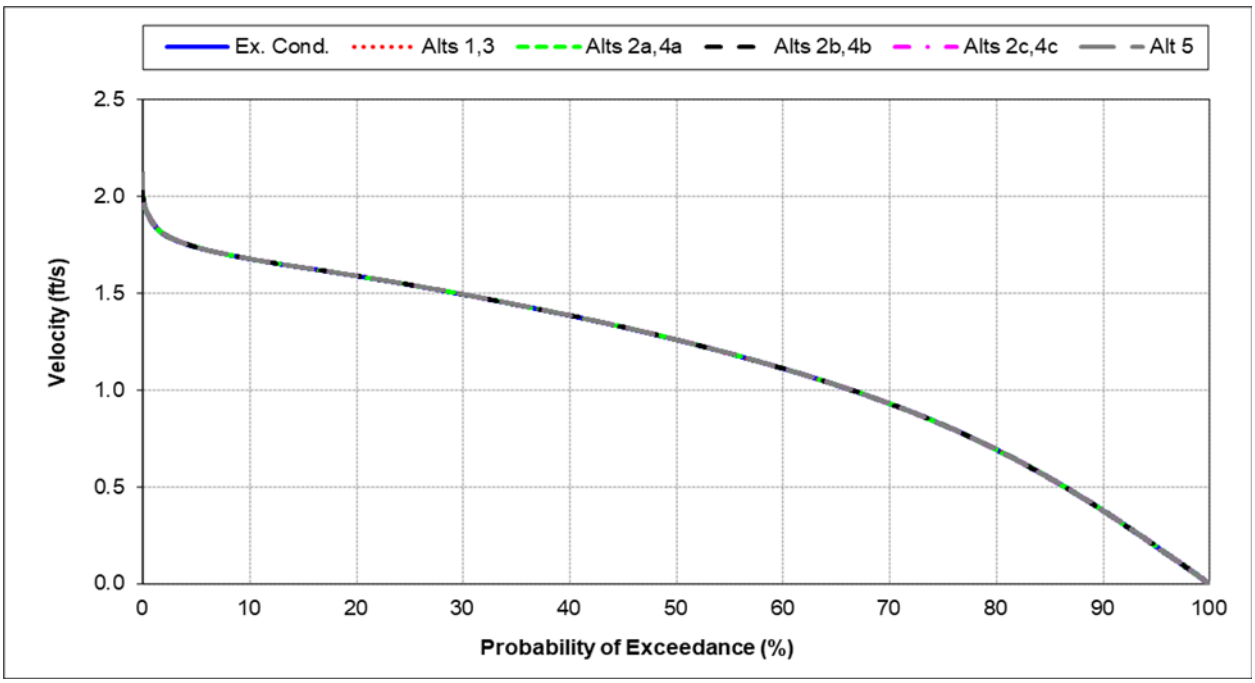



**Figure 6B.1-84. San Joaquin River at Jersey Point, 15-Minute Absolute Velocity (in feet per second), November**

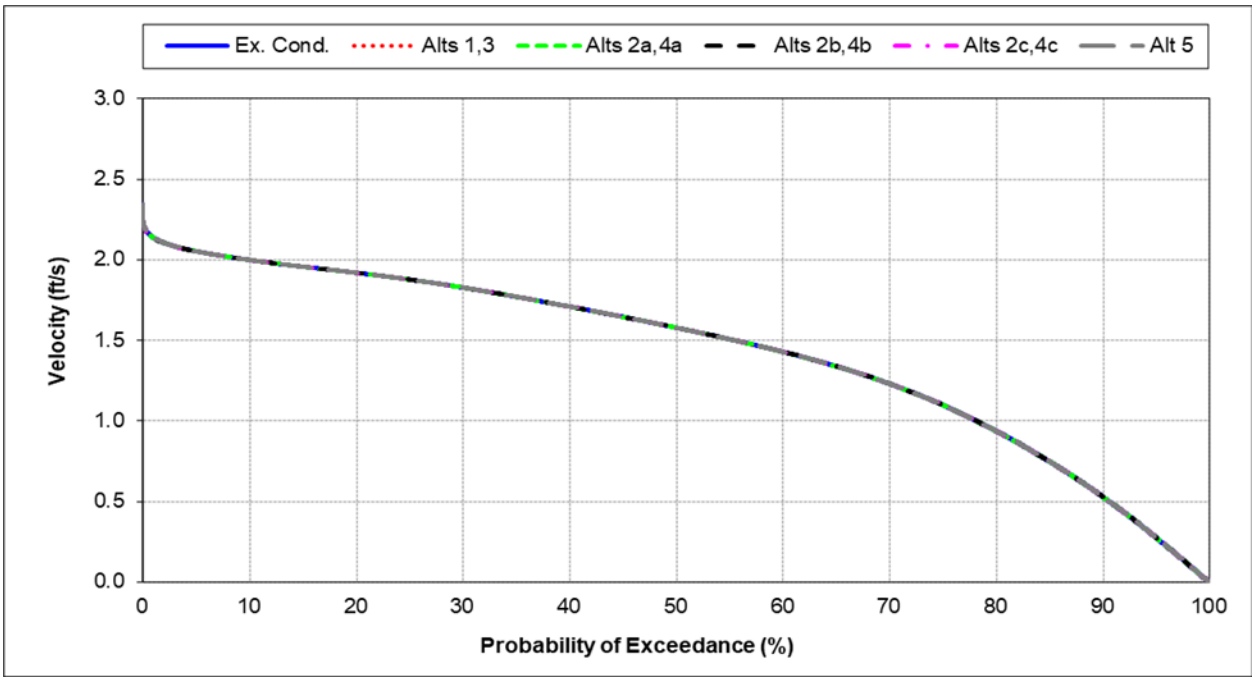



**Figure 6B.1-85. Franks Tract, 15-Minute Absolute Velocity (in feet per second), June**

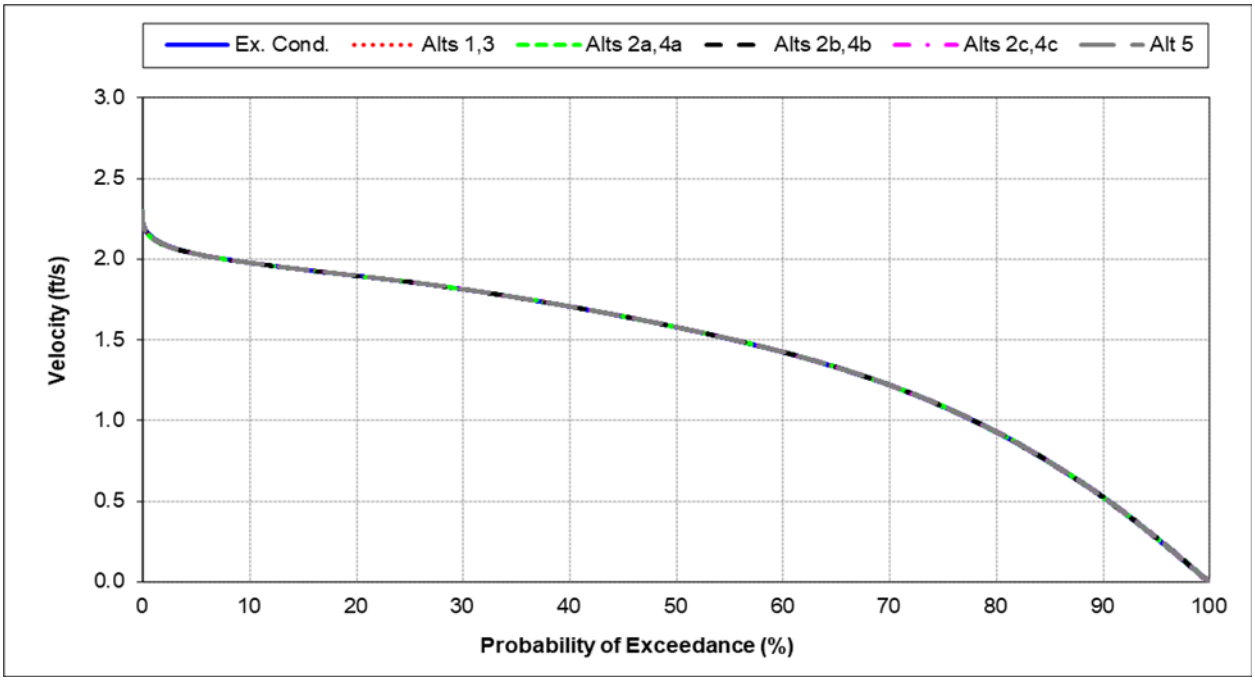



**Figure 6B.1-86. Franks Tract, 15-Minute Absolute Velocity (in feet per second), July**

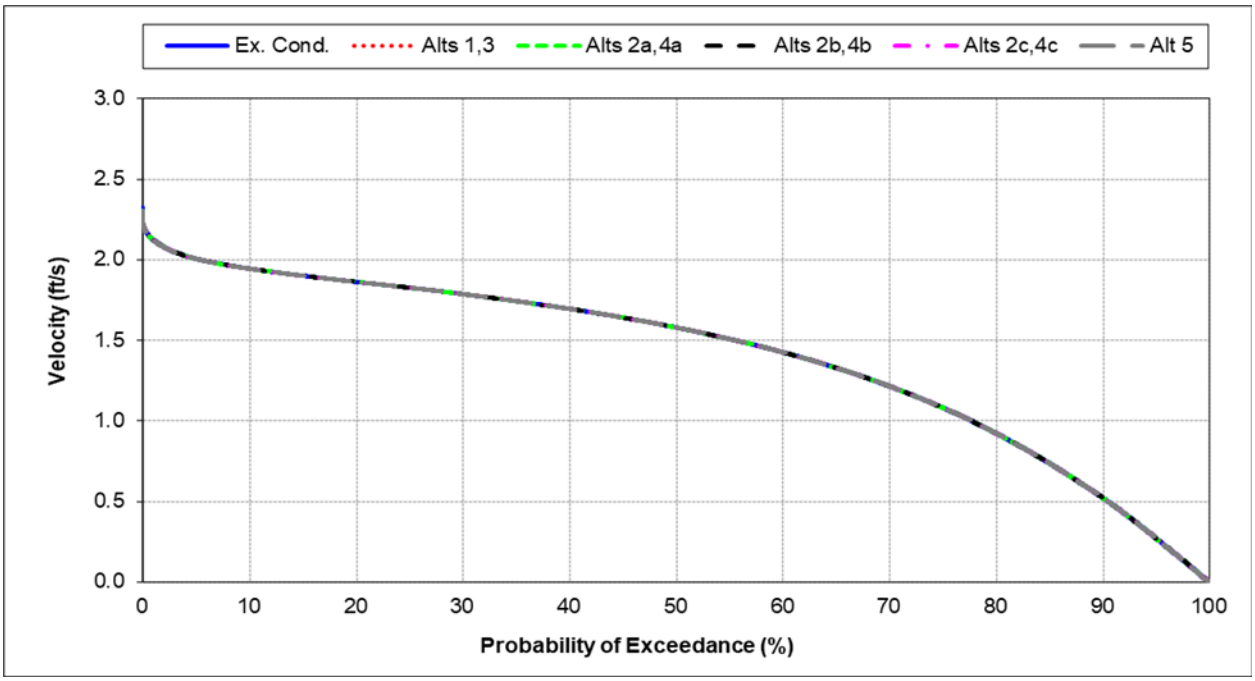



**Figure 6B.1-87. Franks Tract, 15-Minute Absolute Velocity (in feet per second), August**

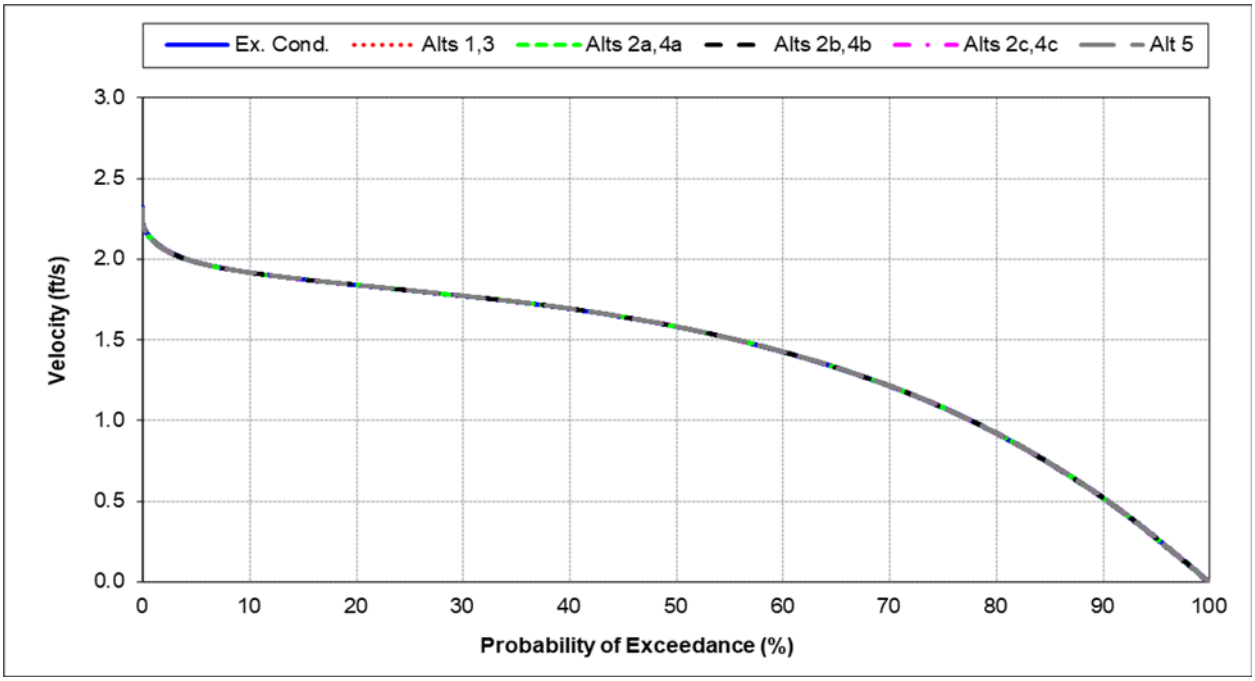



**Figure 6B.1-88. Franks Tract, 15-Minute Absolute Velocity (in feet per second), September**

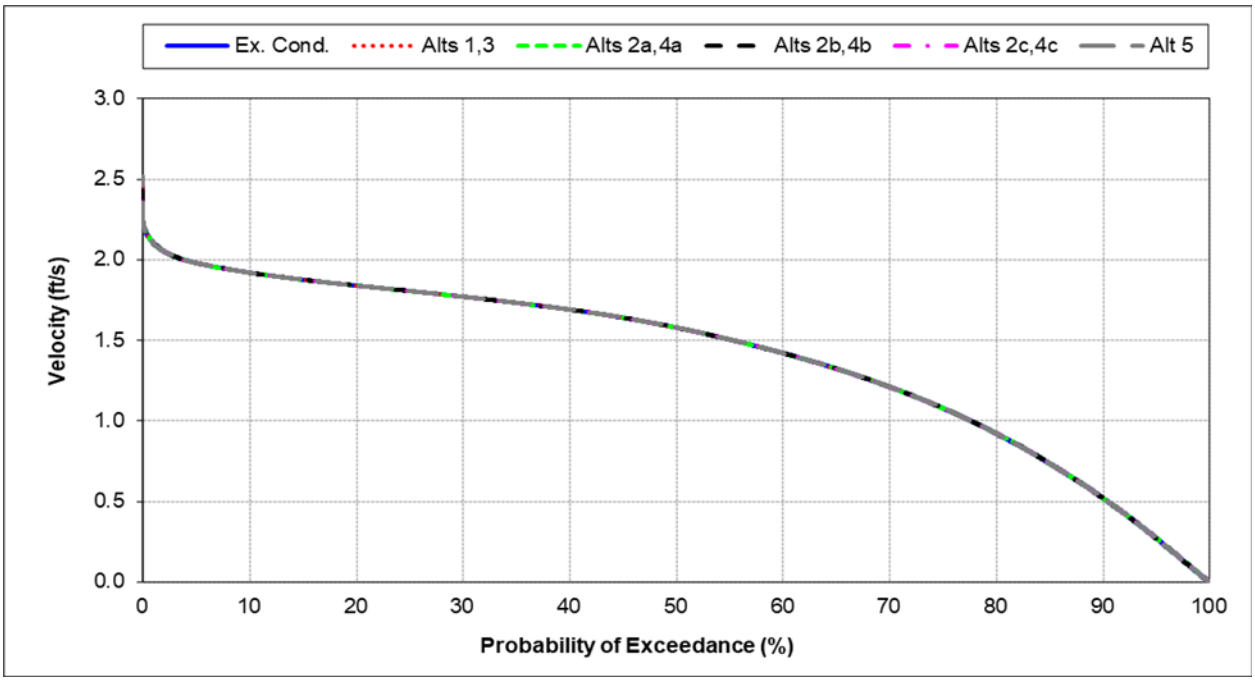



**Figure 6B.1-89. Franks Tract, 15-Minute Absolute Velocity (in feet per second), October**

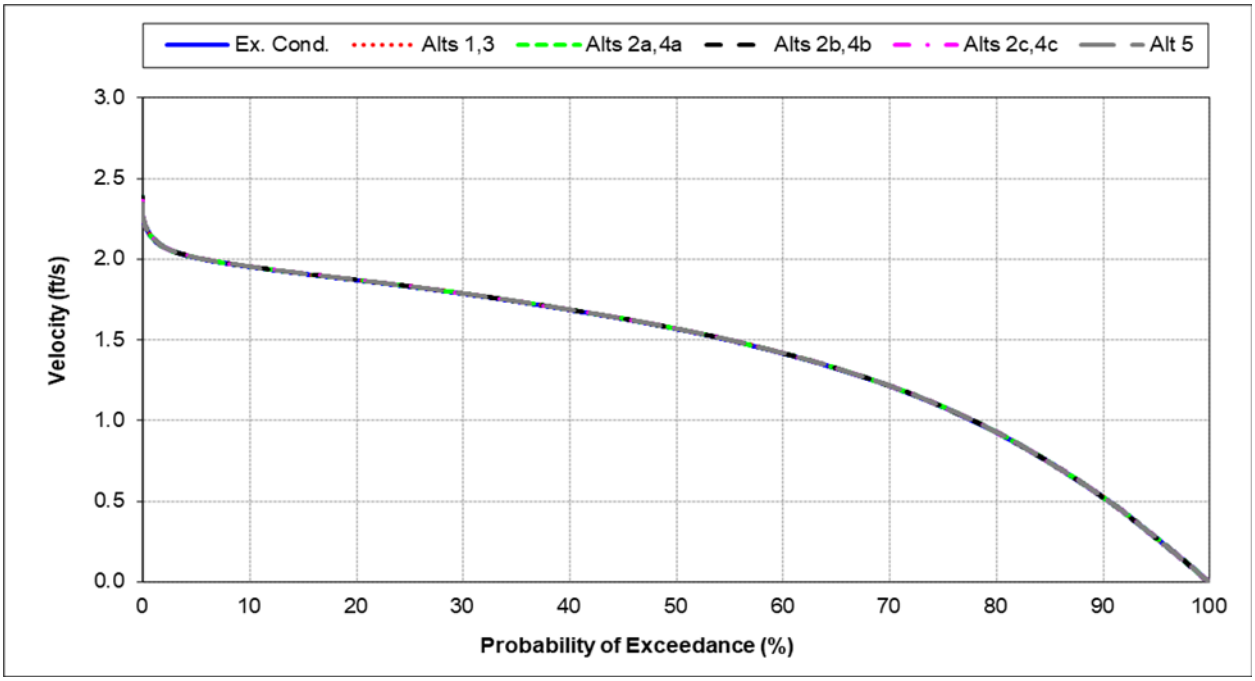



**Figure 6B.1-90. Franks Tract, 15-Minute Absolute Velocity (in feet per second), November**

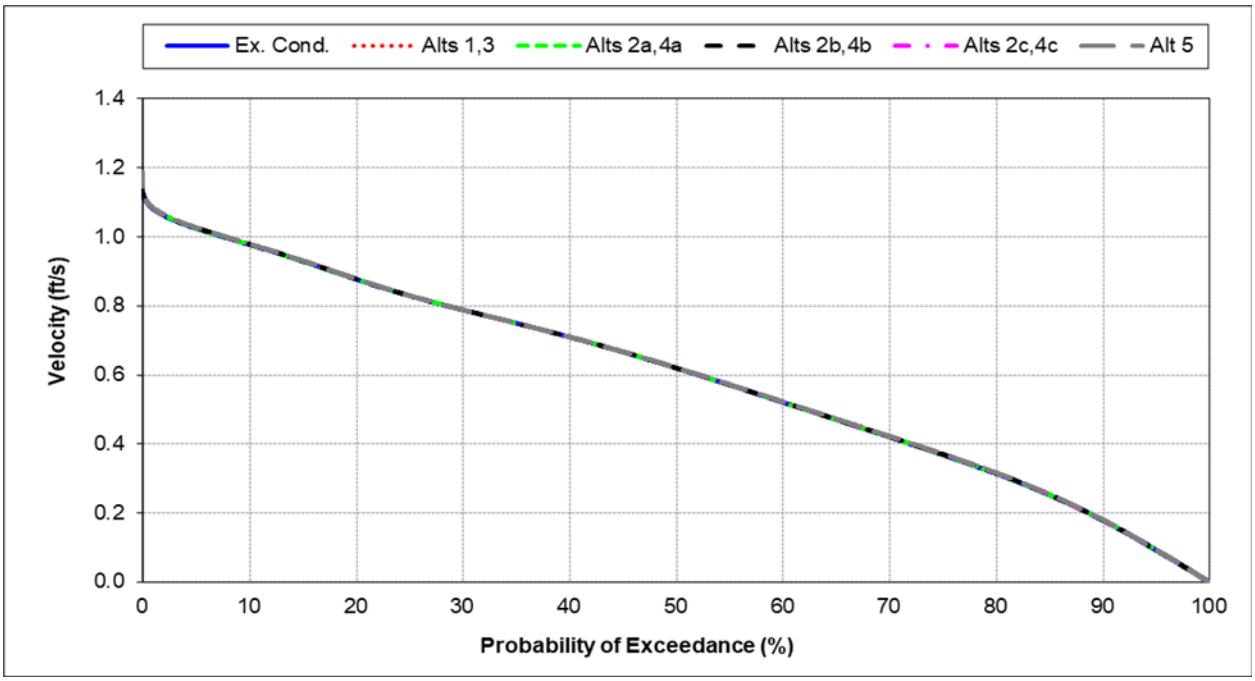



**Figure 6B.1-91. Old River at Rock Slough, 15-Minute Absolute Velocity (in feet per second), June**

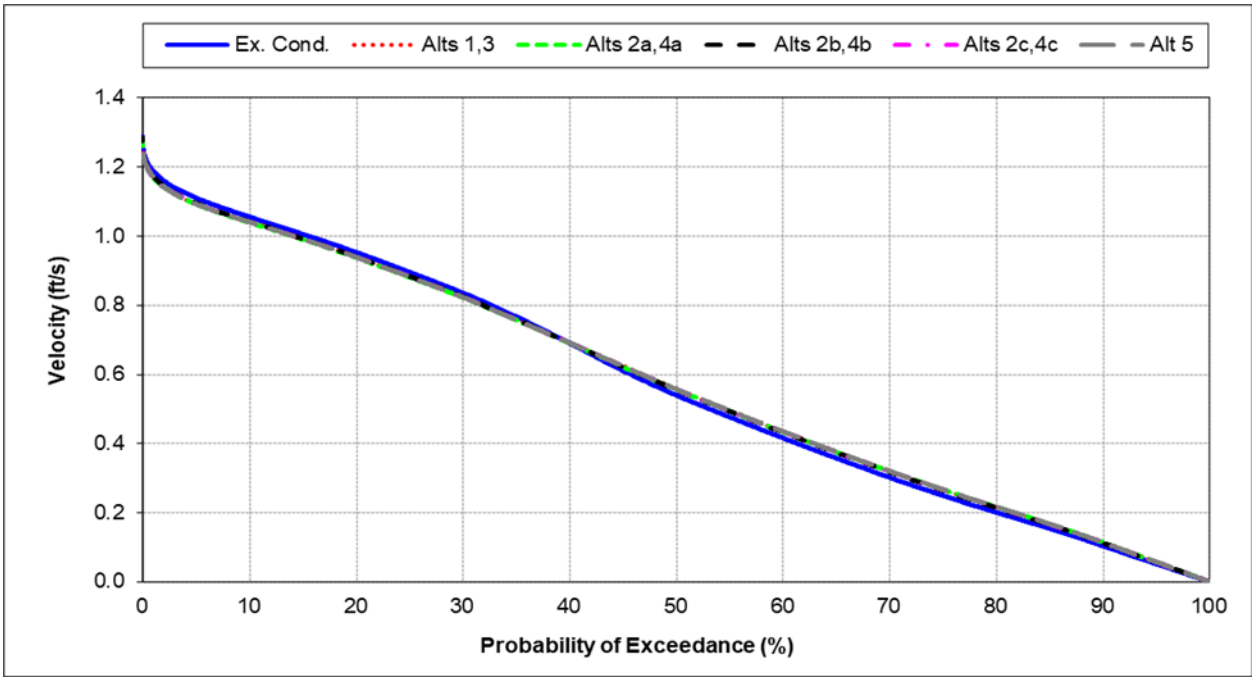



**Figure 6B.1-92. Old River at Rock Slough, 15-Minute Absolute Velocity (in feet per second), July**

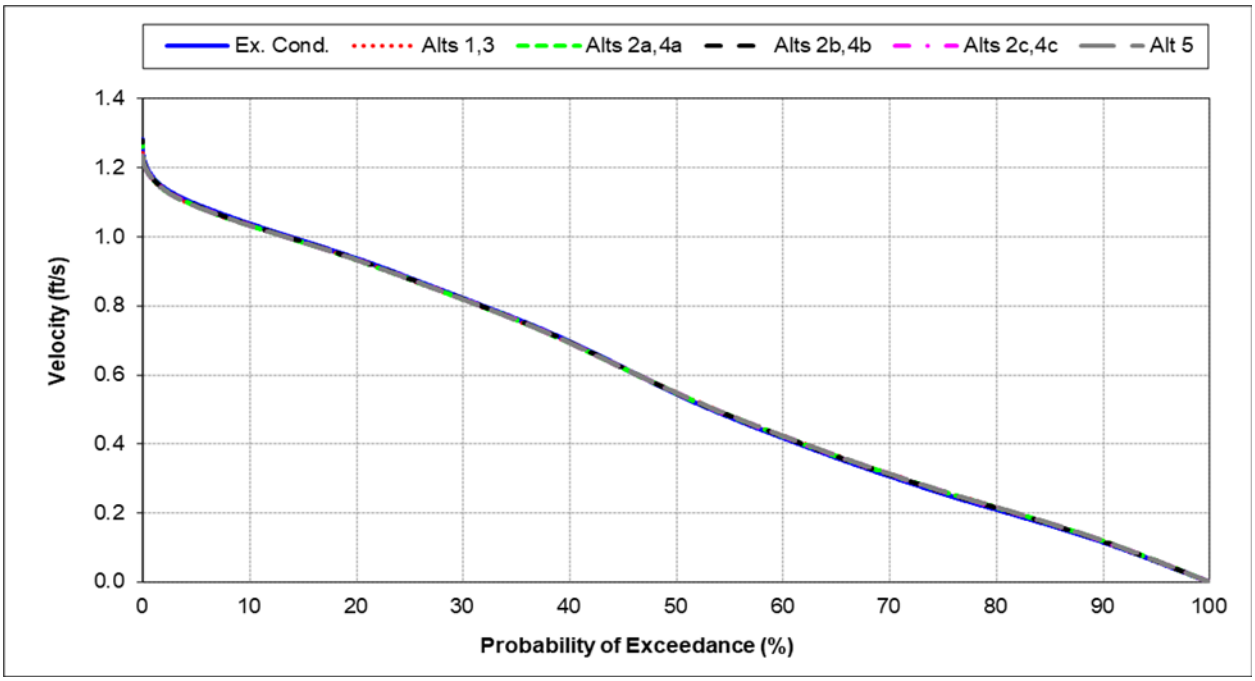



**Figure 6B.1-93. Old River at Rock Slough, 15-Minute Absolute Velocity (in feet per second), August**

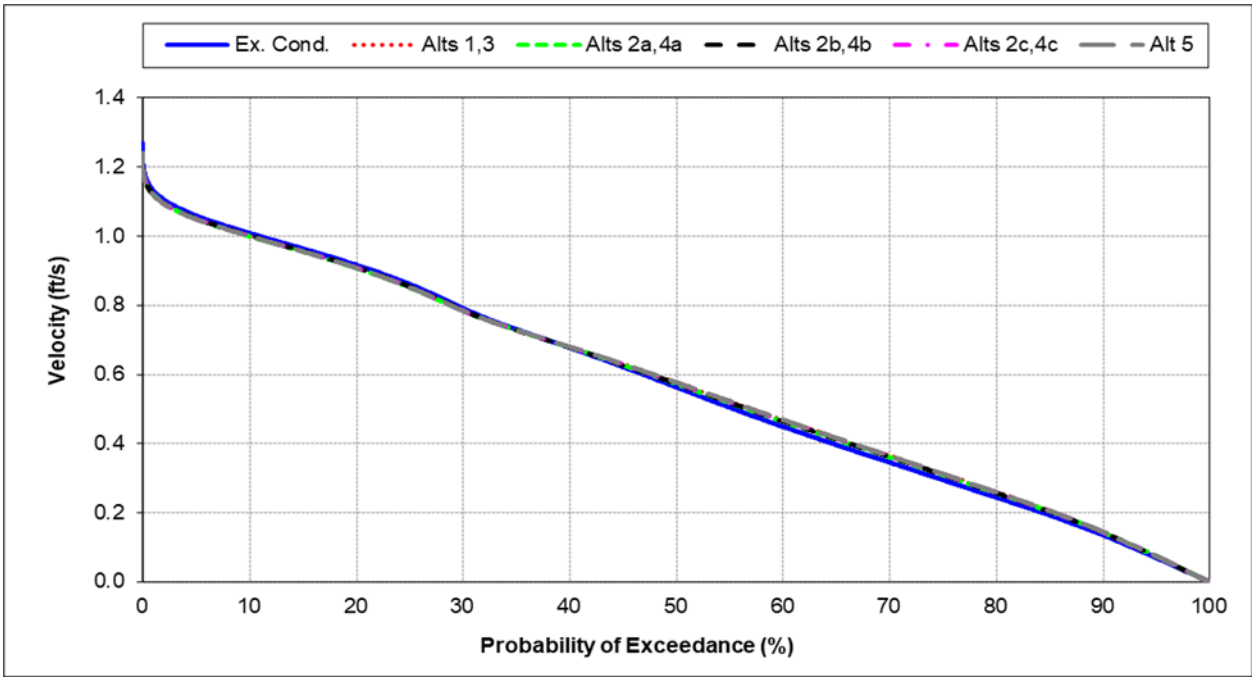



**Figure 6B.1-94. Old River at Rock Slough, 15-Minute Absolute Velocity (in feet per second), September**

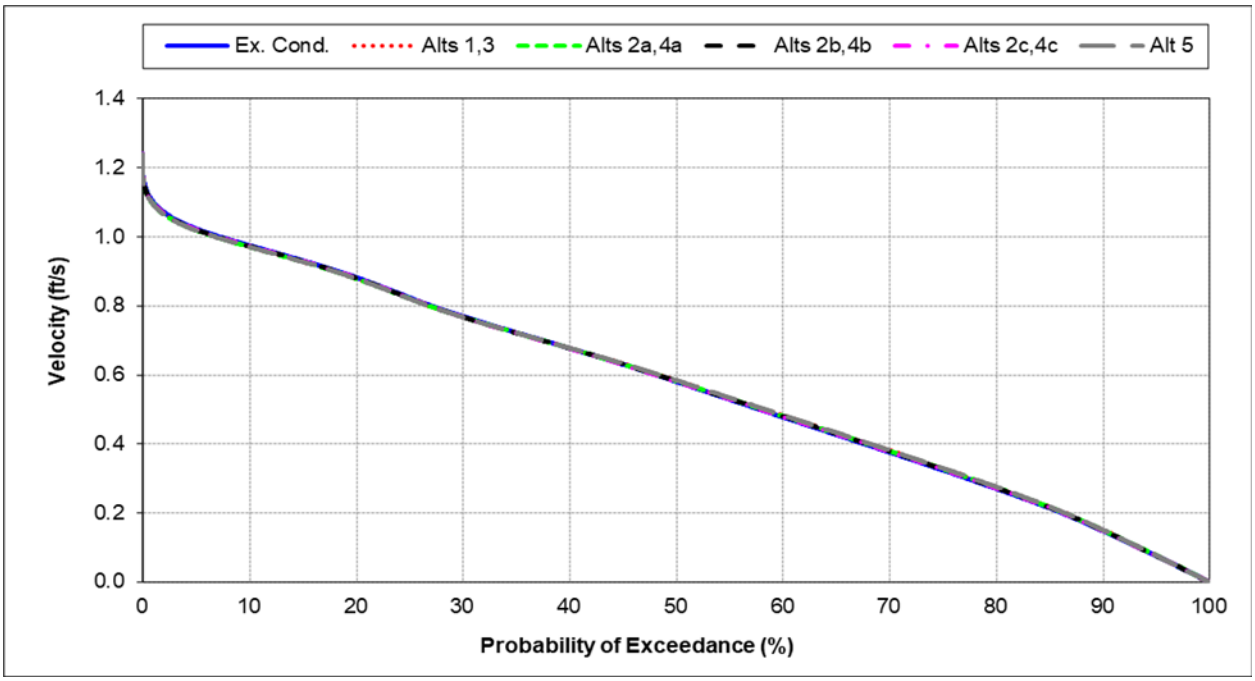



**Figure 6B.1-95. Old River at Rock Slough, 15-Minute Absolute Velocity (in feet per second), October**

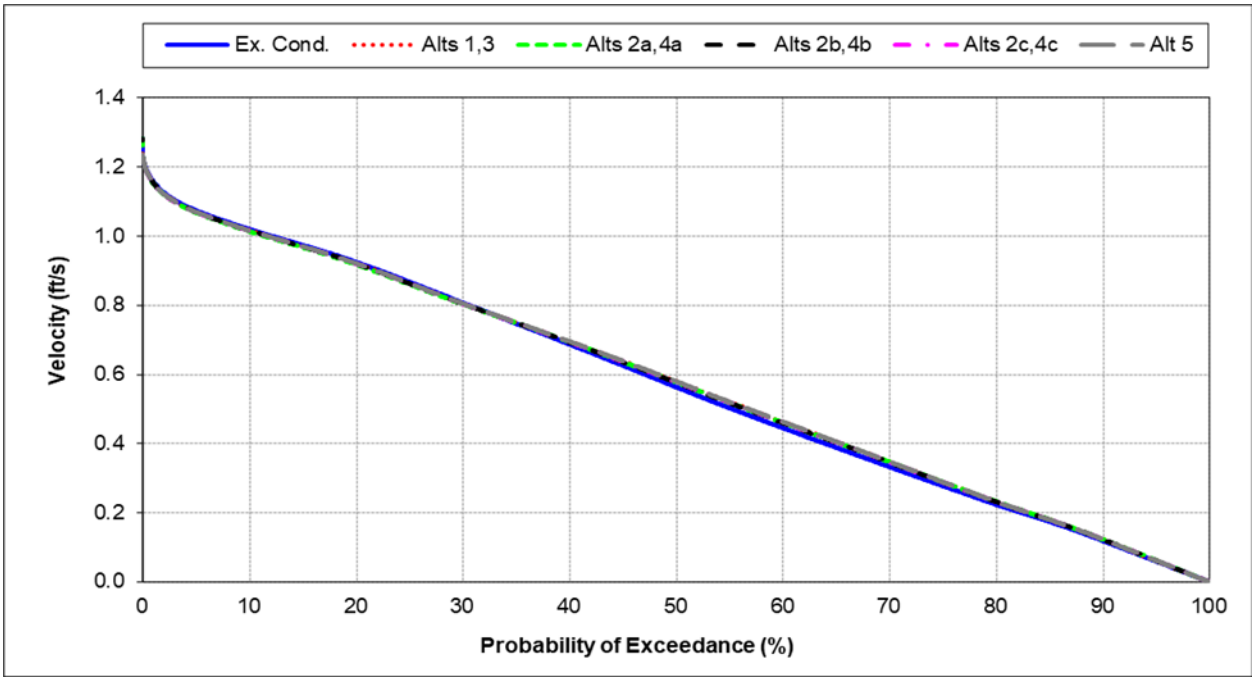



**Figure 6B.1-96. Old River at Rock Slough, 15-Minute Absolute Velocity (in feet per second), November**

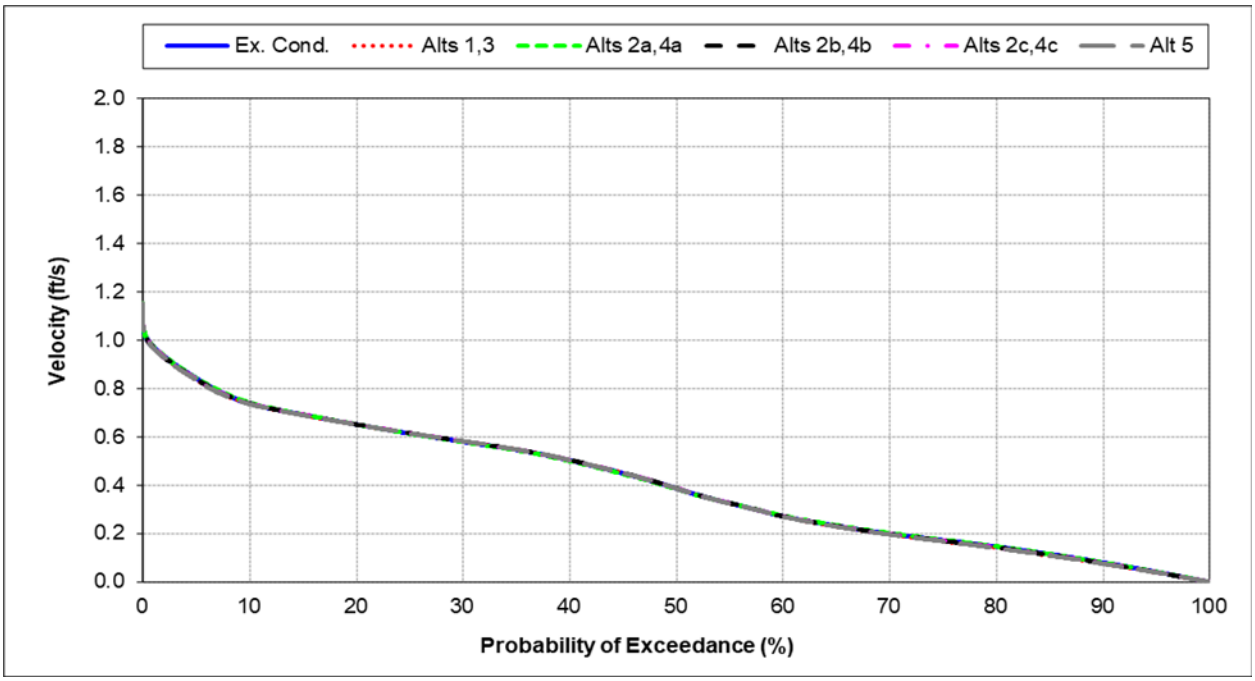



**Figure 6B.1-97. Victoria Canal, 15-Minute Absolute Velocity (in feet per second), June**

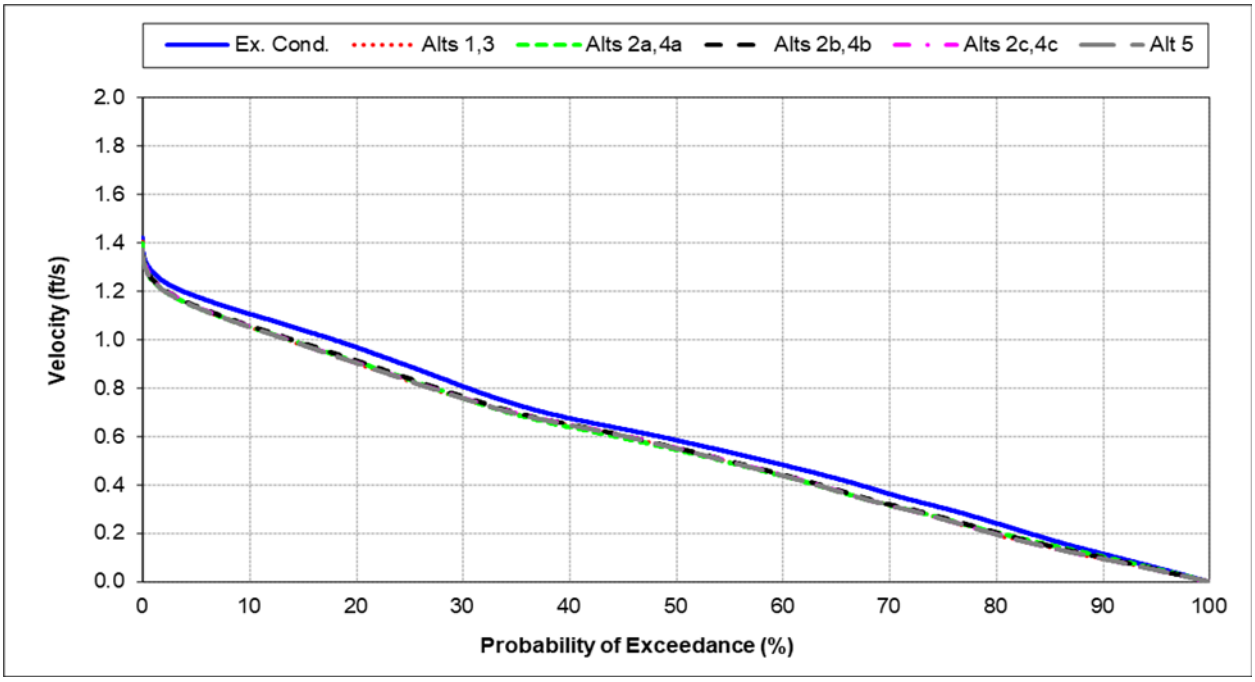



**Figure 6B.1-98. Victoria Canal, 15-Minute Absolute Velocity (in feet per second), July**

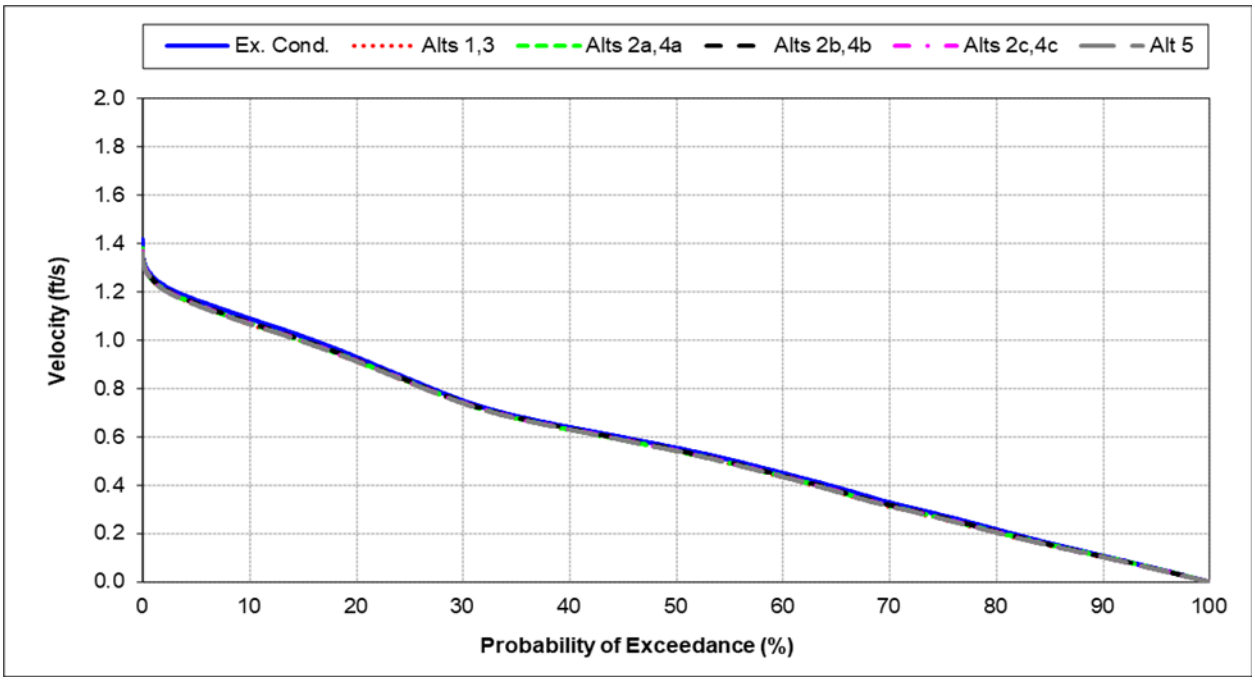



**Figure 6B.1-99. Victoria Canal, 15-Minute Absolute Velocity (in feet per second), August**

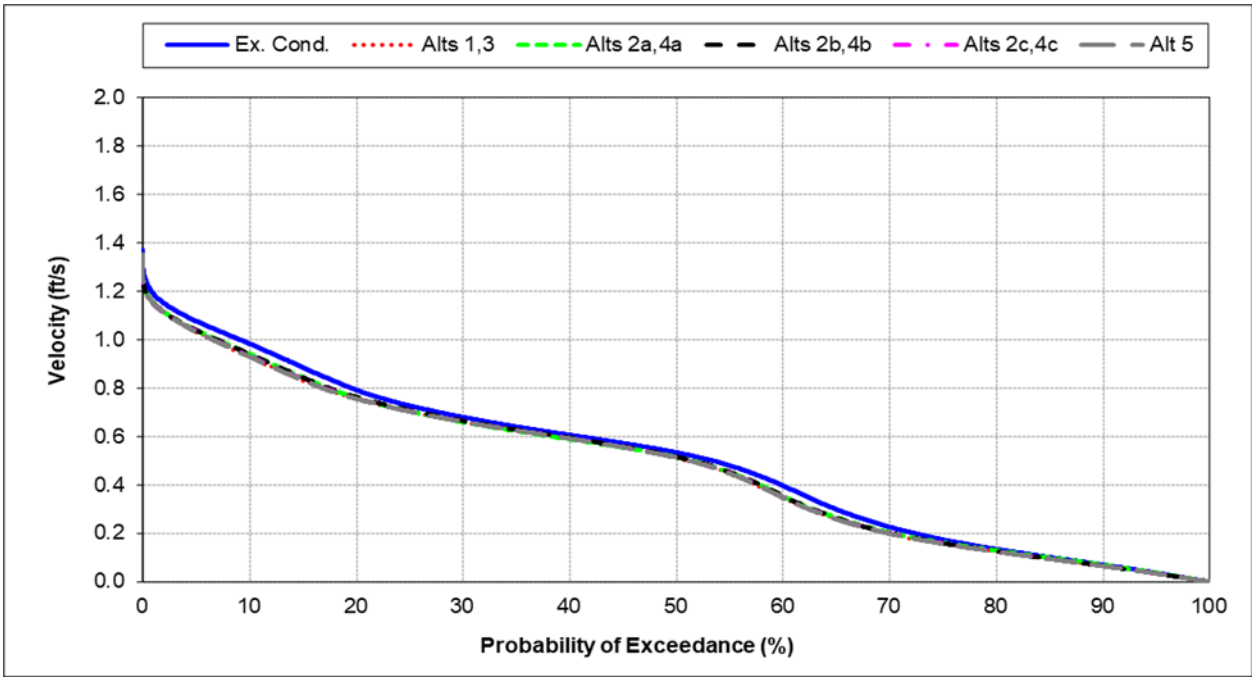



**Figure 6B.1-100. Victoria Canal, 15-Minute Absolute Velocity (in feet per second), September**

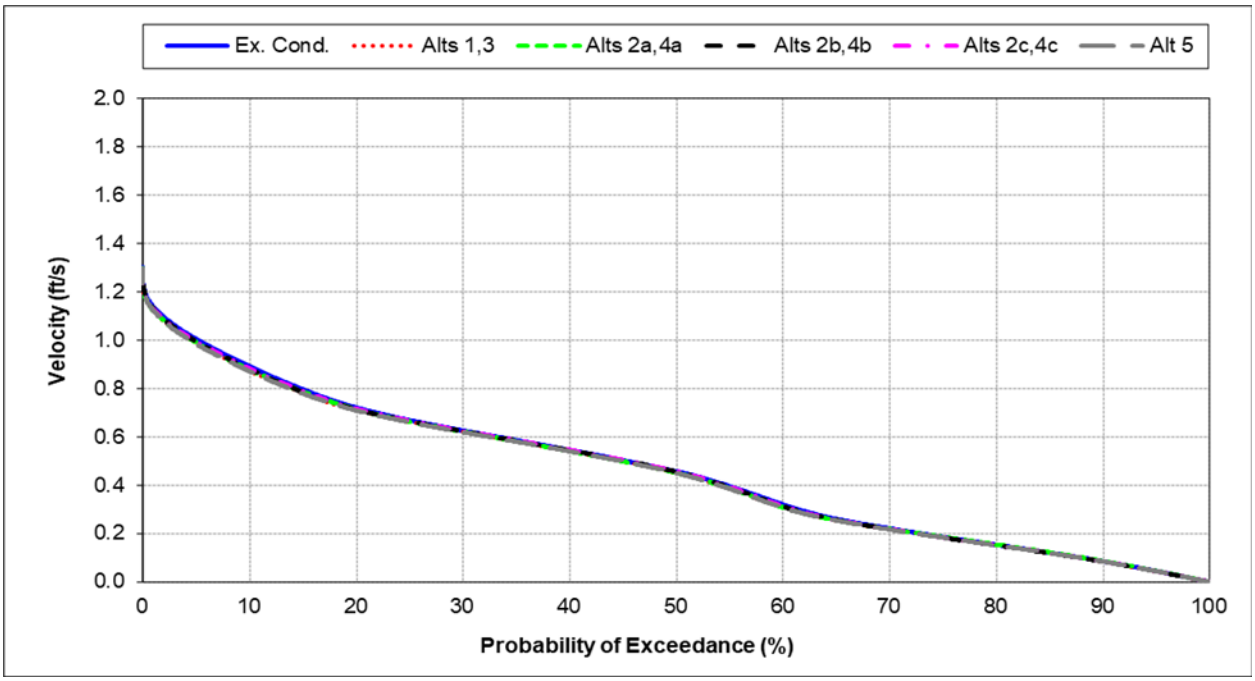



**Figure 6B.1-101. Victoria Canal, 15-Minute Absolute Velocity (in feet per second), October**

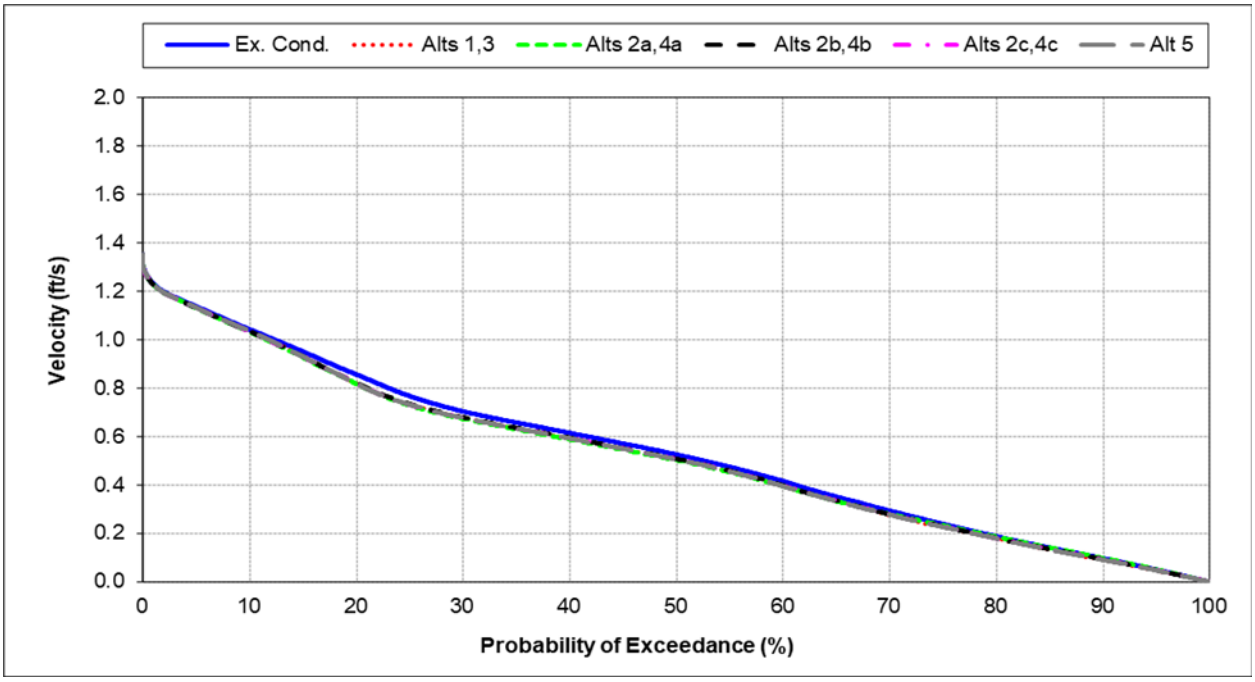



**Figure 6B.1-102. Victoria Canal, 15-Minute Absolute Velocity (in feet per second), November**

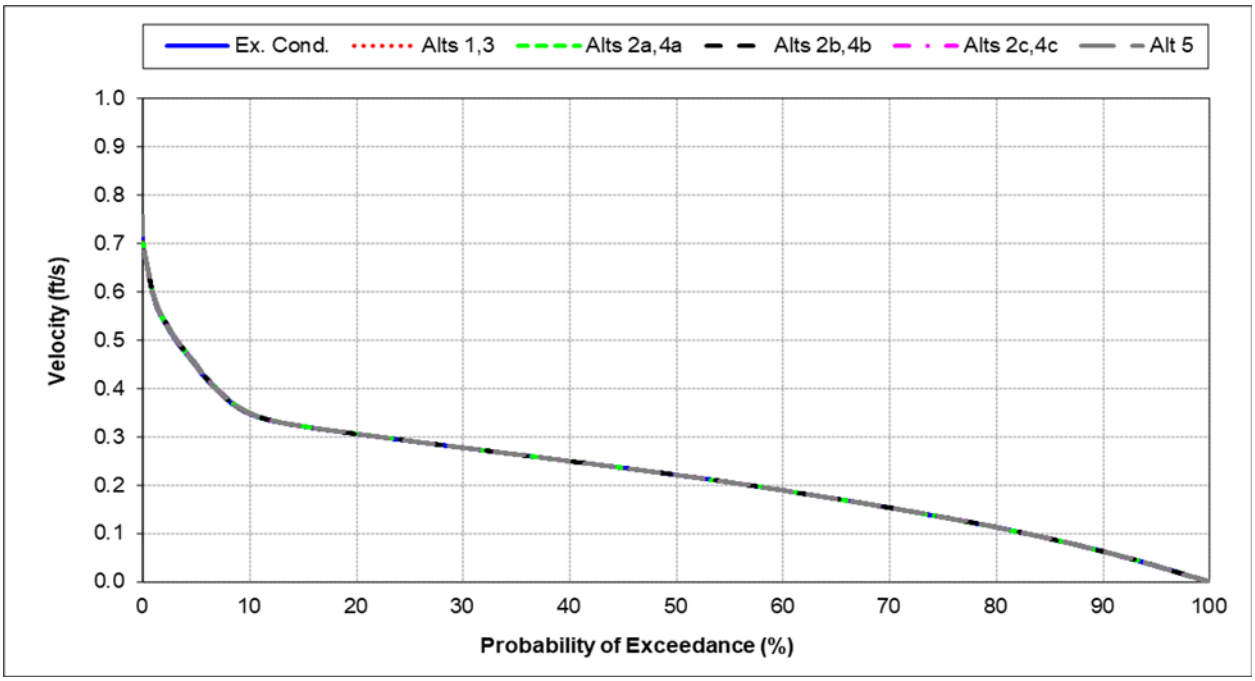



**Figure 6B.1-103. Stockton Deep Water Ship Channel, 15-Minute Absolute Velocity (in feet per second), June**

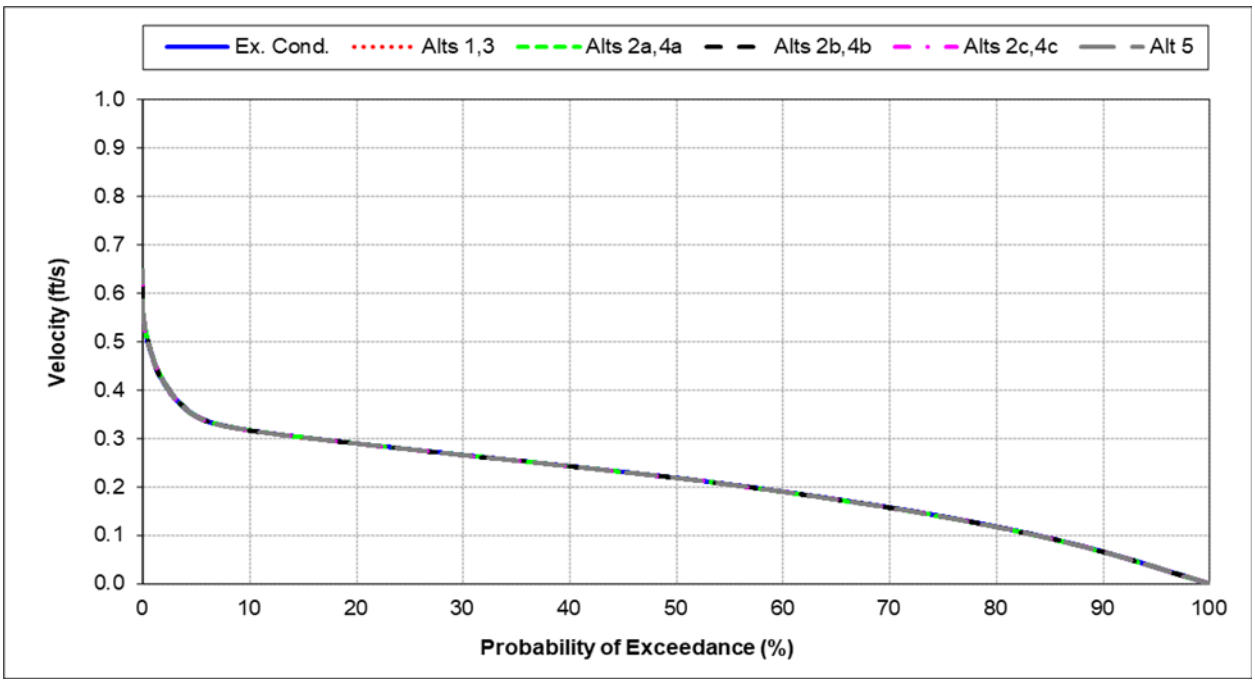



**Figure 6B.1-104. Stockton Deep Water Ship Channel, 15-Minute Absolute Velocity (in feet per second), July**

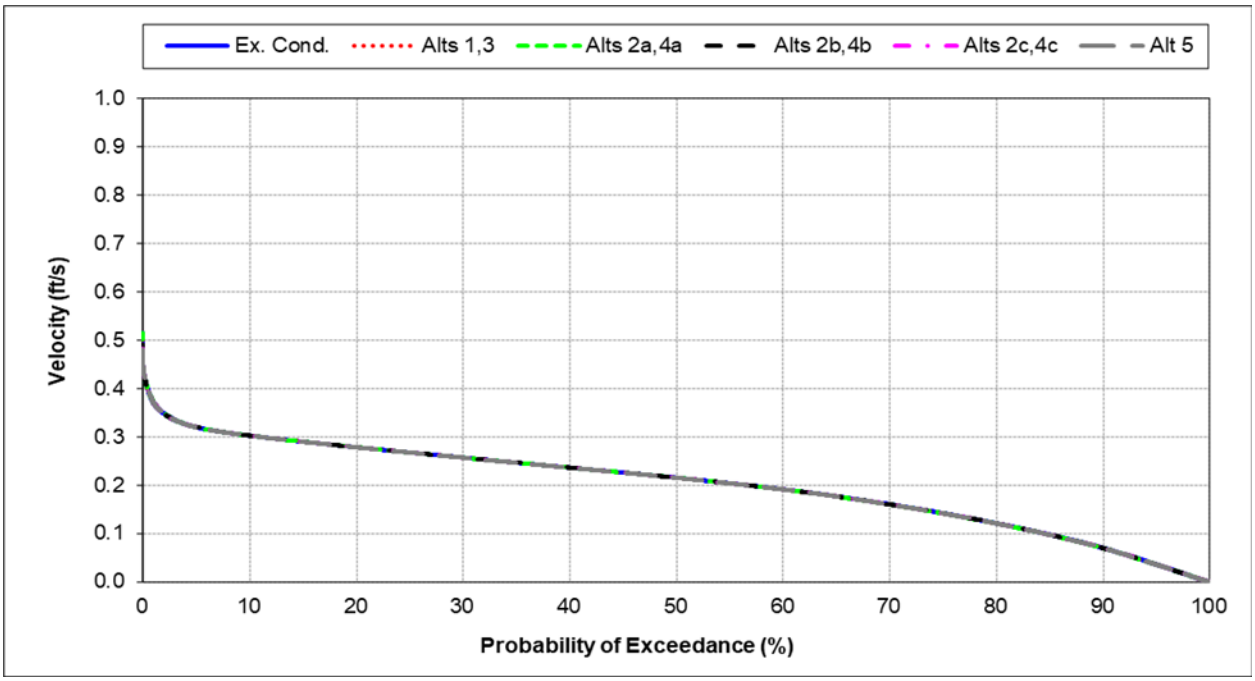



**Figure 6B.1-105. Stockton Deep Water Ship Channel, 15-Minute Absolute Velocity (in feet per second), August**

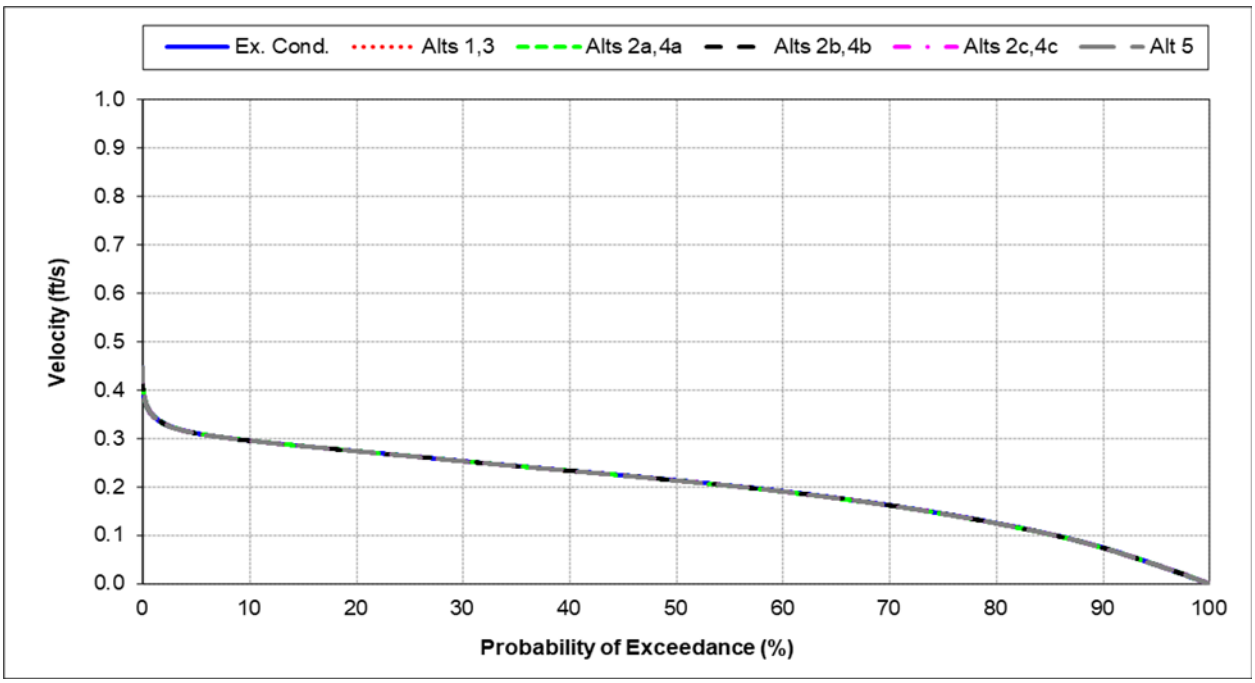



**Figure 6B.1-106. Stockton Deep Water Ship Channel, 15-Minute Absolute Velocity (in feet per second), September**

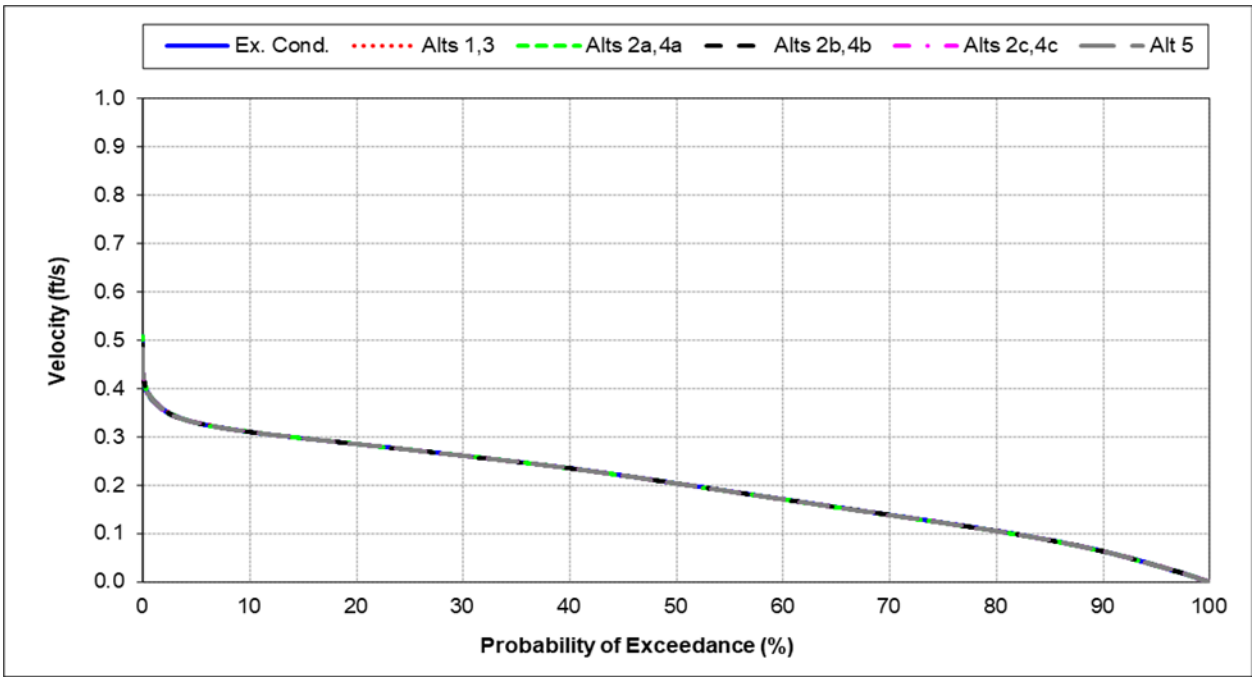



**Figure 6B.1-107. Stockton Deep Water Ship Channel, 15-Minute Absolute Velocity (in feet per second), October**

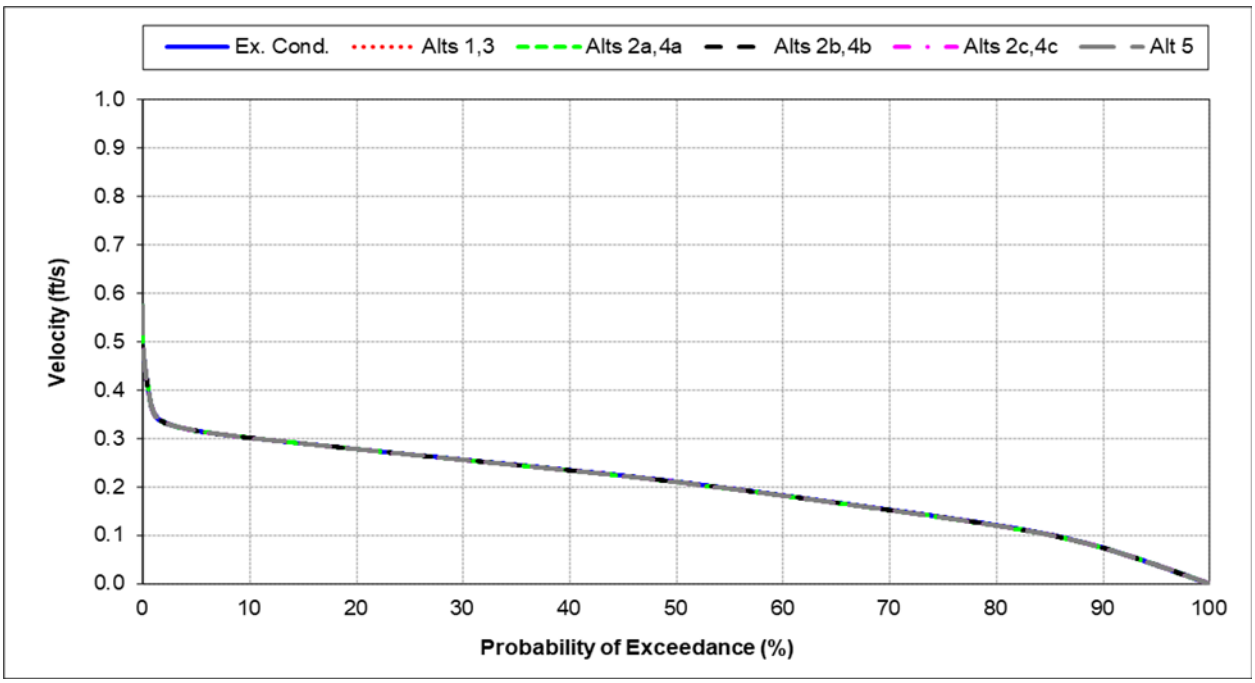



**Figure 6B.1-108. Stockton Deep Water Ship Channel, 15-Minute Absolute Velocity (in feet per second), November**

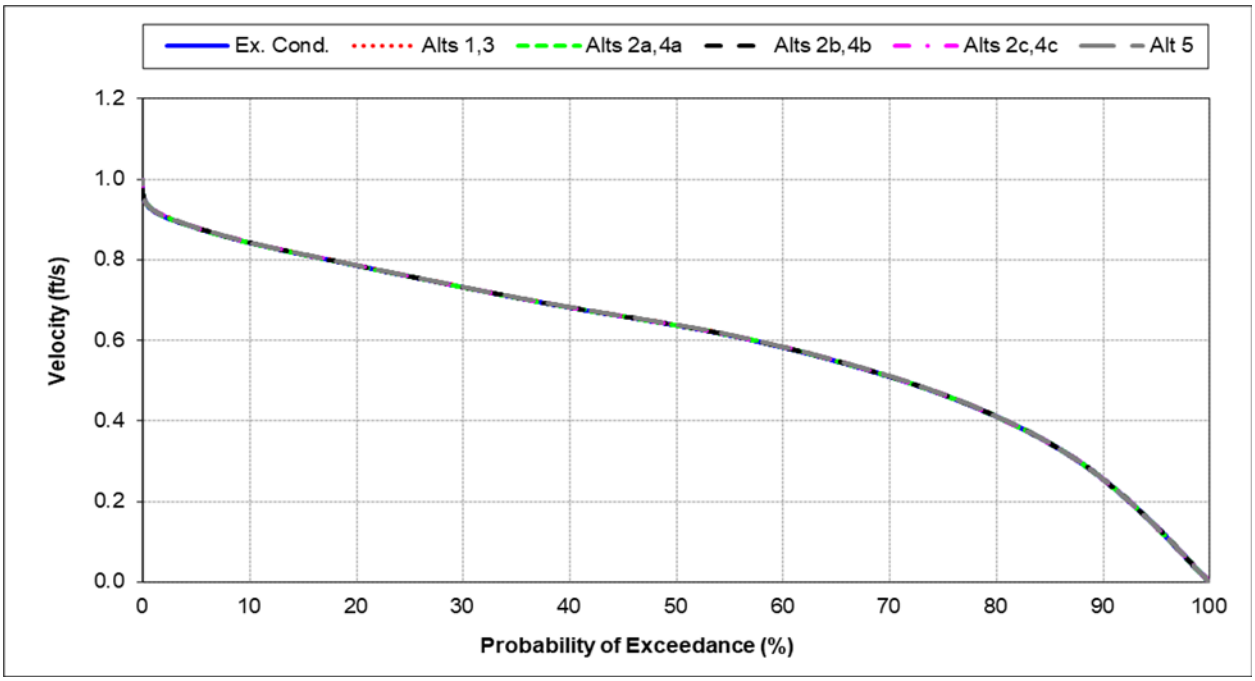



**Figure 6B.1-109. Mildred Island, 15-Minute Absolute Velocity (in feet per second), June**

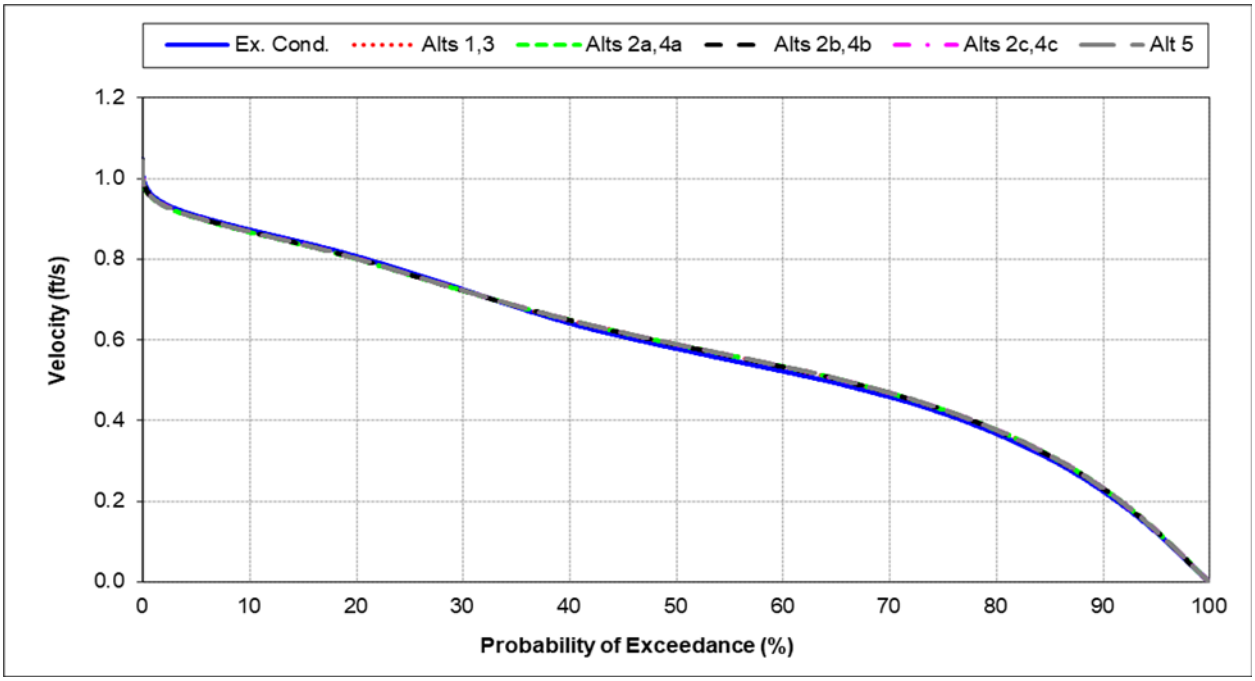



**Figure 6B.1-110. Mildred Island, 15-Minute Absolute Velocity (in feet per second), July**

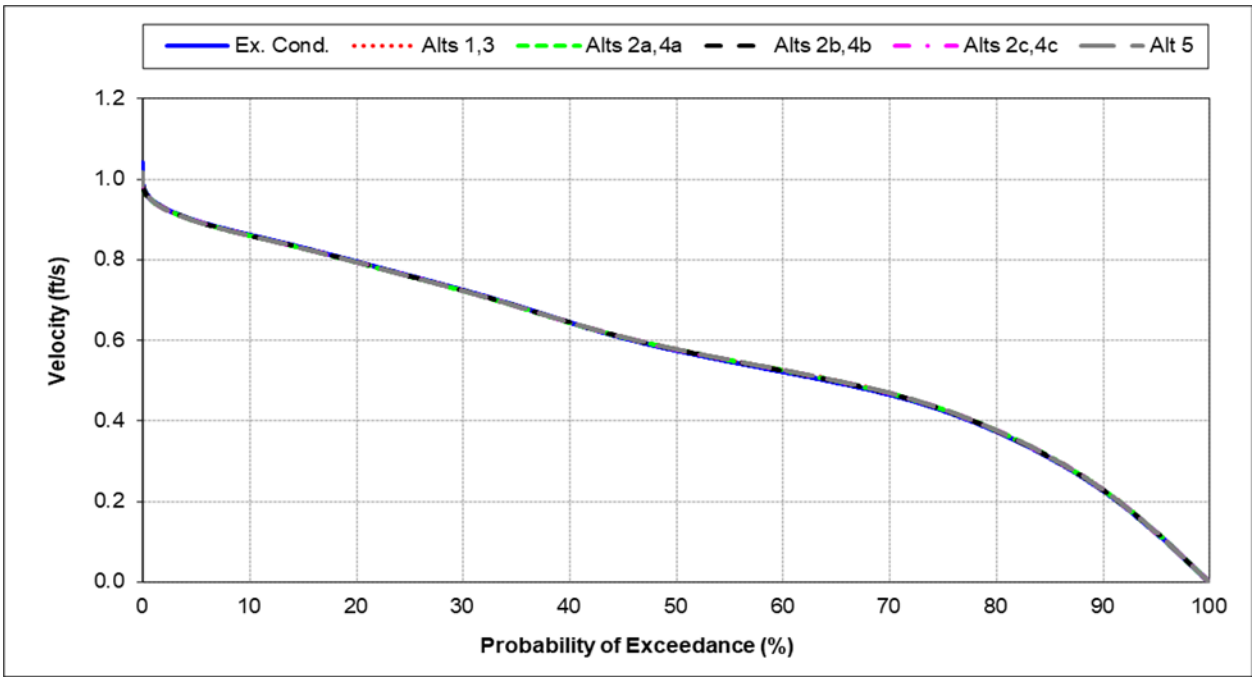



**Figure 6B.1-111. Mildred Island, 15-Minute Absolute Velocity (in feet per second), August**

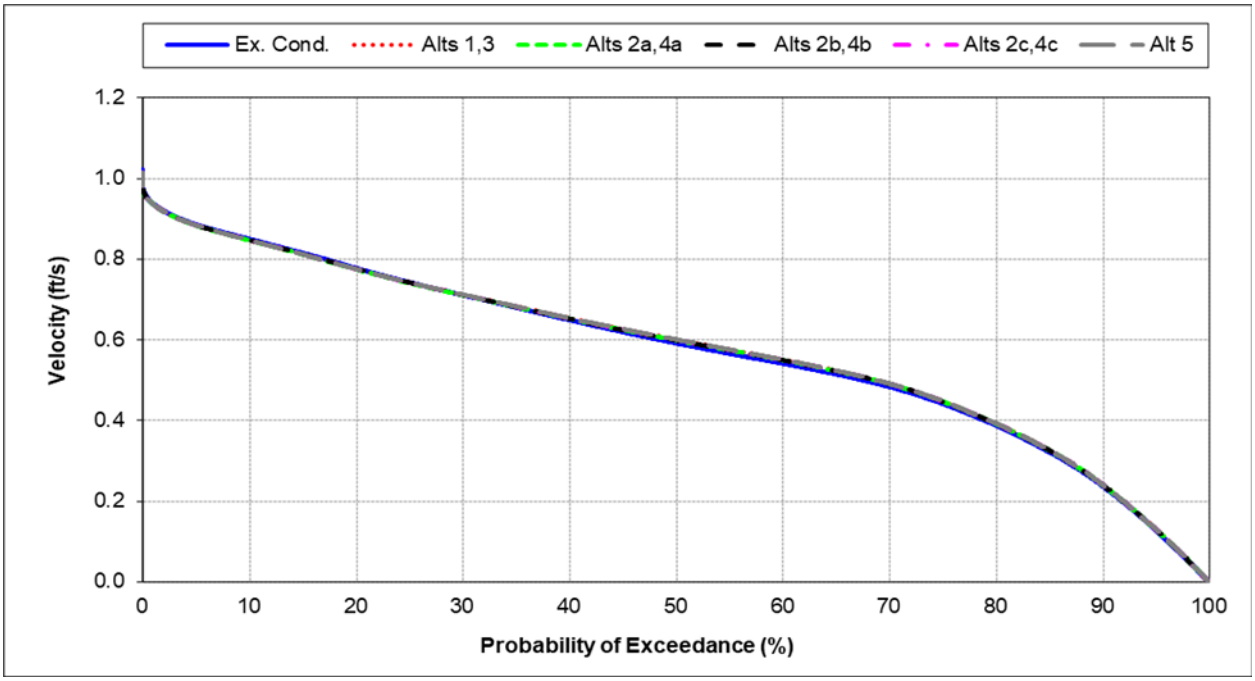



**Figure 6B.1-112. Mildred Island, 15-Minute Absolute Velocity (in feet per second), September**

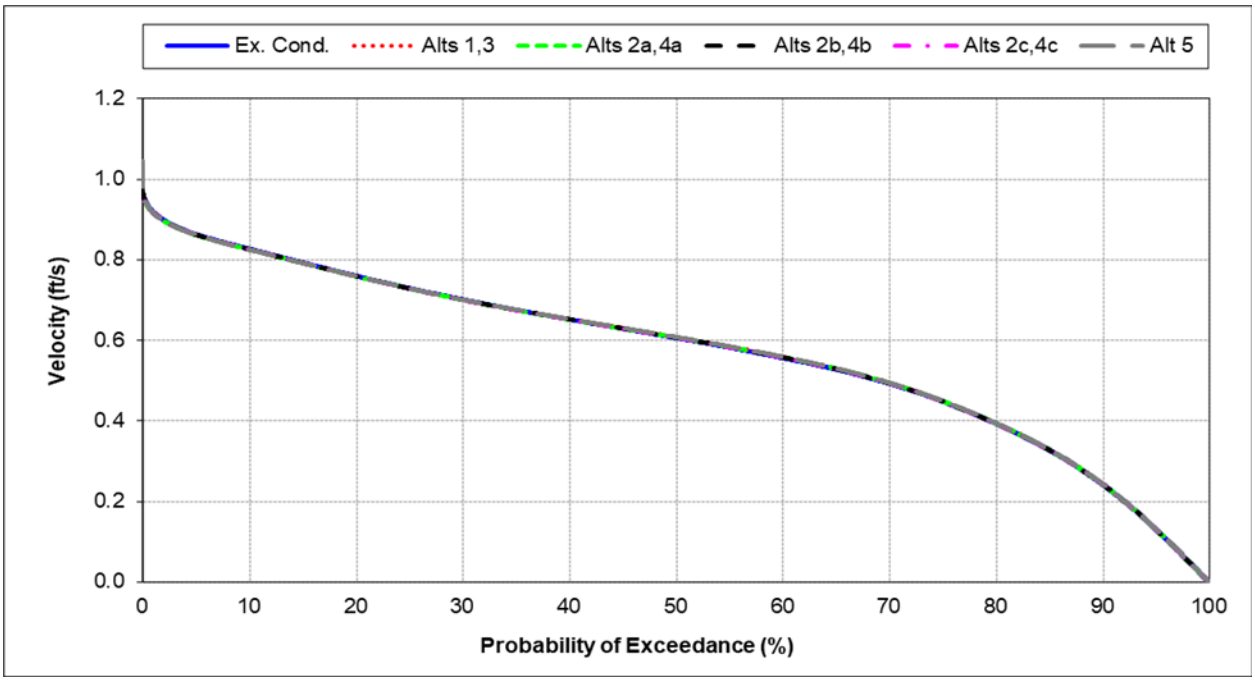



**Figure 6B.1-113. Mildred Island, 15-Minute Absolute Velocity (in feet per second), October**

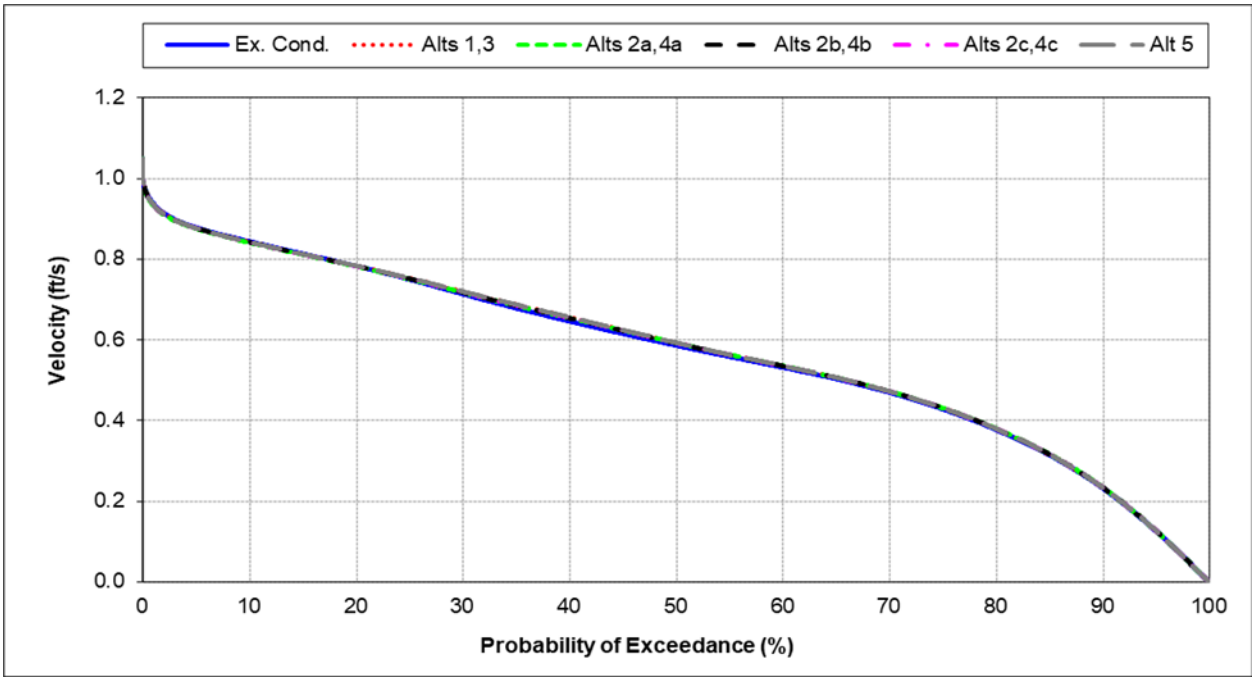



**Figure 6B.1-114. Mildred Island, 15-Minute Absolute Velocity (in feet per second), November**

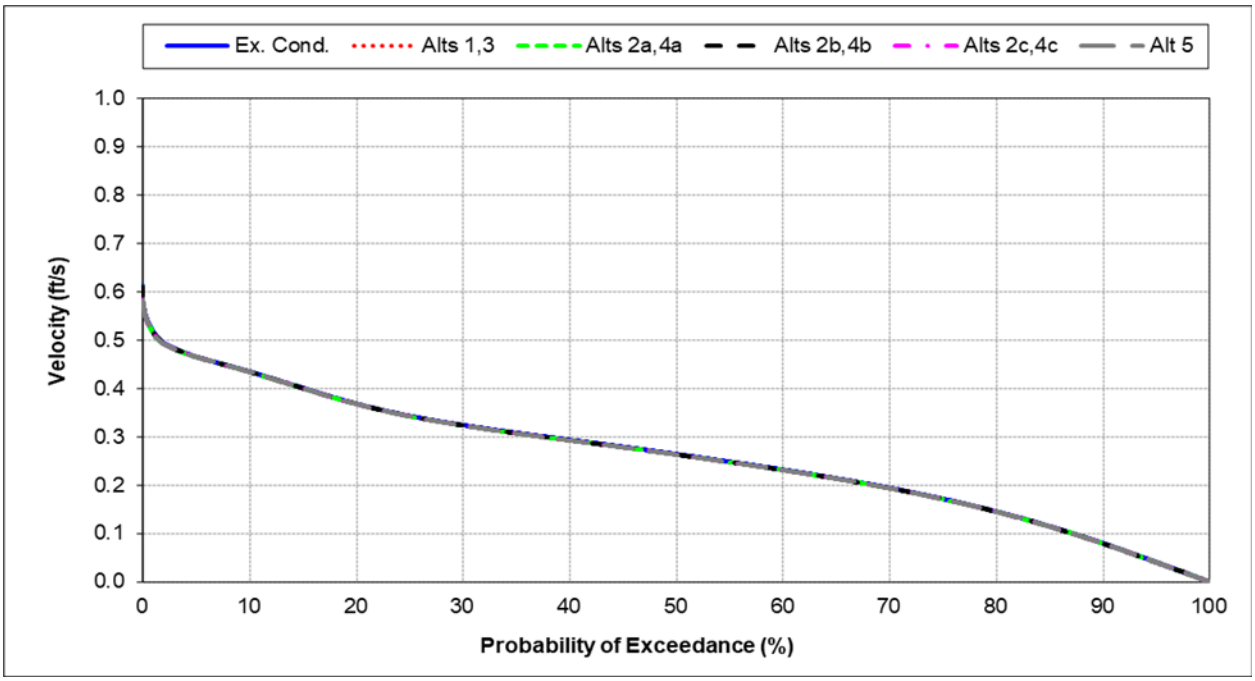



**Figure 6B.1-115. San Joaquin near Venice Island, 15-Minute Absolute Velocity (in feet per second), June**

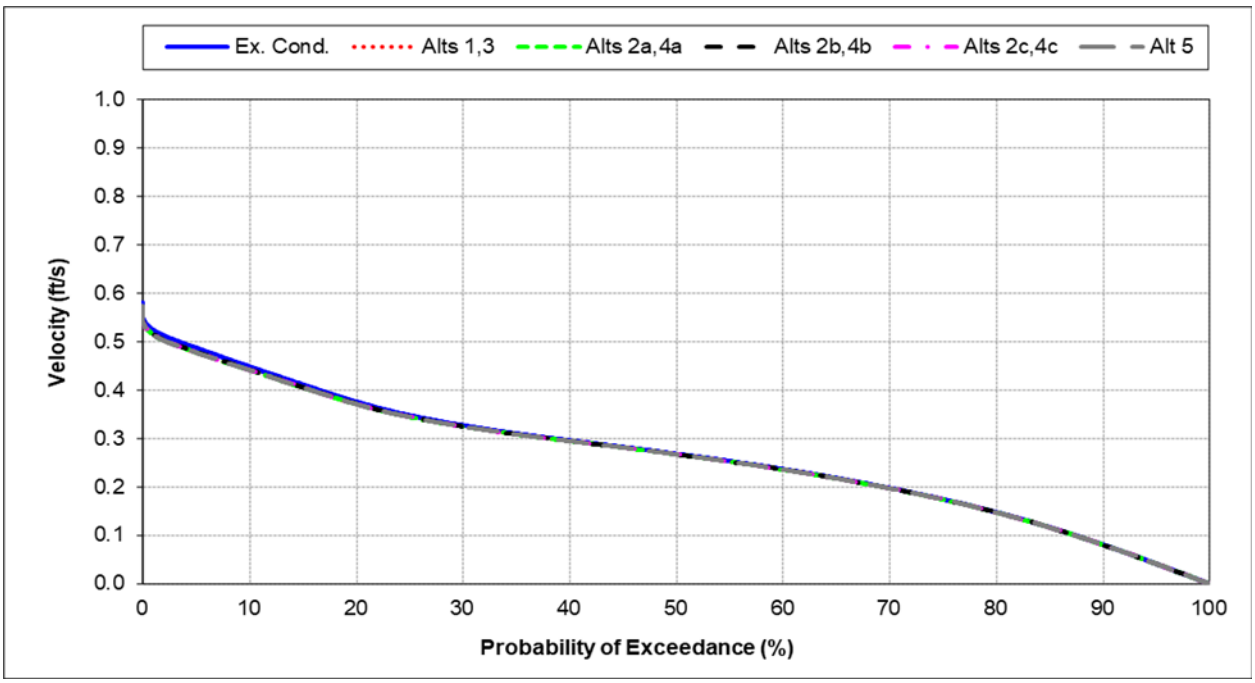



**Figure 6B.1-116. San Joaquin near Venice Island, 15-Minute Absolute Velocity (in feet per second), July**

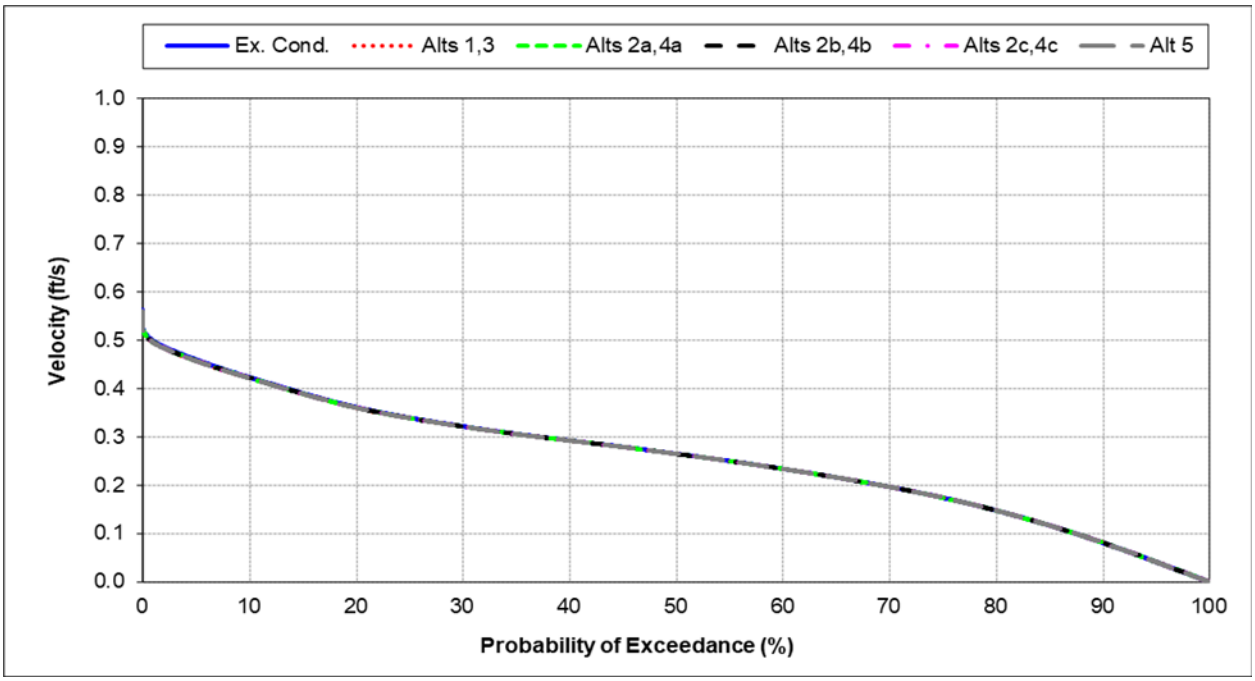



**Figure 6B.1-117. San Joaquin near Venice Island, 15-Minute Absolute Velocity (in feet per second), August**

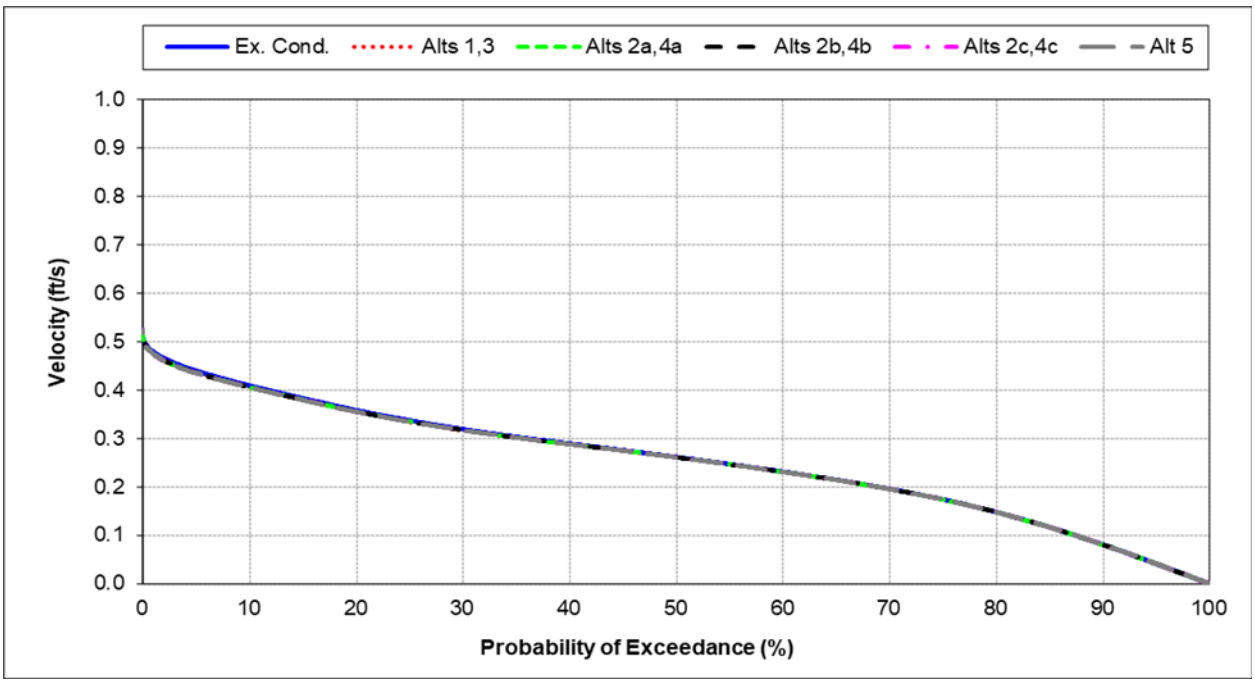



**Figure 6B.1-118. San Joaquin near Venice Island, 15-Minute Absolute Velocity (in feet per second), September**

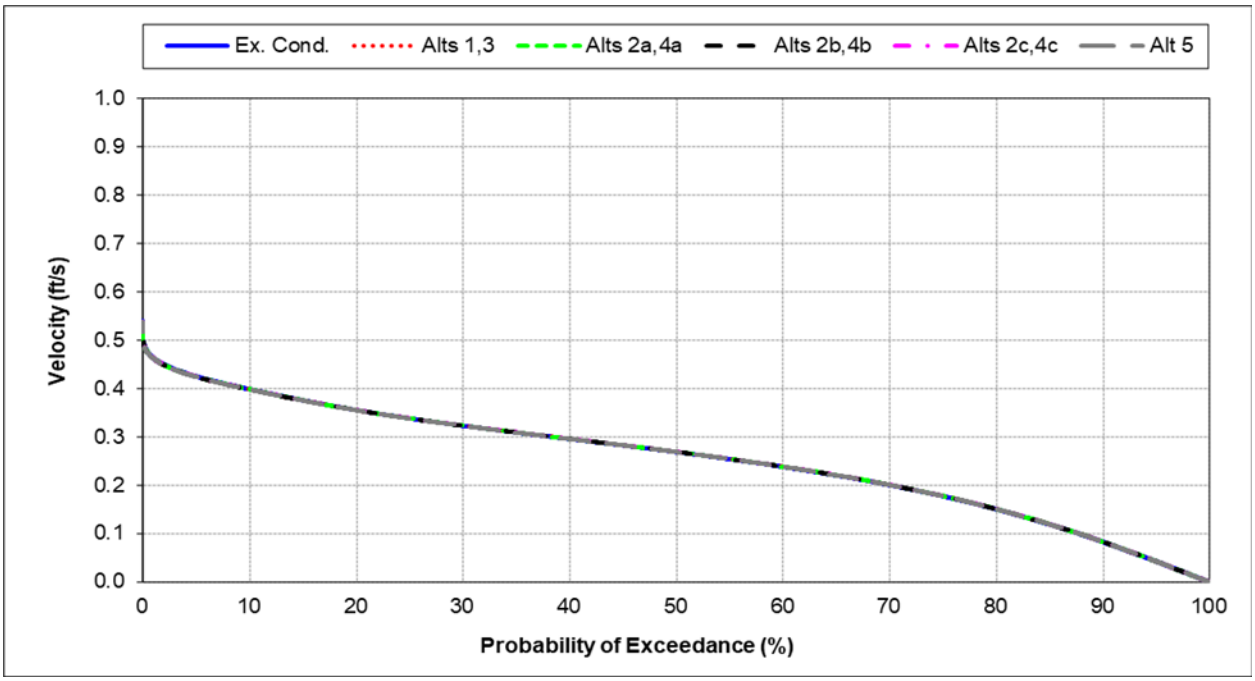



**Figure 6B.1-119. San Joaquin near Venice Island, 15-Minute Absolute Velocity (in feet per second), October**

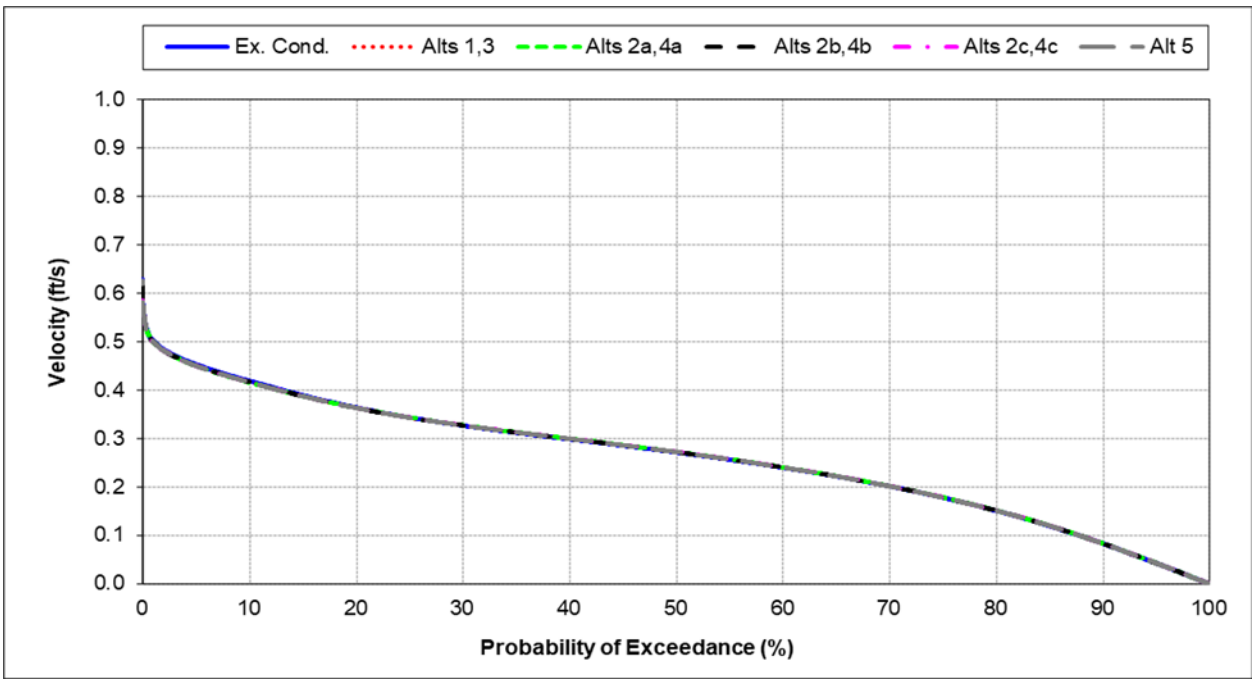



**Figure 6B.1-120. San Joaquin near Venice Island, 15-Minute Absolute Velocity (in feet per second), November**

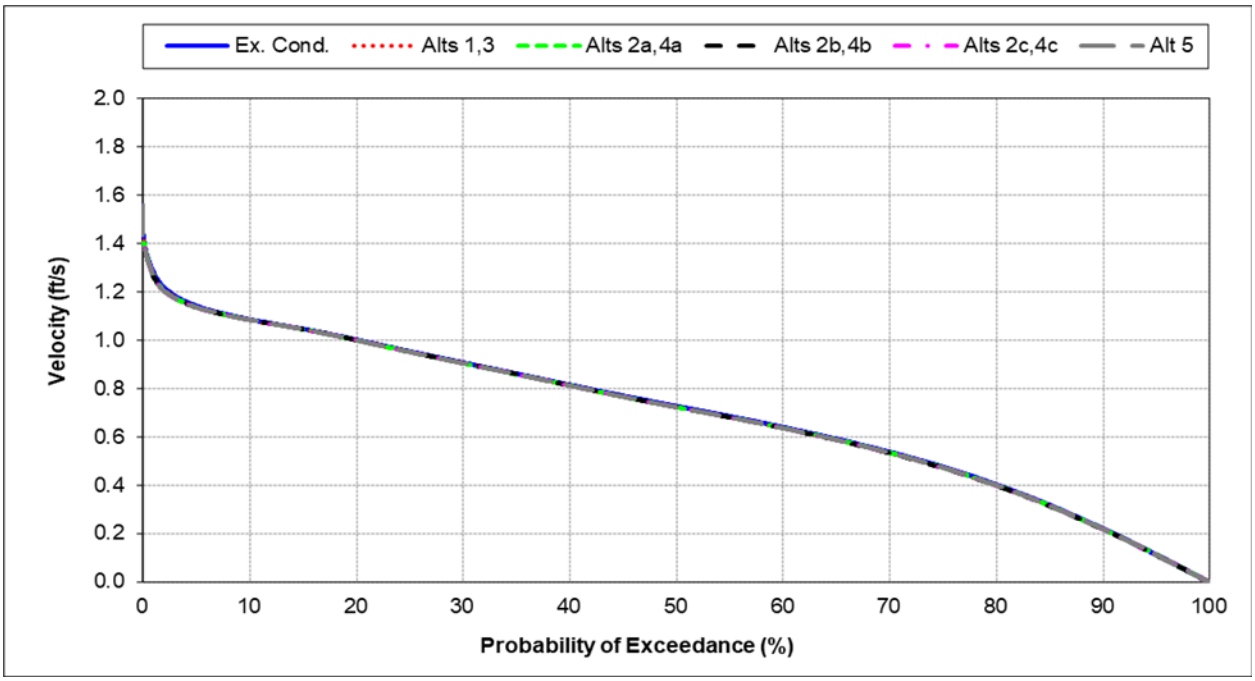



**Figure 6B.1-121. Mokelumne River, 15-Minute Absolute Velocity (in feet per second), June**

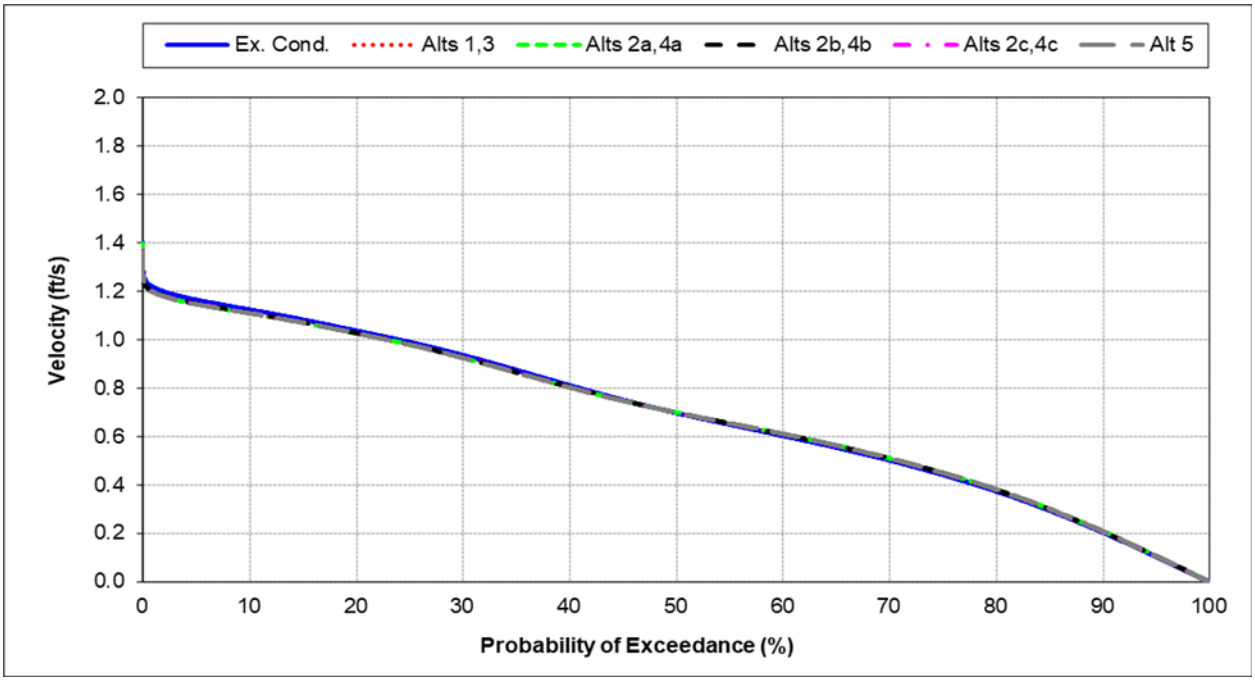



**Figure 6B.1-122. Mokelumne River, 15-Minute Absolute Velocity (in feet per second), July**

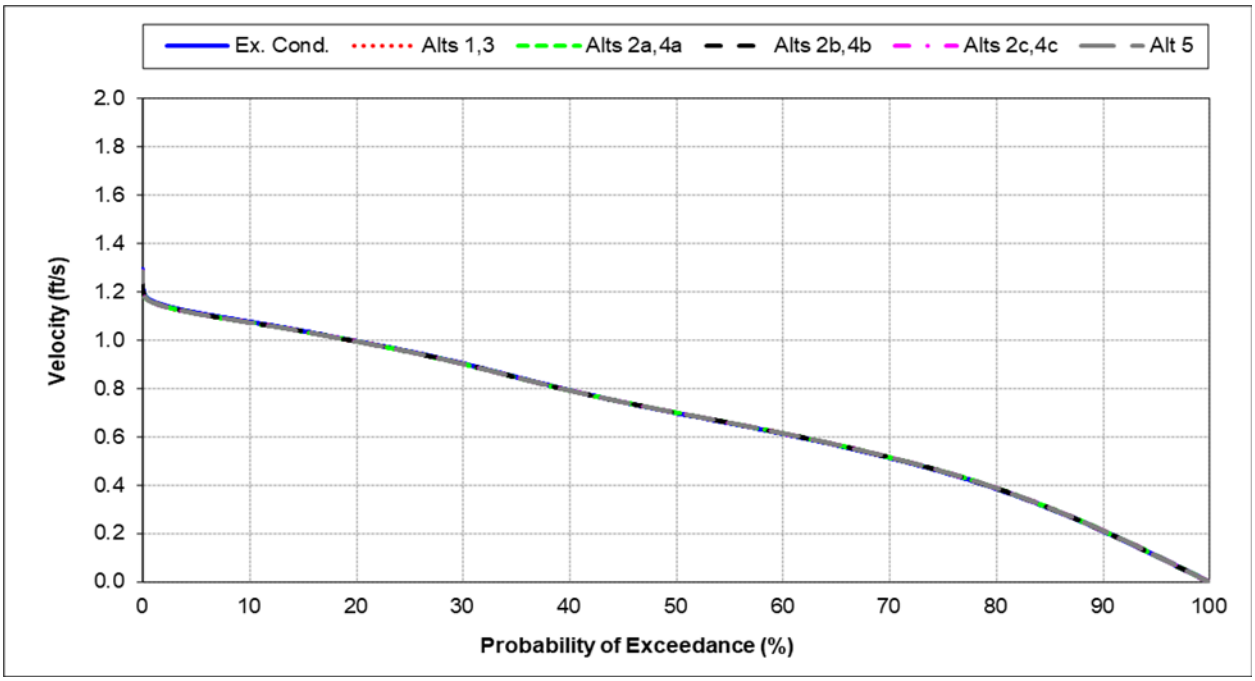



**Figure 6B.1-123. Mokelumne River, 15-Minute Absolute Velocity (in feet per second), August**

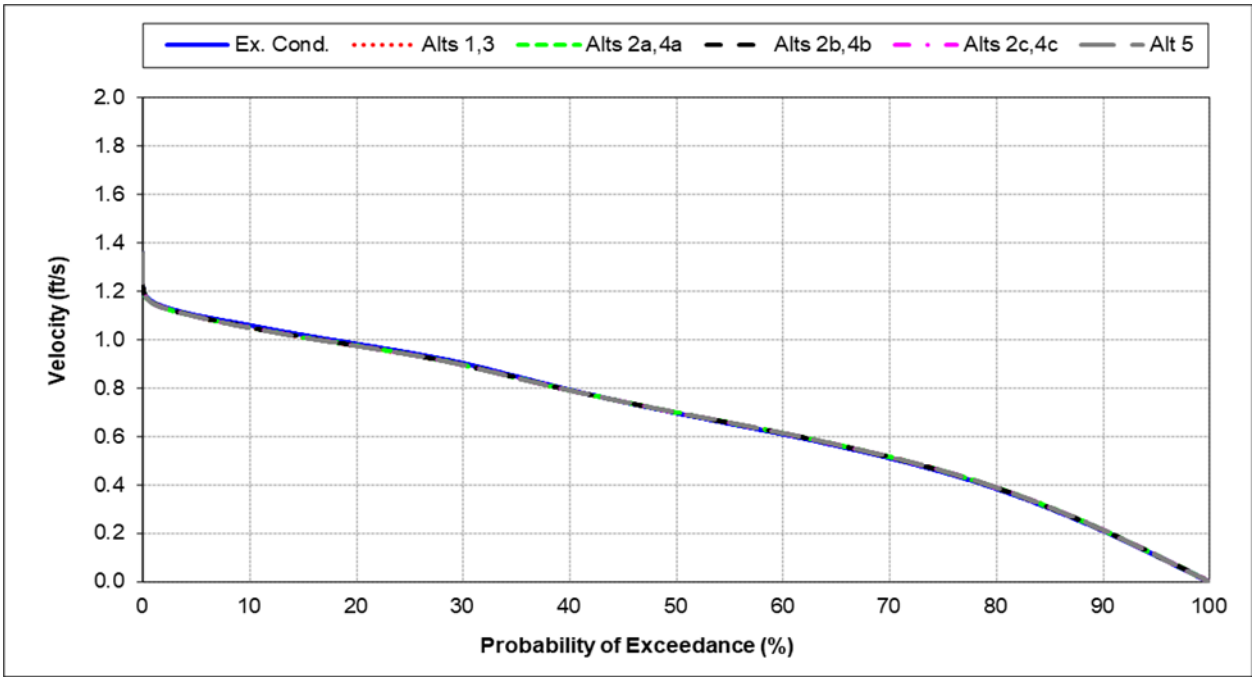



**Figure 6B.1-124. Mokelumne River, 15-Minute Absolute Velocity (in feet per second), September**

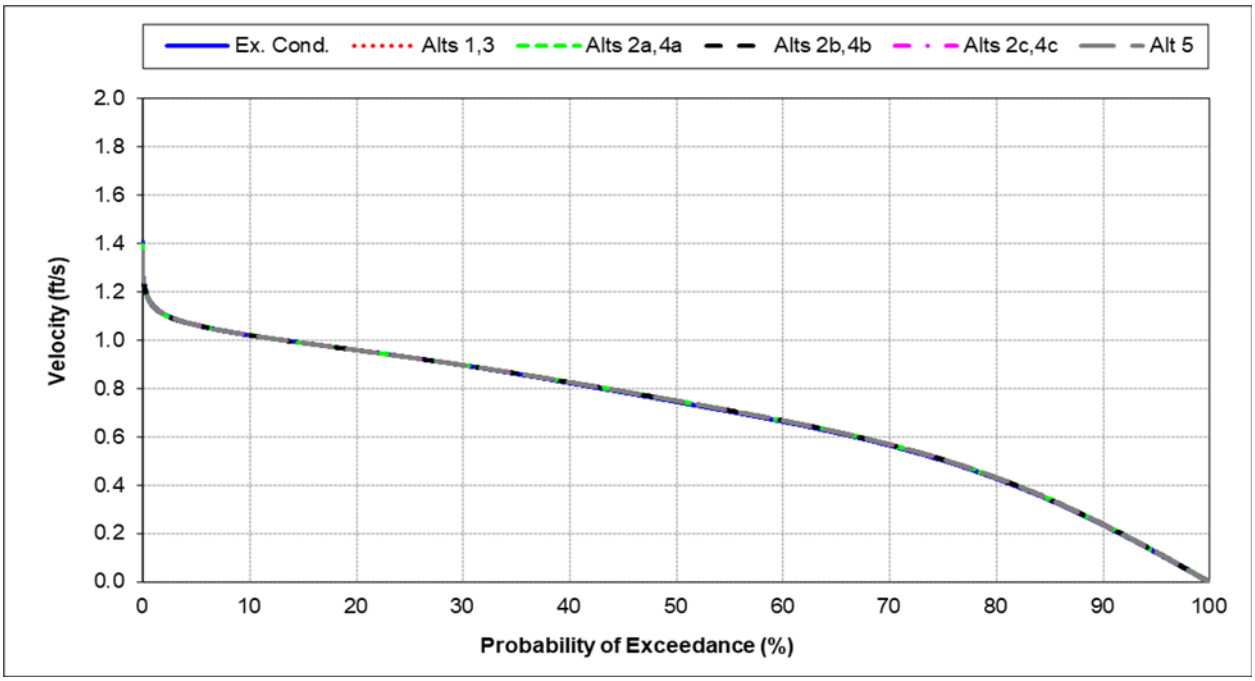



**Figure 6B.1-125. Mokelumne River, 15-Minute Absolute Velocity (in feet per second), October**

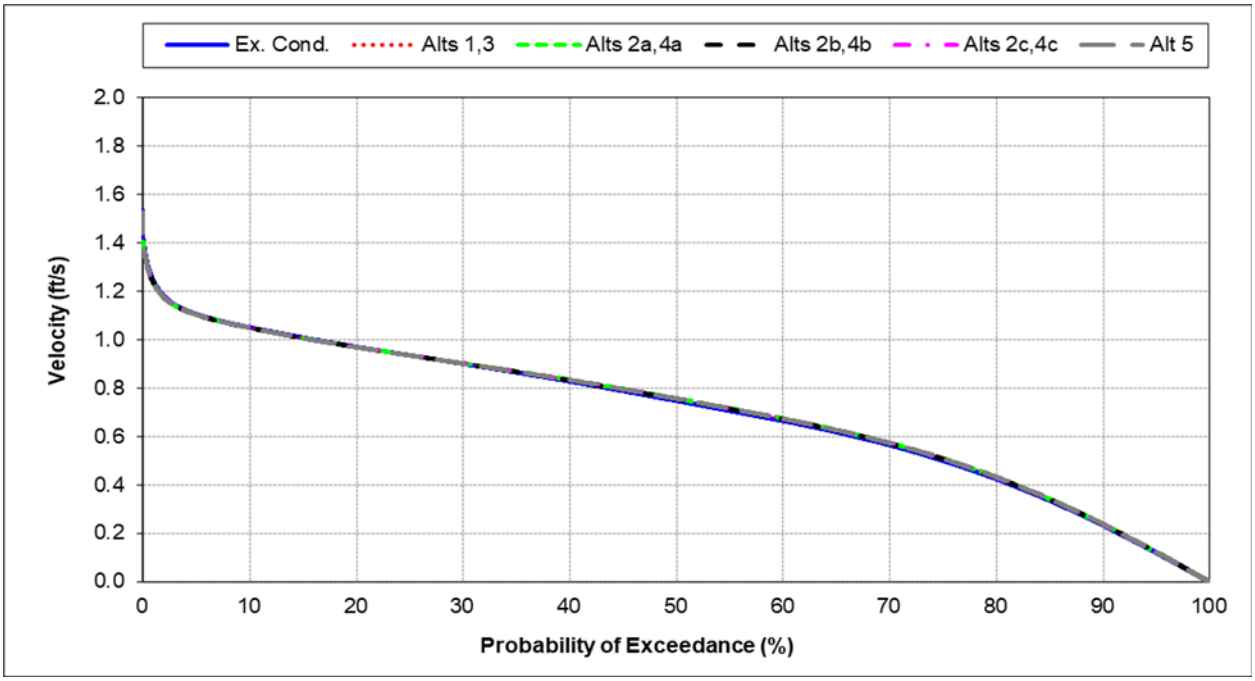



**Figure 6B.1-126. Mokelumne River, 15-Minute Absolute Velocity (in feet per second), November**

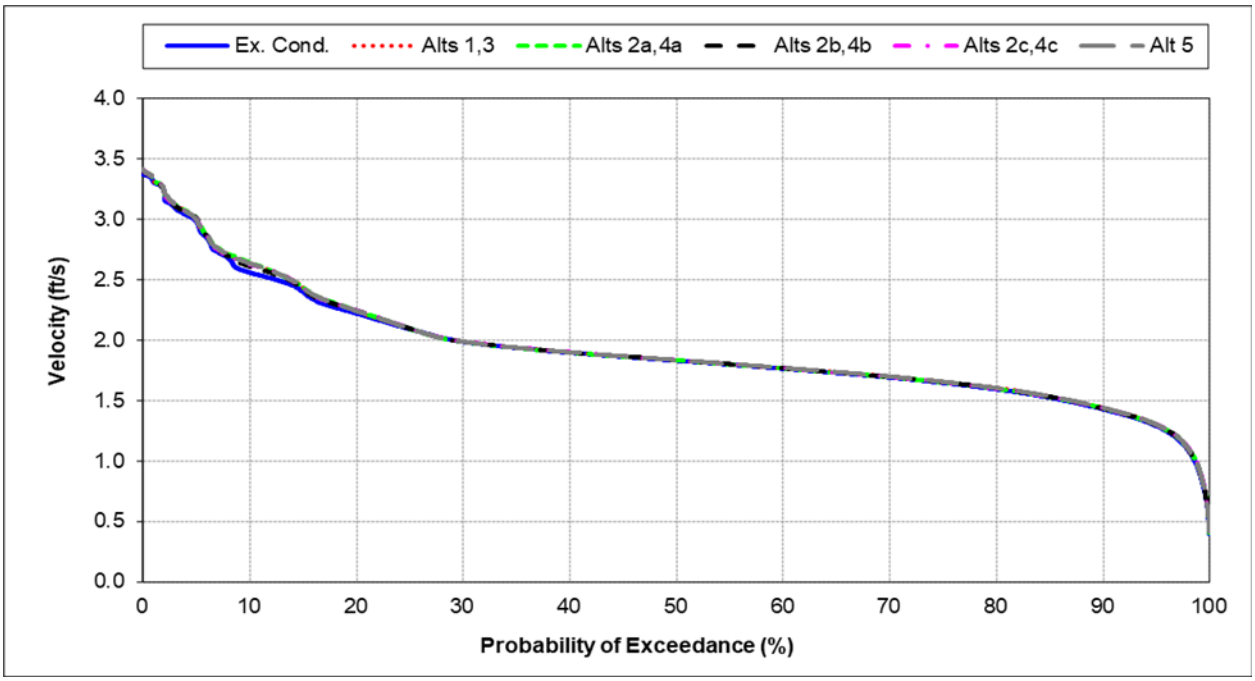



**Figure 6B.1-127. Sacramento River at I Street Bridge, 15-Minute Absolute Velocity (in feet per second), June**

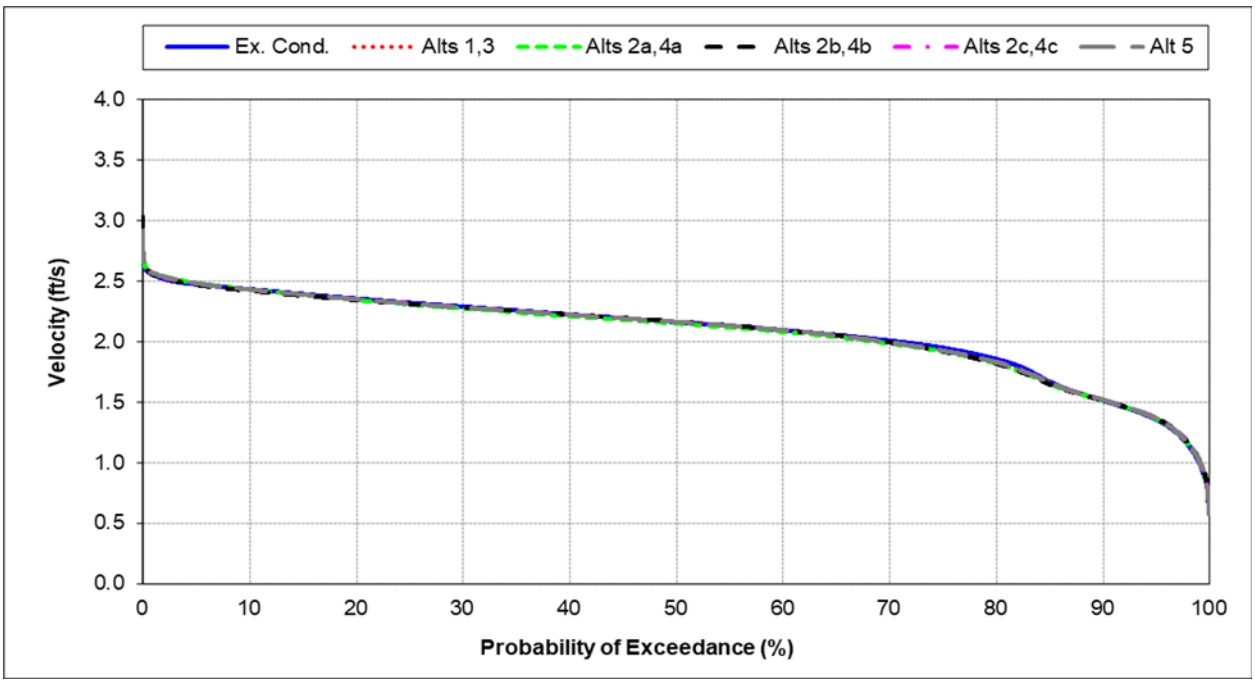



**Figure 6B.1-128. Sacramento River at I Street Bridge, 15-Minute Absolute Velocity (in feet per second), July**

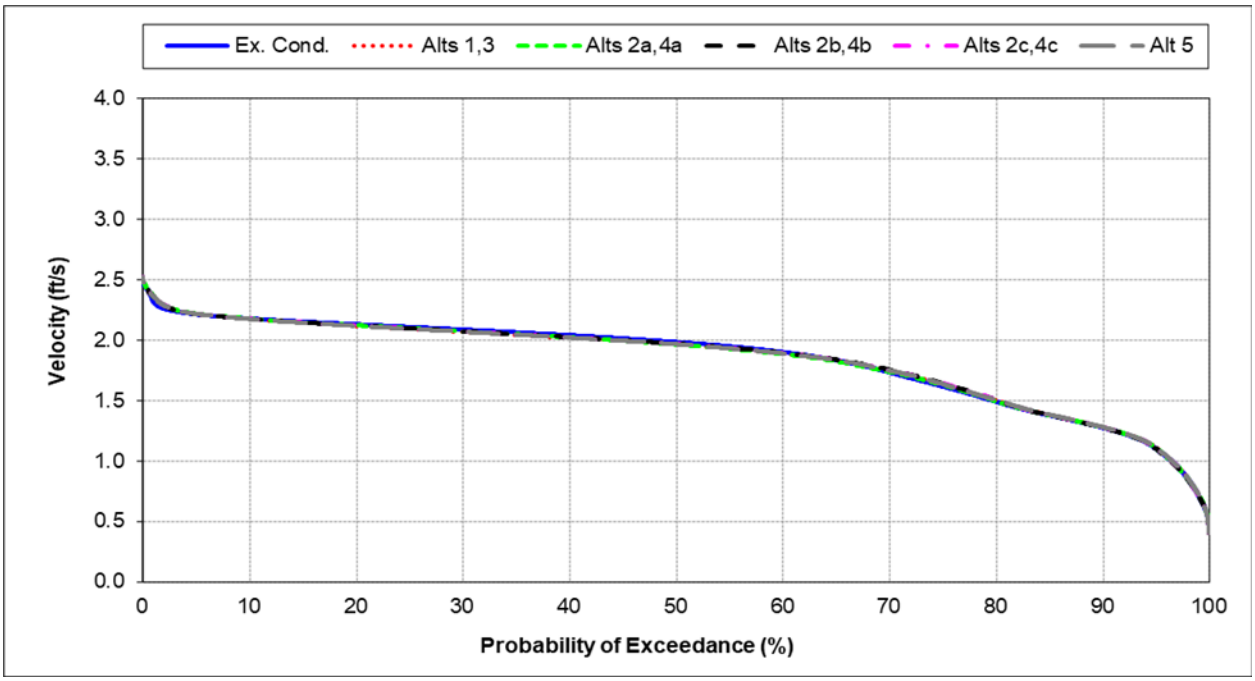



**Figure 6B.1-129. Sacramento River at I Street Bridge, 15-Minute Absolute Velocity (in feet per second), August**

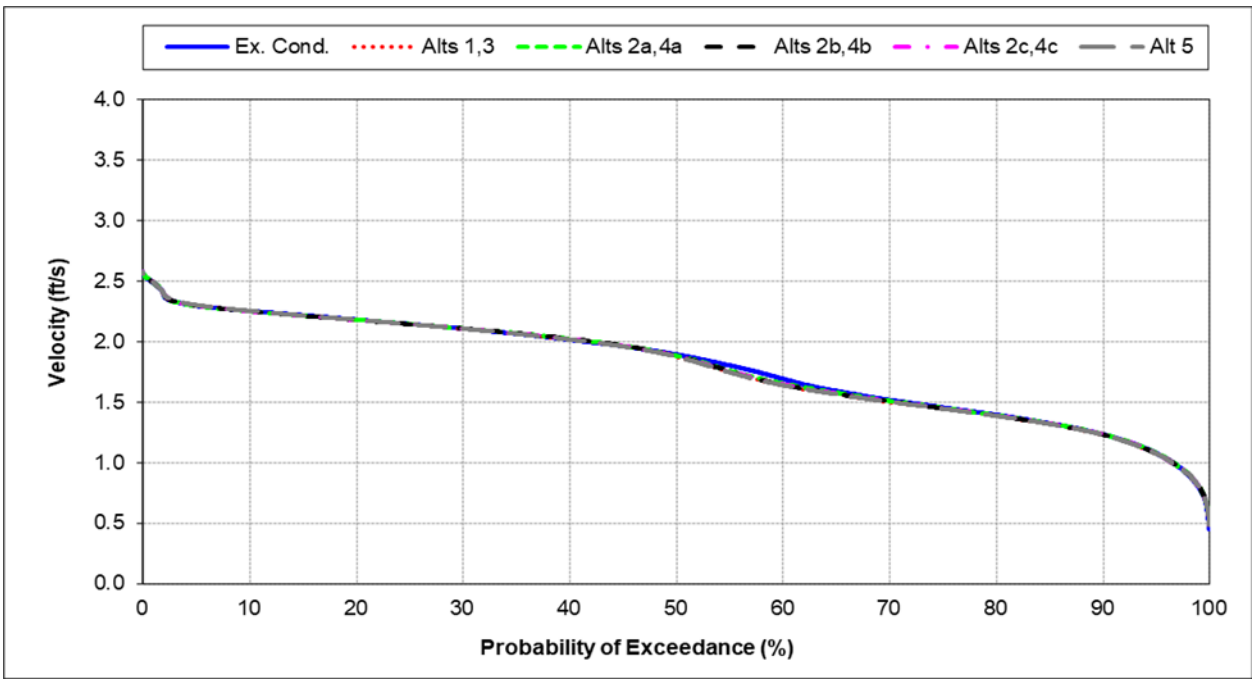



**Figure 6B.1-130. Sacramento River at I Street Bridge, 15-Minute Absolute Velocity (in feet per second), September**

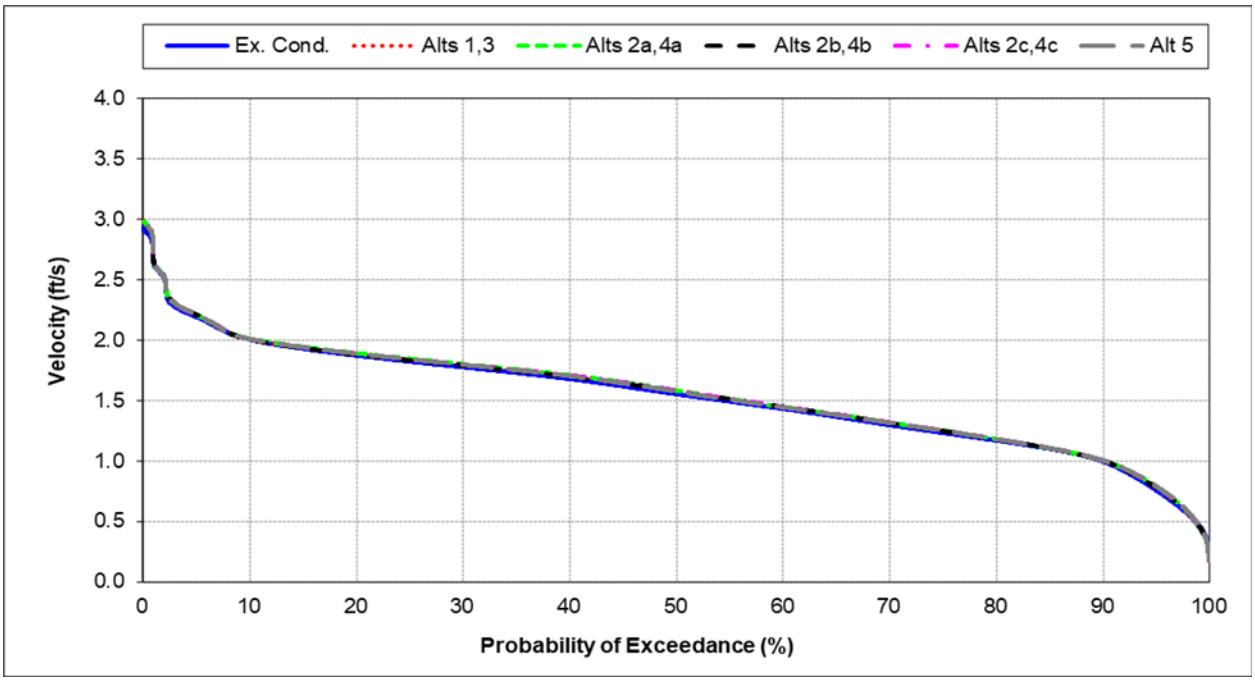



**Figure 6B.1-131. Sacramento River at I Street Bridge, 15-Minute Absolute Velocity (in feet per second), October**

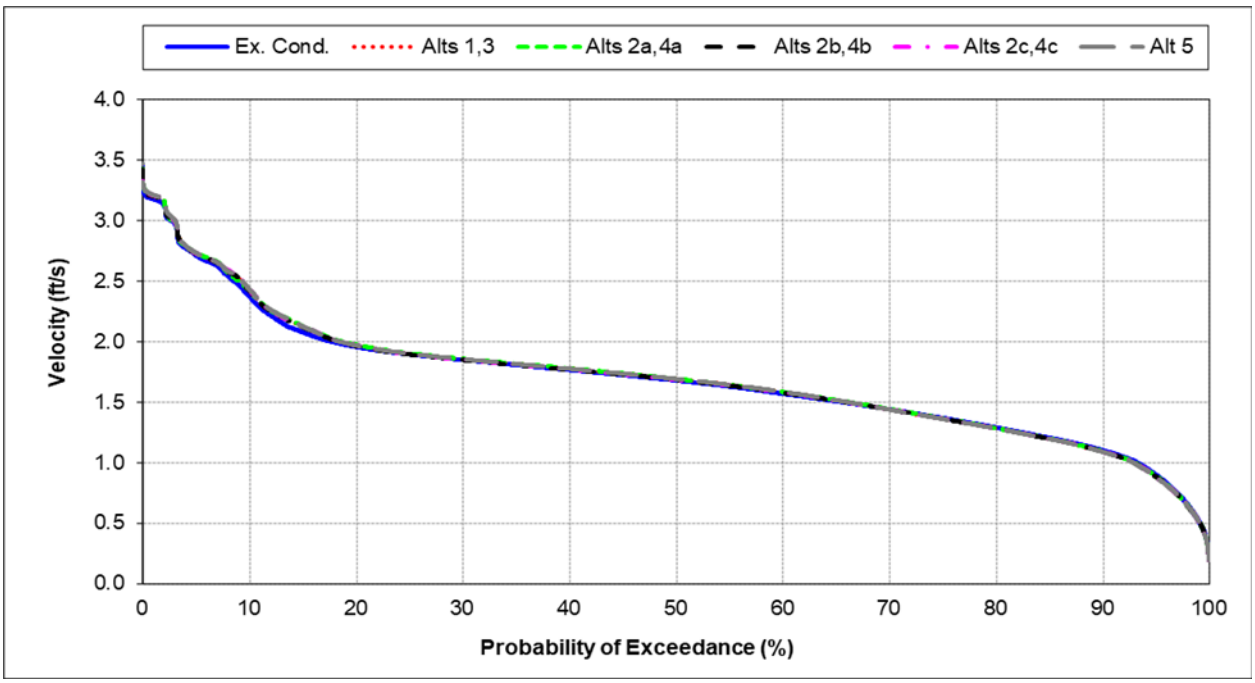



**Figure 6B.1-132. Sacramento River at I Street Bridge, 15-Minute Absolute Velocity (in feet per second), November**

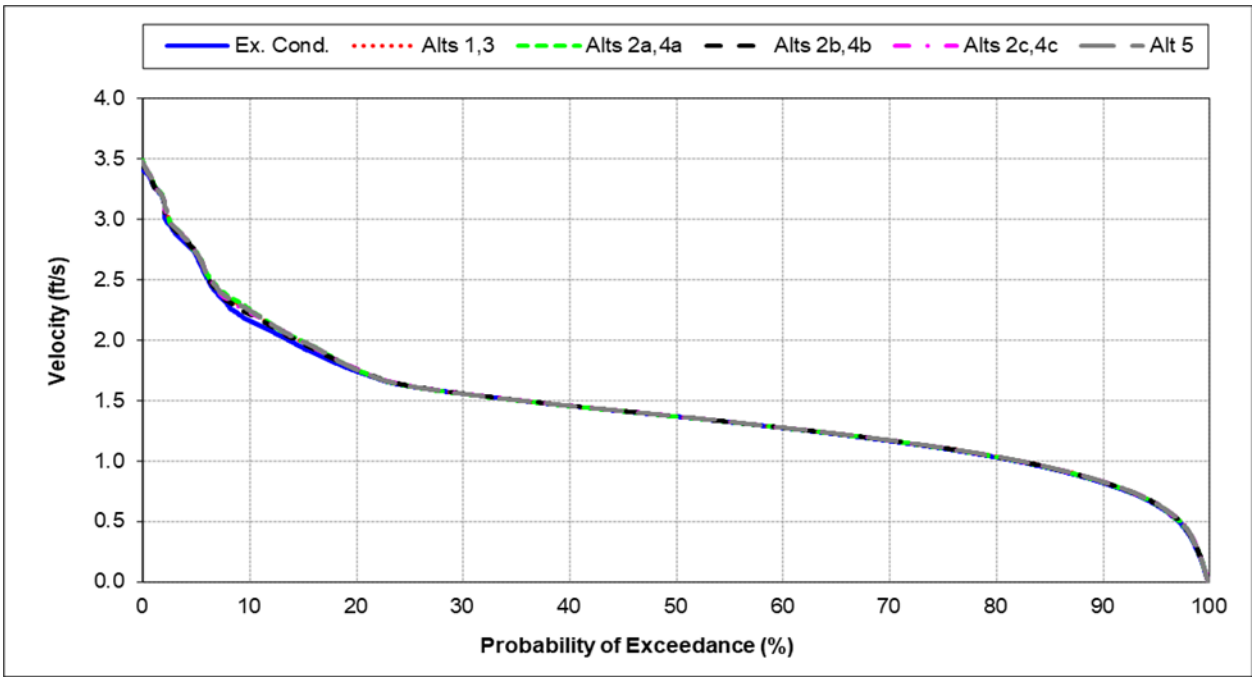



**Figure 6B.1-133. Sacramento River at Freeport, 15-Minute Absolute Velocity (in feet per second), June**

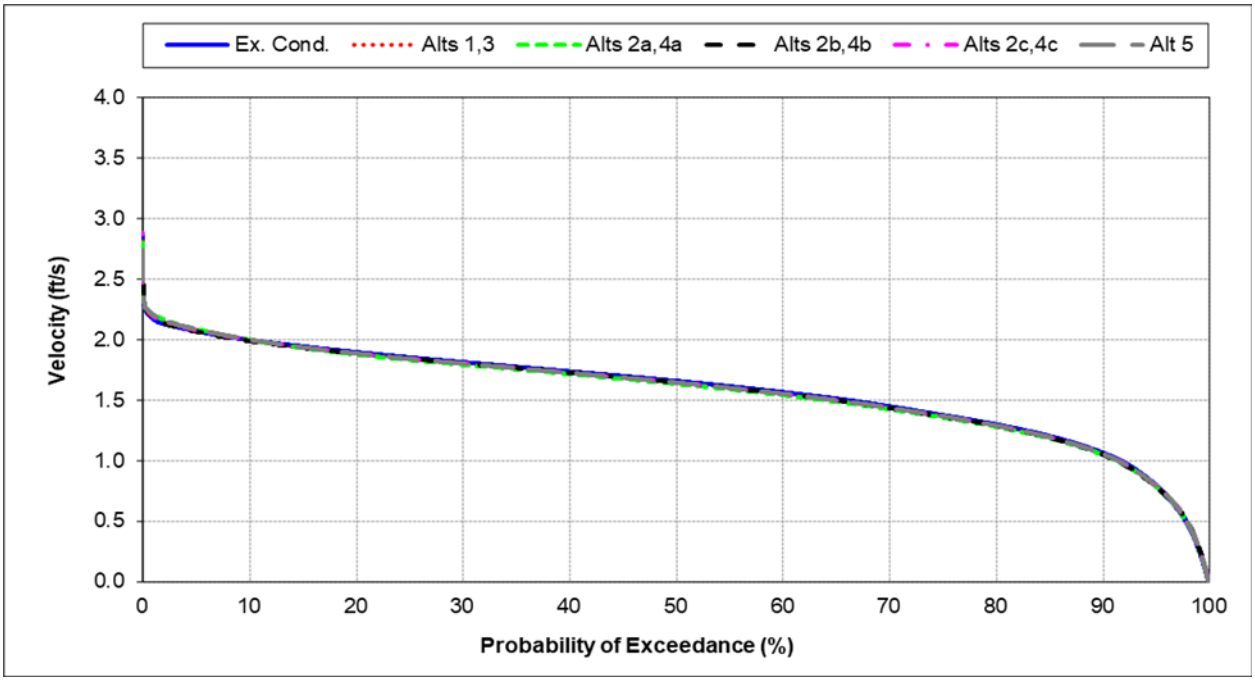



**Figure 6B.1-134. Sacramento River at Freeport, 15-Minute Absolute Velocity (in feet per second), July**

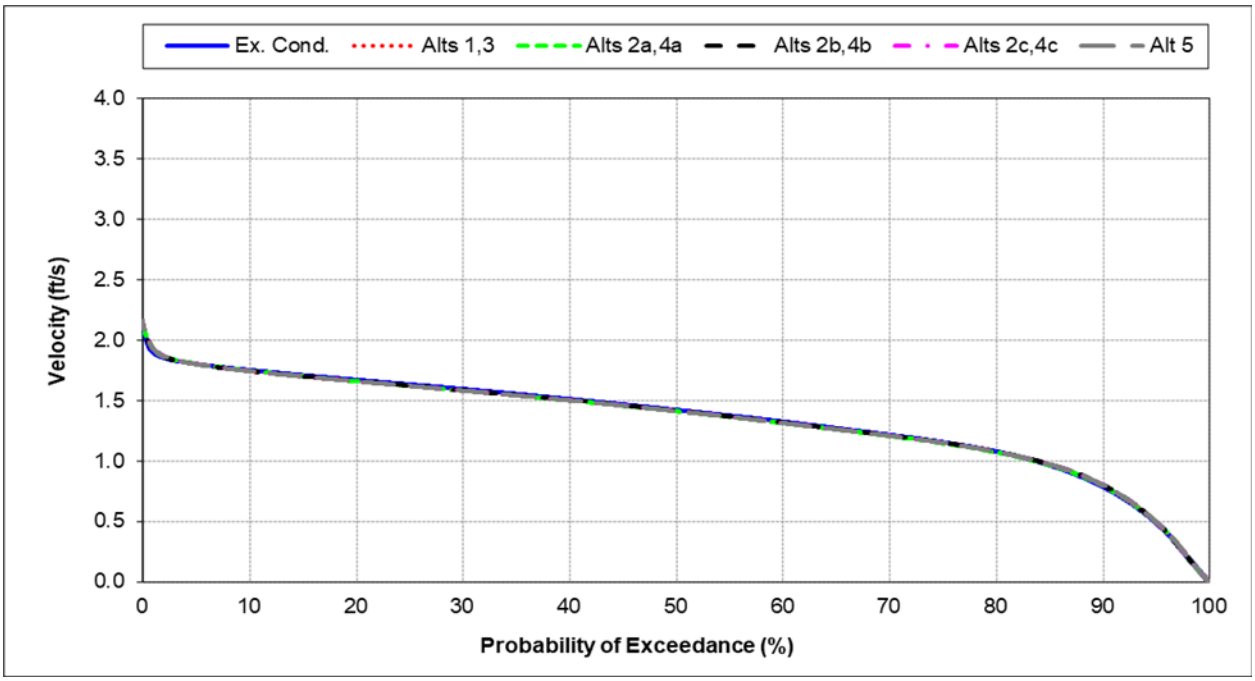



**Figure 6B.1-135. Sacramento River at Freeport, 15-Minute Absolute Velocity (in feet per second), August**

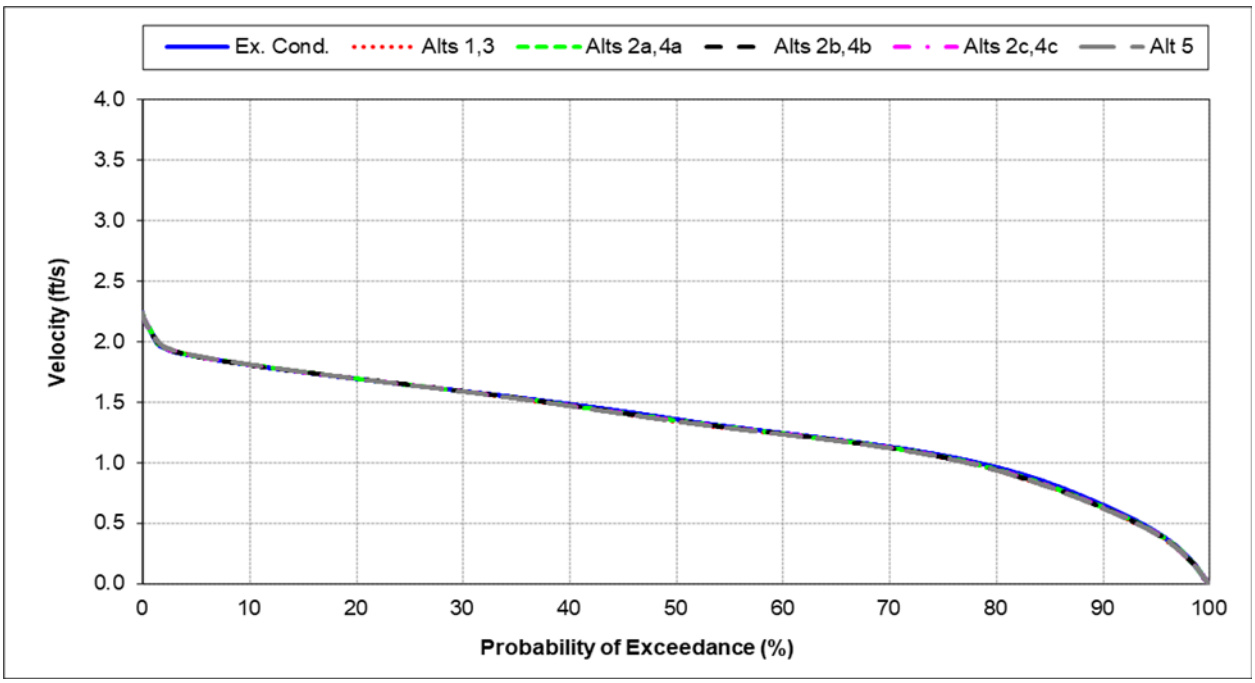



**Figure 6B.1-136. Sacramento River at Freeport, 15-Minute Absolute Velocity (in feet per second), September**

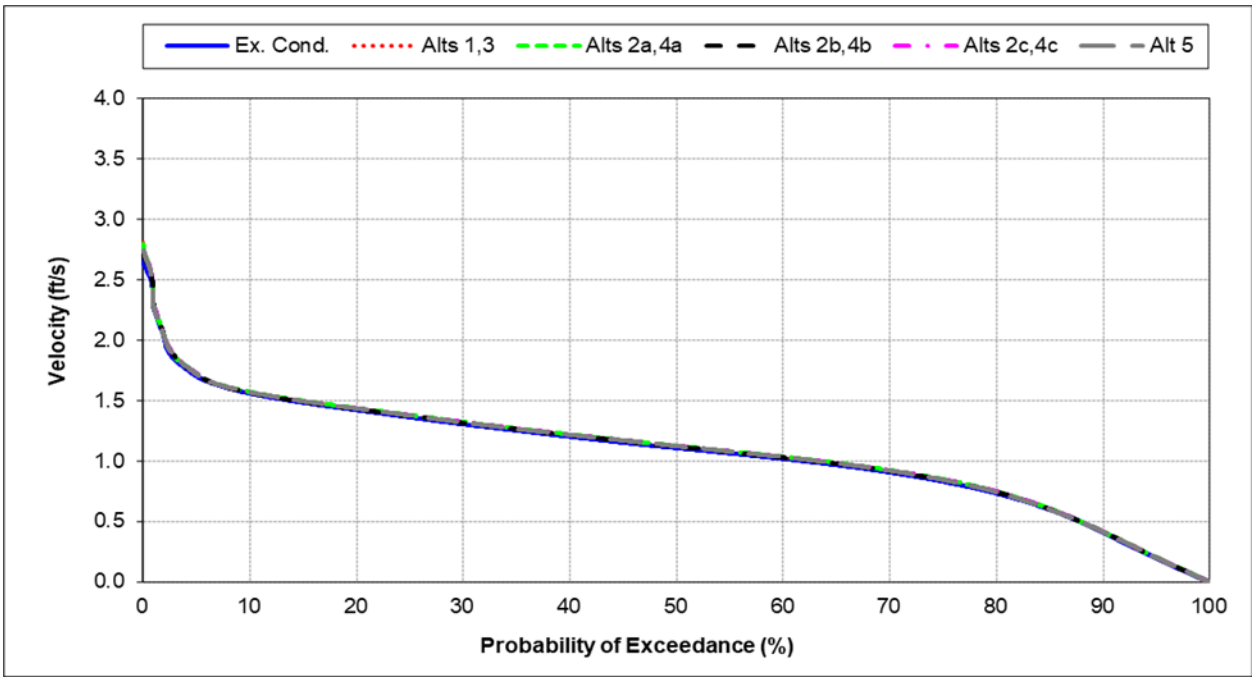



**Figure 6B.1-137. Sacramento River at Freeport, 15-Minute Absolute Velocity (in feet per second), October**

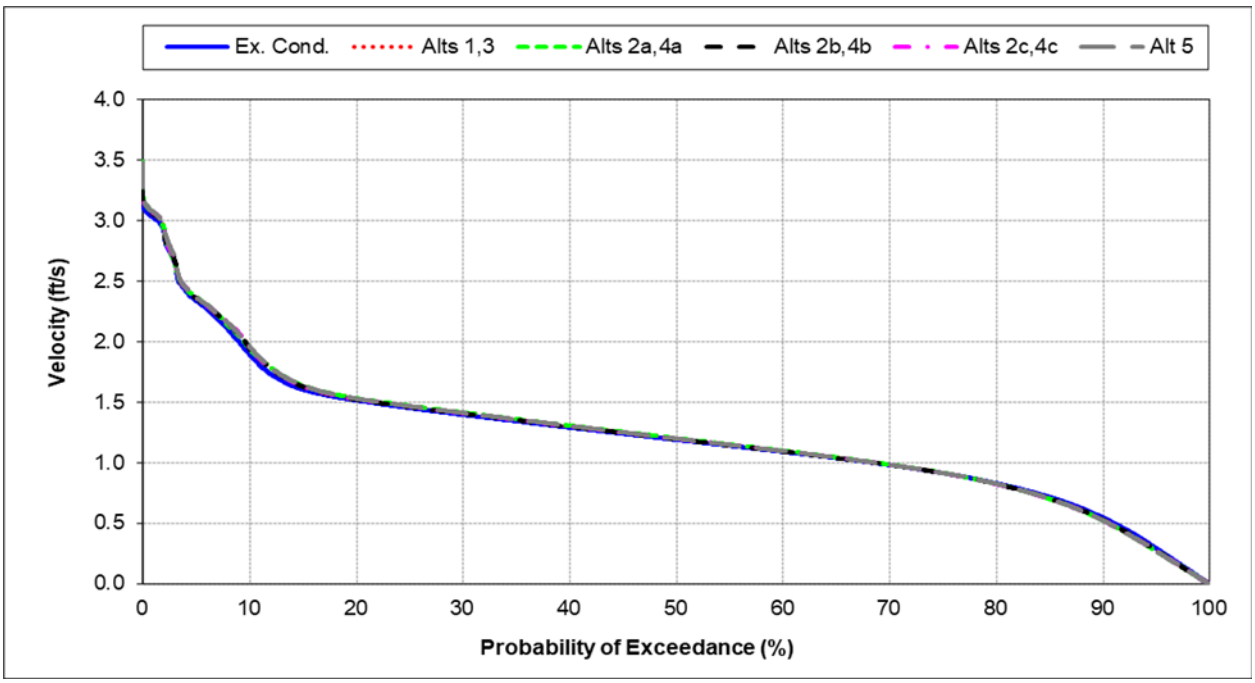



**Figure 6B.1-138. Sacramento River at Freeport, 15-Minute Absolute Velocity (in feet per second), November**

#### 6B.1.1.1.3 Residence Time

Depending on location and month, the proposed action would result in increases, decreases, or no change in modeled median residence time at specific locations for the full simulation period, relative to existing conditions. The proposed action would have little to no effect on median residence time for all locations with short residence time (Table 6B.1-13). At each of these locations, the median residence time was shown to increase by 2 hours or less. Residence times corresponding to the 25th, 75th, and 90th percentiles also show that the proposed action would have little, if any, effect on residence times at various Delta locations, relative to existing conditions (Tables 6B.1-14 through 6B.1-19).In areas where median residence times are relatively short (i.e., 72 hours or less), an increase of up to 2 hours would not provide enough additional time to allow substantial additional growth and accumulation and aggregation of cells, relative to existing conditions. Any negligible changes on growth and accumulation and aggregation of cells at these locations that may occur from such small increases in residence times would not be sufficiently large to cause effects on beneficial uses that would differ from those that would occur for existing conditions. This is true even if there is a 10% increase in residence time (e.g., an increase in median residence time from 8 to 9 hours at Victoria Canal in July) because the absolute magnitude of increase in residence time would not result in conditions substantially more conducive to CHABs, relative to existing conditions.

**Table 6B.1-13. Median residence time in hours modeled using DSM2 for existing conditions and alternatives for locations with short residence times (<=72 hours)**

| Location/ Month | Existing Conditions | 1 & 3 (6,000 cfs) | 2a & 4a (7,500 cfs) | 2b & 4b (3,000 cfs) | 2c & 4c (4,500 cfs) | 5 (6,000 cfs Bethany) |
|---|---|---|---|---|---|---|
| **Brannan Island** | | | | | | |
| June | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |
| July | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |
| August | 2 | 2 (0) | 2 (0) | 2 (0) | 2 (0) | 2 (0) |
| September | 2 | 2 (0) | 2 (0) | 2 (0) | 2 (0) | 2 (0) |
| October | 2 | 2 (0) | 2 (0) | 2 (0) | 2 (0) | 2 (0) |
| November | 2 | 2 (0) | 2 (0) | 2 (0) | 2 (0) | 2 (0) |
| **Discovery Bay Channels** | | | | | | |
| June | 51 | 52 (1) | 52 (1) | 52 (1) | 52 (1) | 52 (1) |
| July | 27 | 28 (1) | 28 (1) | 28 (1) | 28 (1) | 28 (1) |
| August | 25 | 25 (0) | 25 (0) | 25 (0) | 25 (0) | 25 (0) |
| September | 30 | 32 (2) | 32 (2) | 32 (2) | 33 (3) | 32 (2) |
| October | 41 | 41 (0) | 41 (0) | 39 (-2) | 39 (-2) | 41 (0) |
| November | 32 | 34 (2) | 33 (1) | 34 (2) | 34 (2) | 34 (2) |
| **Franks Tract Channels** | | | | | | |
| June | 4 | 4 (0) | 4 (0) | 4 (0) | 4 (0) | 4 (0) |
| July | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |
| August | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |
| September | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |
| October | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |

| Location/ Month | Existing Conditions | 1 & 3 (6,000 cfs) | 2a & 4a (7,500 cfs) | 2b & 4b (3,000 cfs) | 2c & 4c (4,500 cfs) | 5 (6,000 cfs Bethany) |
|---|---|---|---|---|---|---|
| November | 4 | 4 (0) | 4 (0) | 4 (0) | 4 (0) | 4 (0) |
| **Middle River from Woodward Island to Mildred Island** | | | | | | |
| June | 31 | 32 (0) | 32 (0) | 31 (0) | 32 (0) | 32 (0) |
| July | 18 | 19 (1) | 20 (2) | 19 (1) | 19 (1) | 19 (1) |
| August | 21 | 21 (0) | 21 (0) | 20 (0) | 21 (0) | 21 (0) |
| September | 22 | 23 (1) | 23 (1) | 23 (1) | 24 (2) | 23 (1) |
| October | 24 | 25 (1) | 25 (1) | 25 (1) | 25 (1) | 25 (1) |
| November | 18 | 19 (1) | 19 (1) | 18 (0) | 18 (0) | 19 (1) |
| **Mildred Island Channels** | | | | | | |
| June | 5 | 5 (0) | 5 (0) | 5 (0) | 5 (0) | 5 (0) |
| July | 5 | 5 (0) | 5 (0) | 5 (0) | 5 (0) | 5 (0) |
| August | 5 | 5 (0) | 5 (0) | 5 (0) | 5 (0) | 5 (0) |
| September | 4 | 4 (0) | 4 (0) | 4 (0) | 4 (0) | 4 (0) |
| October | 4 | 4 (0) | 4 (0) | 4 (0) | 4 (0) | 4 (0) |
| November | 5 | 5 (0) | 5 (0) | 5 (0) | 5 (0) | 5 (0) |
| **Mokelumne River** | | | | | | |
| June | 6 | 6 (0) | 6 (0) | 6 (0) | 6 (0) | 6 (0) |
| July | 6 | 6 (0) | 6 (0) | 6 (0) | 6 (0) | 6 (0) |
| August | 6 | 6 (0) | 6 (0) | 6 (0) | 6 (0) | 6 (0) |
| September | 6 | 6 (0) | 6 (0) | 6 (0) | 6 (0) | 6 (0) |
| October | 8 | 7 (-1) | 7 (-1) | 8 (0) | 8 (0) | 7 (-1) |
| November | 8 | 9 (1) | 8 (0) | 9 (1) | 9 (1) | 9 (1) |
| **Old River at Rock Slough** | | | | | | |
| June | 25 | 24 (-1) | 25 (0) | 24 (-1) | 25 (0) | 24 (-1) |
| July | 15 | 16 (1) | 16 (1) | 16 (1) | 16 (1) | 16 (1) |
| August | 17 | 18 (1) | 18 (1) | 18 (1) | 18 (1) | 18 (1) |
| September | 17 | 18 (1) | 18 (1) | 18 (1) | 18 (1) | 18 (1) |
| October | 17 | 17 (0) | 17 (0) | 17 (0) | 17 (0) | 17 (0) |
| November | 13 | 13 (0) | 14 (1) | 13 (0) | 13 (0) | 13 (0) |
| **San Joaquin River at Jersey Point** | | | | | | |
| June | 4 | 4 (0) | 4 (0) | 4 (0) | 4 (0) | 4 (0) |
| July | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |
| August | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |
| September | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |
| October | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |
| November | 3 | 3 (0) | 3 (0) | 3 (0) | 3 (0) | 3 (0) |
| **Victoria Canal** | | | | | | |
| June | 16 | 16 (0) | 16 (0) | 16 (0) | 16 (0) | 16 (0) |
| July | 8 | 9 (1) | 9 (1) | 9 (1) | 9 (1) | 9 (1) |

| Location/ Month | Existing Conditions | 1 & 3 (6,000 cfs) | 2a & 4a (7,500 cfs) | 2b & 4b (3,000 cfs) | 2c & 4c (4,500 cfs) | 5 (6,000 cfs Bethany) |
|---|---|---|---|---|---|---|
| August | 10 | 10 (0) | 10 (1) | 10 (0) | 10 (0) | 10 (0) |
| September | 12 | 13 (1) | 13 (1) | 13 (1) | 13 (1) | 13 (1) |
| October | 14 | 15 (1) | 15 (1) | 15 (1) | 14 (0) | 15 (1) |
| November | 11 | 11 (0) | 11 (0) | 11 (0) | 11 (0) | 11 (0) |

**Table 6B.1-14. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, Stockton Deep Water Ship Channel**

| Month | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | Existing Conditions | 1, 3 (6,000 cfs) | 2a, 4a (7,500 cfs) | 2b, 4b (3,000 cfs) | 2c, 4c (4,500 cfs) | 5 (6,000 cfs Bethany) |
| **25th Percentile** | | | | | | |
| June | 370 | 370 (0) | 369 (-1) | 369 (-1) | 369 (-1) | 370 (0) |
| July | 407 | 405 (-2) | 405 (-2) | 407 (0) | 402 (-5) | 405 (-2) |
| August | 455 | 455 (0) | 455 (0) | 458 (3) | 455 (0) | 455 (0) |
| September | 436 | 435 (-1) | 436 (0) | 435 (-1) | 435 (-1) | 435 (-1) |
| October | 393 | 394 (1) | 394 (1) | 394 (1) | 394 (1) | 394 (1) |
| November | 452 | 448 (-4) | 447 (-5) | 452 (0) | 451 (-1) | 448 (-4) |
| **50th (Median) Percentile** | | | | | | |
| June | 414 | 412 (-2) | 412 (-2) | 412 (-2) | 412 (-2) | 412 (-2) |
| July | 496 | 480 (-16) | 480 (-16) | 484 (-12) | 484 (-12) | 480 (-16) |
| August | 541 | 530 (-11) | 526 (-15) | 534 (-7) | 534 (-7) | 530 (-11) |
| September | 477 | 471 (-6) | 470 (-7) | 471 (-6) | 471 (-6) | 471 (-6) |
| October | 419 | 420 (1) | 420 (1) | 418 (-1) | 420 (1) | 420 (1) |
| November | 487 | 479 (-8) | 479 (-8) | 484 (-3) | 479 (-8) | 479 (-8) |
| **75th Percentile** | | | | | | |
| June | 465 | 465 (0) | 465 (0) | 468 (3) | 467 (2) | 465 (0) |
| July | 624 | 595 (-29) | 586 (-37) | 595 (-29) | 595 (-29) | 610 (-14) |
| August | 616 | 613 (-3) | 616 (0) | 616 (0) | 614 (-2) | 613 (-3) |
| September | 530 | 512 (-18) | 508 (-22) | 517 (-13) | 512 (-18) | 512 (-18) |
| October | 441 | 441 (0) | 441 (0) | 441 (0) | 441 (0) | 441 (0) |
| November | 555 | 528 (-27) | 538 (-17) | 536 (-19) | 536 (-19) | 528 (-27) |
| **90th Percentile** | | | | | | |
| June | 544 | 524 (-20) | 520 (-24) | 530 (-14) | 524 (-20) | 524 (-20) |
| July | 844 | 805 (-39) | 801 (-43) | 831 (-13) | 833 (-11) | 805 (-39) |
| August | 731 | 729 (-2) | 721 (-10) | 738 (7) | 731 (0) | 731 (0) |
| September | 568 | 554 (-14) | 554 (-14) | 555 (-13) | 555 (-13) | 554 (-14) |
| October | 463 | 458 (-5) | 458 (-5) | 458 (-5) | 456 (-7) | 458 (-5) |
| November | 604 | 583 (-21) | 581 (-23) | 583 (-21) | 583 (-21) | 583 (-21) |

Note: Change in residence time in hours for the proposed action, relative to existing conditions, are in parentheses.

**Table 6B.1-15. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, Old River South of Clifton Court Forebay**

| Month | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | Existing Conditions | 1, 3 (6,000 cfs) | 2a, 4a (7,500 cfs) | 2b, 4b (3,000 cfs) | 2c, 4c (4,500 cfs) | 5 (6,000 cfs Bethany) |
| **25th Percentile** | | | | | | |
| June | 68 (-3) | 69 (-2) | 68 (-3) | 68 (-3) | 68 (-3) | 68 (-3) |
| July | 115 (7) | 115 (7) | 114 (6) | 115 (7) | 115 (7) | 115 (7) |
| August | 135 (-1) | 134 (-2) | 135 (-1) | 135 (-1) | 135 (-1) | 135 (-1) |
| September | 189 (-38) | 201 (-26) | 176 (-51) | 176 (-51) | 189 (-38) | 189 (-38) |
| October | 50 (0) | 50 (0) | 50 (0) | 50 (0) | 50 (0) | 50 (0) |
| November | 65 (0) | 64 (-1) | 64 (-1) | 65 (0) | 65 (0) | 65 (0) |
| **50th (Median) Percentile** | | | | | | |
| June | 184 | 182 (-2) | 174 (-10) | 180 (-4) | 182 (-2) | 180 (-4) |
| July | 368 | 333 (-35) | 325 (-43) | 339 (-29) | 333 (-35) | 333 (-35) |
| August | 342 | 340 (-2) | 324 (-18) | 335 (-7) | 333 (-9) | 340 (-2) |
| September | 318 | 310 (-8) | 311 (-7) | 314 (-4) | 309 (-9) | 310 (-8) |
| October | 74 | 74 (0) | 73 (-1) | 72 (-2) | 73 (-1) | 74 (0) |
| November | 83 | 84 (1) | 83 (0) | 82 (-1) | 84 (1) | 84 (1) |
| **75th Percentile** | | | | | | |
| June | 417 | 392 (-25) | 411 (-6) | 413 (-4) | 413 (-4) | 392 (-25) |
| July | 593 | 553 (-40) | 562 (-31) | 581 (-12) | 551 (-42) | 553 (-40) |
| August | 654 | 641 (-13) | 631 (-23) | 642 (-12) | 646 (-8) | 641 (-13) |
| September | 332 | 337 (5) | 334 (2) | 337 (5) | 336 (4) | 337 (5) |
| October | 88 | 88 (0) | 89 (1) | 84 (-4) | 84 (-4) | 88 (0) |
| November | 170 | **194 (24)** | 187 (17) | 193 (23) | 193 (23) | 193 (23) |
| **90th Percentile** | | | | | | |
| June | 643 | 654 (11) | 649 (6) | 651 (8) | 652 (9) | 654 (11) |
| July | 693 | 676 (-17) | 680 (-13) | 668 (-25) | 663 (-30) | 676 (-17) |
| August | 718 | 716 (-2) | 723 (5) | 716 (-2) | 716 (-2) | 716 (-2) |
| September | 344 | 349 (5) | 348 (4) | 351 (7) | 349 (5) | 349 (5) |
| October | 118 | 112 (-6) | 112 (-6) | 113 (-5) | 112 (-6) | 112 (-6) |
| November | 368 | 320 (-48) | 301 (-67) | 353 (-15) | 331 (-37) | 319 (-49) |

Note: Change in residence time in hours for the proposed action, relative to existing conditions, are in parentheses. Increases of 24 hours or greater are bolded.

**Table 6B.1-16. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, San Joaquin River near Venice Island**

| Month | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | Existing Conditions | 1, 3 (6,000 cfs) | 2a, 4a (7,500 cfs) | 2b, 4b (3,000 cfs) | 2c, 4c (4,500 cfs) | 5 (6,000 cfs Bethany) |
| **25th Percentile** | | | | | | |
| June | 90 | 88 (-2) | 88 (-2) | 88 (-2) | 88 (-2) | 88 (-2) |
| July | 71 | 79 (8) | 79 (8) | 79 (8) | 79 (8) | 79 (8) |
| August | 81 | 81 (0) | 81 (0) | 81 (0) | 81 (0) | 81 (0) |
| September | 92 | 96 (4) | 94 (2) | 96 (4) | 96 (4) | 96 (4) |
| October | 104 | 106 (2) | 106 (2) | 106 (2) | 105 (1) | 106 (2) |
| November | 82 | 82 (0) | 82 (0) | 82 (0) | 82 (0) | 82 (0) |
| **50th (Median) Percentile** | | | | | | |
| June | 130 | 129 (-1) | 129 (-1) | 130 (0) | 128 (-2) | 129 (-1) |
| July | 87 | 98 (11) | 98 (11) | 98 (11) | 98 (11) | 98 (11) |
| August | 94 | 99 (5) | 98 (4) | 98 (4) | 98 (4) | 99 (5) |
| September | 115 | 129 (14) | 128 (13) | 128 (13) | 128 (13) | 129 (14) |
| October | 143 | 147 (4) | 147 (4) | 147 (4) | 146 (3) | 147 (4) |
| November | 105 | 104 (-1) | 105 (0) | 106 (1) | 105 (0) | 104 (-1) |
| **75th Percentile** | | | | | | |
| June | 154 | 157 (3) | 157 (3) | 156 (2) | 154 (0) | 157 (3) |
| July | 104 | 121 (17) | 122 (18) | 117 (13) | 122 (18) | 121 (17) |
| August | 131 | 131 (0) | 133 (2) | 133 (2) | 131 (0) | 131 (0) |
| September | 159 | 160 (1) | 160 (1) | 159 (0) | 160 (1) | 160 (1) |
| October | 188 | 195 (7) | 191 (3) | 194 (6) | 191 (3) | 194 (6) |
| November | 165 | 181 (16) | **197 (32)** | 182 (17) | 181 (16) | 181 (16) |
| **90th Percentile** | | | | | | |
| June | 187 | 187 (0) | 188 (1) | 185 (-2) | 186 (-1) | 187 (0) |
| July | 170 | 166 (-4) | 164 (-6) | 164 (-6) | 169 (-1) | 166 (-4) |
| August | 197 | 205 (8) | 206 (9) | 202 (5) | 204 (7) | 205 (8) |
| September | 181 | 187 (6) | 189 (8) | 187 (6) | 187 (6) | 187 (6) |
| October | 234 | 227 (-7) | 226 (-8) | 228 (-6) | 226 (-8) | 226 (-8) |
| November | 225 | 229 (4) | 231 (6) | 228 (3) | 230 (5) | 229 (4) |

Note: Change in residence time in hours for the proposed action, relative to existing conditions, are in parentheses. Increases of 24 hours or greater are bolded.

**Table 6B.1-17. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, Mildred Island**

| Month | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | Existing Conditions | 1, 3 (6,000 cfs) | 2a, 4a (7,500 cfs) | 2b, 4b (3,000 cfs) | 2c, 4c (4,500 cfs) | 5 (6,000 cfs Bethany) |
| **25th Percentile** | | | | | | |
| June | 283 | 281 (-2) | 282 (-1) | 283 (0) | 282 (-1) | 281 (-2) |
| July | 196 | 209 (13) | 208 (12) | 208 (12) | 208 (12) | 209 (13) |
| August | 204 | 207 (3) | 206 (2) | 206 (2) | 206 (2) | 207 (3) |
| September | 219 | 230 (11) | 227 (8) | 225 (6) | 230 (11) | 230 (11) |
| October | 240 | 243 (3) | 243 (3) | 243 (3) | 241 (1) | 245 (5) |
| November | 202 | 203 (1) | 203 (1) | 203 (1) | 203 (1) | 203 (1) |
| **50th (Median) Percentile** | | | | | | |
| June | 289 | 287 (-2) | 288 (-1) | 288 (-1) | 287 (-2) | 287 (-2) |
| July | 210 | 218 (8) | 218 (8) | 217 (7) | 219 (9) | 218 (8) |
| August | 210 | 219 (9) | 217 (7) | 217 (7) | 218 (8) | 219 (9) |
| September | 245 | 256 (11) | 257 (12) | 255 (10) | 256 (11) | 256 (11) |
| October | 279 | 296 (17) | 296 (17) | 299 (20) | 293 (14) | 296 (17) |
| November | 226 | 228 (2) | 227 (1) | 229 (3) | 228 (2) | 228 (2) |
| **75th Percentile** | | | | | | |
| June | 320 | 322 (2) | 322 (2) | 315 (-5) | 321 (1) | 322 (2) |
| July | 232 | 241 (9) | 241 (9) | 241 (9) | 238 (6) | 241 (9) |
| August | 278 | 264 (-14) | 264 (-14) | 265 (-13) | 264 (-14) | 264 (-14) |
| September | 296 | 303 (7) | 308 (12) | 297 (1) | 300 (4) | 303 (7) |
| October | 349 | 339 (-10) | 342 (-7) | 339 (-10) | 332 (-17) | 339 (-10) |
| November | 312 | 327 (15) | 333 (21) | 329 (17) | 329 (17) | 327 (15) |
| **90th Percentile** | | | | | | |
| June | 408 | 421 (13) | 421 (13) | 416 (8) | 416 (8) | 421 (13) |
| July | 361 | 370 (9) | 373 (12) | 378 (17) | 367 (6) | 370 (9) |
| August | 420 | 398 (-22) | 407 (-13) | 411 (-9) | 413 (-7) | 398 (-22) |
| September | 335 | 340 (5) | 338 (3) | 336 (1) | 342 (7) | 339 (4) |
| October | 427 | 421 (-6) | 421 (-6) | 421 (-6) | 421 (-6) | 421 (-6) |
| November | 421 | 420 (-1) | 427 (6) | 427 (6) | 419 (-2) | 420 (-1) |

Note: Change in residence time in hours for proposed action, relative to existing conditions, are in parentheses.

**Table 6B.1-18. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, Franks Tract**

| Month | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | Existing Conditions | 1, 3 (6,000 cfs) | 2a, 4a (7,500 cfs) | 2b, 4b (3,000 cfs) | 2c, 4c (4,500 cfs) | 5 (6,000 cfs Bethany) |
| **25th Percentile** | | | | | | |
| June | 289 | 288 (-1) | 288 (-1) | 288 (-1) | 288 (-1) | 288 (-1) |
| July | 273 | 280 (7) | 280 (7) | 278 (5) | 280 (7) | 280 (7) |
| August | 278 | 281 (3) | 280 (2) | 280 (2) | 280 (2) | 281 (3) |
| September | 283 | 289 (6) | 289 (6) | 289 (6) | 289 (6) | 289 (6) |
| October | 296 | 297 (1) | 297 (1) | 298 (2) | 296 (0) | 297 (1) |
| November | 268 | 268 (0) | 268 (0) | 269 (1) | 268 (0) | 268 (0) |
| **50th (Median) Percentile** | | | | | | |
| June | 311 | 311 (0) | 311 (0) | 311 (0) | 311 (0) | 311 (0) |
| July | 283 | 287 (4) | 287 (4) | 286 (3) | 286 (3) | 287 (4) |
| August | 292 | 297 (5) | 297 (5) | 294 (2) | 298 (6) | 297 (5) |
| September | 303 | 305 (2) | 305 (2) | 305 (2) | 305 (2) | 305 (2) |
| October | 315 | 317 (2) | 321 (6) | 316 (1) | 317 (2) | 317 (2) |
| November | 290 | 293 (3) | 293 (3) | 293 (3) | 293 (3) | 293 (3) |
| **75th Percentile** | | | | | | |
| June | 322 | 320 (-2) | 320 (-2) | 319 (-3) | 319 (-3) | 320 (-2) |
| July | 297 | 303 (6) | 302 (5) | 305 (8) | 303 (6) | 303 (6) |
| August | 332 | 338 (6) | 337 (5) | 337 (5) | 337 (5) | 338 (6) |
| September | 335 | 348 (13) | 345 (10) | 348 (13) | 349 (14) | 348 (13) |
| October | 362 | 362 (0) | 361 (-1) | 360 (-2) | 360 (-2) | 362 (0) |
| November | 325 | 343 (18) | 346 (21) | 341 (16) | 344 (19) | 343 (18) |
| **90th Percentile** | | | | | | |
| June | 352 | 352 (0) | 348 (-4) | 353 (1) | 348 (-4) | 352 (0) |
| July | 351 | 351 (0) | 353 (2) | 353 (2) | 350 (-1) | 355 (4) |
| August | 381 | 378 (-3) | 378 (-3) | 377 (-4) | 378 (-3) | 378 (-3) |
| September | 377 | 382 (5) | 384 (7) | 381 (4) | 381 (4) | 382 (5) |
| October | 409 | 410 (1) | 409 (0) | 409 (0) | 415 (6) | 410 (1) |
| November | 391 | 391 (0) | 393 (2) | 386 (-5) | 391 (0) | 391 (0) |

Note: Change in residence time in hours for proposed action, relative to existing conditions, are in parentheses.

**Table 6B.1-19. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Proposed action, Discovery Bay**

| Month | Alternative | | | | | |
|---|---|---|---|---|---|---|
| | Existing Conditions | 1, 3 (6,000 cfs) | 2a, 4a (7,500 cfs) | 2b, 4b (3,000 cfs) | 2c, 4c (4,500 cfs) | 5 (6,000 cfs Bethany) |
| **25th Percentile** | | | | | | |
| June | 619 | 615 (-4) | 620 (1) | 614 (-5) | 615 (-4) | 615 (-4) |
| July | 456 | **482 (26)** | 479 (23) | 478 (22) | **482 (26)** | **482 (26)** |
| August | 472 | 478 (6) | 478 (6) | 477 (5) | 478 (6) | 478 (6) |
| September | 520 | **544 (24)** | **545 (25)** | 541 (21) | **544 (24)** | **544 (24)** |
| October | 568 | 570 (2) | 570 (2) | 574 (6) | 570 (2) | 574 (6) |
| November | 470 | 474 (4) | 475 (5) | 471 (1) | 471 (1) | 474 (4) |
| **50th (Median) Percentile** | | | | | | |
| June | 629 | 628 (-1) | 628 (-1) | 628 (-1) | 627 (-2) | 628 (-1) |
| July | 482 | **507 (25)** | **508 (26)** | 502 (20) | **515 (33)** | **513 (31)** |
| August | 498 | 510 (12) | 509 (11) | 508 (10) | 508 (10) | 510 (12) |
| September | 575 | **608 (33)** | 597 (22) | **605 (30)** | **609 (34)** | **605 (30)** |
| October | 662 | **687 (25)** | **687 (25)** | **686 (24)** | **686 (24)** | **687 (25)** |
| November | 539 | 551 (12) | 551 (12) | 540 (1) | 551 (12) | 551 (12) |
| **75th Percentile** | | | | | | |
| June | 685 | 687 (2) | 691 (6) | 687 (2) | 687 (2) | 687 (2) |
| July | 533 | **570 (37)** | **573 (40)** | **577 (44)** | 555 (22) | **570 (37)** |
| August | 639 | 620 (-19) | 623 (-16) | 624 (-15) | 620 (-19) | 620 (-19) |
| September | 687 | 690 (3) | 701 (14) | 688 (1) | 688 (1) | 696 (9) |
| October | 759 | 760 (1) | 758 (-1) | 759 (0) | 759 (0) | 760 (1) |
| November | 689 | **733 (44)** | **736 (47)** | **732 (43)** | **733 (44)** | **733 (44)** |
| **90th Percentile** | | | | | | |
| June | 779 | 773 (-6) | 783 (4) | 773 (-6) | 774 (-5) | 773 (-6) |
| July | 763 | 761 (-2) | 764 (1) | 765 (2) | 761 (-2) | 761 (-2) |
| August | 832 | 815 (-17) | 824 (-8) | 806 (-26) | 807 (-25) | 815 (-17) |
| September | 764 | 775 (11) | 772 (8) | 772 (8) | 775 (11) | 775 (11) |
| October | 857 | 850 (-7) | 849 (-8) | 850 (-7) | 833 (-24) | 850 (-7) |
| November | 847 | 850 (3) | 849 (2) | 850 (3) | 850 (3) | 850 (3) |

Note: Change in residence time in hours for the proposed action, relative to existing conditions, are in parentheses. Increases of 24 hours or greater are bolded.

**Table 6B.1-20. Brannan Island, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 4 | 4 | 4 | 4 | 4 | 4 |
| 90th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-21. Brannan Island, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 4 | 4 | 4 | 4 | 4 | 4 |
| 90th percentile | 4 | 4 | 4 | 4 | 4 | 4 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-22. Brannan Island, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 2 | 2 | 2 | 2 | 2 | 2 |
| 75th percentile | 3 | 3 | 3 | 3 | 3 | 3 |
| 90th percentile | 4 | 4 | 4 | 4 | 4 | 4 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-23. Brannan Island, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 2 | 2 | 2 | 2 | 2 | 2 |
| 75th percentile | 3 | 3 | 3 | 3 | 3 | 3 |
| 90th percentile | 4 | 4 | 4 | 4 | 4 | 4 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-24. Brannan Island, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 2 | 2 | 2 | 2 | 2 | 2 |
| 75th percentile | 4 | 4 | 4 | 4 | 4 | 4 |
| 90th percentile | 4 | 4 | 4 | 4 | 4 | 4 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-25. Brannan Island, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 2 | 2 | 2 | 2 | 2 | 2 |
| 75th percentile | 3 | 3 | 3 | 3 | 3 | 3 |
| 90th percentile | 4 | 4 | 4 | 4 | 4 | 4 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-26. San Joaquin River at Jersey Point, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 3 | 3 | 3 | 3 | 3 | 3 |
| 50th percentile (Median) | 4 | 4 | 4 | 4 | 4 | 4 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 7 | 7 | 7 | 7 | 7 | 7 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-27. San Joaquin River at Jersey Point, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 6 | 6 | 6 | 6 | 6 | 6 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-28. San Joaquin River at Jersey Point, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 6 | 6 | 6 | 6 | 6 | 6 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-29. San Joaquin River at Jersey Point, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 6 | 6 | 6 | 6 | 6 | 6 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-30. San Joaquin River at Jersey Point, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-31. San Joaquin River at Jersey Point, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 8 | 8 | 8 | 8 | 8 | 8 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-32. Old River at Rock Slough, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 17 | 17 | 17 | 17 | 17 | 17 |
| 50th percentile (Median) | 25 | 24 | 25 | 24 | 25 | 24 |
| 75th percentile | 33 | 33 | 33 | 33 | 33 | 33 |
| 90th percentile | 47 | 45 | 45 | 44 | 45 | 45 |
| Median - Alternative minus Ex. Cond. | - | -1 | 0 | -1 | 0 | -1 |
| 90th percentile - Alternative minus Ex. Cond. | - | -2 | -2 | -3 | -2 | -2 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-33. Old River at Rock Slough, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 10 | 11 | 11 | 11 | 11 | 11 |
| 50th percentile (Median) | 15 | 16 | 16 | 16 | 16 | 16 |
| 75th percentile | 19 | 19 | 19 | 20 | 19 | 20 |
| 90th percentile | 45 | 47 | 47 | 48 | 47 | 47 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 2 | 2 | 3 | 2 | 2 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 1 | 0 | 1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-34. Old River at Rock Slough, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 12 | 13 | 13 | 13 | 13 | 13 |
| 50th percentile (Median) | 17 | 18 | 18 | 18 | 18 | 18 |
| 75th percentile | 22 | 22 | 23 | 21 | 21 | 22 |
| 90th percentile | 42 | 39 | 41 | 41 | 41 | 39 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | -3 | -1 | -1 | -1 | -3 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 1 | -1 | -1 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-35. Old River at Rock Slough, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 14 | 14 | 14 | 14 | 14 | 14 |
| 50th percentile (Median) | 17 | 18 | 18 | 18 | 18 | 18 |
| 75th percentile | 23 | 25 | 25 | 25 | 25 | 25 |
| 90th percentile | 30 | 30 | 32 | 30 | 30 | 30 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 2 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 2 | 2 | 2 | 2 | 2 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-36. Old River at Rock Slough, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 13 | 14 | 14 | 14 | 14 | 14 |
| 50th percentile (Median) | 17 | 17 | 17 | 17 | 17 | 17 |
| 75th percentile | 24 | 23 | 24 | 23 | 23 | 23 |
| 90th percentile | 40 | 42 | 41 | 40 | 41 | 42 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 2 | 1 | 0 | 1 | 2 |
| 75th percentile - Alternative minus Ex. Cond. | - | -1 | 0 | -1 | -1 | -1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-37. Old River at Rock Slough, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 10 | 10 | 10 | 10 | 10 | 10 |
| 50th percentile (Median) | 13 | 13 | 14 | 13 | 13 | 13 |
| 75th percentile | 17 | 18 | 21 | 18 | 18 | 18 |
| 90th percentile | 39 | 40 | 40 | 41 | 40 | 40 |
| Median - Alternative minus Ex. Cond. | - | 0 | 1 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 2 | 1 | 1 |
| 75th percentile - Alternative minus Ex. Cond. | - | 1 | 4 | 1 | 1 | 1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-38. Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 289 | 288 | 288 | 288 | 288 | 288 |
| 50th percentile (Median) | 311 | 311 | 311 | 311 | 311 | 311 |
| 75th percentile | 322 | 320 | 320 | 319 | 319 | 320 |
| 90th percentile | 352 | 352 | 348 | 353 | 348 | 352 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | -4 | 1 | -4 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | -2 | -2 | -3 | -3 | -2 |
| 25th percentile - Alternative minus Ex. Cond. | - | -1 | -1 | -1 | -1 | -1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-39. Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 273 | 280 | 280 | 278 | 280 | 280 |
| 50th percentile (Median) | 283 | 287 | 287 | 286 | 286 | 287 |
| 75th percentile | 297 | 303 | 302 | 305 | 303 | 303 |
| 90th percentile | 351 | 351 | 353 | 353 | 350 | 355 |
| Median - Alternative minus Ex. Cond. | - | 4 | 4 | 3 | 3 | 4 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 2 | 2 | -1 | 4 |
| 75th percentile - Alternative minus Ex. Cond. | - | 6 | 5 | 8 | 6 | 6 |
| 25th percentile - Alternative minus Ex. Cond. | - | 7 | 7 | 5 | 7 | 7 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-40. Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 278 | 281 | 280 | 280 | 280 | 281 |
| 50th percentile (Median) | 292 | 297 | 297 | 294 | 298 | 297 |
| 75th percentile | 332 | 338 | 337 | 337 | 337 | 338 |
| 90th percentile | 381 | 378 | 378 | 377 | 378 | 378 |
| Median - Alternative minus Ex. Cond. | - | 5 | 5 | 2 | 6 | 5 |
| 90th percentile - Alternative minus Ex. Cond. | - | -3 | -3 | -4 | -3 | -3 |
| 75th percentile - Alternative minus Ex. Cond. | - | 6 | 5 | 5 | 5 | 6 |
| 25th percentile - Alternative minus Ex. Cond. | - | 3 | 2 | 2 | 2 | 3 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-41. Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 283 | 289 | 289 | 289 | 289 | 289 |
| 50th percentile (Median) | 303 | 305 | 305 | 305 | 305 | 305 |
| 75th percentile | 335 | 348 | 345 | 348 | 349 | 348 |
| 90th percentile | 377 | 382 | 384 | 381 | 381 | 382 |
| Median - Alternative minus Ex. Cond. | - | 2 | 2 | 2 | 2 | 2 |
| 90th percentile - Alternative minus Ex. Cond. | - | 5 | 7 | 4 | 4 | 5 |
| 75th percentile - Alternative minus Ex. Cond. | - | 13 | 10 | 13 | 14 | 13 |
| 25th percentile - Alternative minus Ex. Cond. | - | 6 | 6 | 6 | 6 | 6 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-42. Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 296 | 297 | 297 | 298 | 296 | 297 |
| 50th percentile (Median) | 315 | 317 | 321 | 316 | 317 | 317 |
| 75th percentile | 362 | 362 | 361 | 360 | 360 | 362 |
| 90th percentile | 409 | 410 | 409 | 409 | 415 | 410 |
| Median - Alternative minus Ex. Cond. | - | 2 | 6 | 1 | 2 | 2 |
| 90th percentile - Alternative minus Ex. Cond. | - | 1 | 0 | 0 | 6 | 1 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | -1 | -2 | -2 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 2 | 0 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-43. Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 268 | 268 | 268 | 269 | 268 | 268 |
| 50th percentile (Median) | 290 | 293 | 293 | 293 | 293 | 293 |
| 75th percentile | 325 | 343 | 346 | 341 | 344 | 343 |
| 90th percentile | 391 | 391 | 393 | 386 | 391 | 391 |
| Median - Alternative minus Ex. Cond. | - | 3 | 3 | 3 | 3 | 3 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 2 | -5 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 18 | 21 | 16 | 19 | 18 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 1 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-44. Channels around Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 3 | 3 | 3 | 3 | 3 | 3 |
| 50th percentile (Median) | 4 | 4 | 4 | 4 | 4 | 4 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 8 | 8 | 8 | 8 | 8 | 8 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-45. Channels around Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 3 | 3 | 3 | 3 | 3 | 3 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 6 | 7 | 7 | 7 | 7 | 7 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-46. Channels around Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 6 | 6 | 6 | 6 | 6 | 6 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-47. Channels around Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 6 | 6 | 6 | 6 | 6 | 6 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-48. Channels around Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 3 | 3 | 3 | 3 | 3 | 3 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 6 | 6 | 6 | 6 | 6 | 6 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-49. Channels around Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 4 | 4 | 4 | 4 | 4 | 4 |
| 75th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 90th percentile | 7 | 7 | 7 | 7 | 7 | 7 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-50a. Victoria Canal, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 13 | 13 | 13 | 13 | 13 | 13 |
| 50th percentile (Median) | 16 | 16 | 16 | 16 | 16 | 16 |
| 75th percentile | 19 | 19 | 19 | 19 | 19 | 19 |
| 90th percentile | 32 | 31 | 30 | 30 | 30 | 30 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | -1 | -2 | -2 | -2 | -2 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-50b. Victoria Canal, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 7 | 8 | 8 | 8 | 8 | 8 |
| 50th percentile (Median) | 8 | 9 | 9 | 9 | 9 | 9 |
| 75th percentile | 11 | 13 | 13 | 13 | 13 | 13 |
| 90th percentile | 28 | 27 | 28 | 30 | 28 | 27 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | -1 | 0 | 2 | 0 | -1 |
| 75th percentile - Alternative minus Ex. Cond. | - | 2 | 2 | 2 | 2 | 2 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-50c. Victoria Canal, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 8 | 8 | 8 | 9 | 9 | 8 |
| 50th percentile (Median) | 10 | 10 | 10 | 10 | 10 | 10 |
| 75th percentile | 15 | 15 | 15 | 15 | 15 | 15 |
| 90th percentile | 48 | 43 | 45 | 47 | 47 | 43 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | -5 | -3 | -1 | -1 | -5 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 1 | 1 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-50d. Victoria Canal, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 10 | 11 | 11 | 11 | 11 | 11 |
| 50th percentile (Median) | 12 | 13 | 13 | 13 | 13 | 13 |
| 75th percentile | 16 | 17 | 17 | 17 | 17 | 17 |
| 90th percentile | 21 | 26 | 25 | 25 | 26 | 25 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 5 | 4 | 4 | 5 | 4 |
| 75th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-50e. Victoria Canal, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 11 | 12 | 12 | 12 | 12 | 12 |
| 50th percentile (Median) | 14 | 15 | 15 | 15 | 14 | 15 |
| 75th percentile | 19 | 19 | 19 | 19 | 18 | 19 |
| 90th percentile | 31 | 28 | 28 | 28 | 28 | 28 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 0 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | -3 | -3 | -3 | -3 | -3 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | -1 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-50f. Victoria Canal, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 8 | 9 | 9 | 9 | 9 | 9 |
| 50th percentile (Median) | 11 | 11 | 11 | 11 | 11 | 11 |
| 75th percentile | 17 | 19 | 21 | 18 | 19 | 19 |
| 90th percentile | 42 | 42 | 42 | 42 | 42 | 42 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 2 | 4 | 1 | 2 | 2 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-51a. Stockton Deep Water Ship Channel, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 370 | 370 | 369 | 369 | 369 | 370 |
| 50th percentile (Median) | 414 | 412 | 412 | 412 | 412 | 412 |
| 75th percentile | 465 | 465 | 465 | 468 | 467 | 465 |
| 90th percentile | 544 | 524 | 520 | 530 | 524 | 524 |
| Median - Alternative minus Ex. Cond. | - | -2 | -2 | -2 | -2 | -2 |
| 90th percentile - Alternative minus Ex. Cond. | - | -20 | -24 | -14 | -20 | -20 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 3 | 2 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | -1 | -1 | -1 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-51b. Stockton Deep Water Ship Channel, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 407 | 405 | 405 | 407 | 402 | 405 |
| 50th percentile (Median) | 496 | 480 | 480 | 484 | 484 | 480 |
| 75th percentile | 624 | 595 | 587 | 595 | 595 | 610 |
| 90th percentile | 844 | 805 | 801 | 831 | 833 | 805 |
| Median - Alternative minus Ex. Cond. | - | -16 | -16 | -12 | -12 | -16 |
| 90th percentile - Alternative minus Ex. Cond. | - | -39 | -43 | -13 | -11 | -39 |
| 75th percentile - Alternative minus Ex. Cond. | - | -29 | -37 | -29 | -29 | -14 |
| 25th percentile - Alternative minus Ex. Cond. | - | -2 | -2 | 0 | -5 | -2 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-51c. Stockton Deep Water Ship Channel, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 455 | 455 | 455 | 458 | 455 | 455 |
| 50th percentile (Median) | 541 | 530 | 526 | 534 | 534 | 530 |
| 75th percentile | 616 | 613 | 616 | 616 | 614 | 613 |
| 90th percentile | 731 | 729 | 721 | 738 | 731 | 731 |
| Median - Alternative minus Ex. Cond. | - | -11 | -15 | -7 | -7 | -11 |
| 90th percentile - Alternative minus Ex. Cond. | - | -2 | -10 | 7 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | -3 | 0 | 0 | -2 | -3 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 3 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-51d. Stockton Deep Water Ship Channel, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 436 | 435 | 436 | 435 | 435 | 435 |
| 50th percentile (Median) | 477 | 471 | 470 | 471 | 471 | 471 |
| 75th percentile | 530 | 512 | 508 | 517 | 512 | 512 |
| 90th percentile | 568 | 554 | 554 | 555 | 555 | 554 |
| Median - Alternative minus Ex. Cond. | - | -6 | -7 | -6 | -6 | -6 |
| 90th percentile - Alternative minus Ex. Cond. | - | -14 | -14 | -13 | -13 | -14 |
| 75th percentile - Alternative minus Ex. Cond. | - | -18 | -22 | -13 | -18 | -18 |
| 25th percentile - Alternative minus Ex. Cond. | - | -1 | 0 | -1 | -1 | -1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-51e. Stockton Deep Water Ship Channel, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 393 | 394 | 394 | 394 | 394 | 394 |
| 50th percentile (Median) | 419 | 420 | 420 | 418 | 420 | 420 |
| 75th percentile | 441 | 441 | 441 | 441 | 441 | 441 |
| 90th percentile | 463 | 458 | 458 | 458 | 456 | 458 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | -1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | -5 | -5 | -5 | -7 | -5 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-51f. Stockton Deep Water Ship Channel, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 452 | 448 | 447 | 452 | 451 | 448 |
| 50th percentile (Median) | 487 | 479 | 479 | 484 | 479 | 479 |
| 75th percentile | 555 | 528 | 538 | 536 | 536 | 528 |
| 90th percentile | 604 | 583 | 581 | 583 | 583 | 583 |
| Median - Alternative minus Ex. Cond. | - | -8 | -8 | -3 | -8 | -8 |
| 90th percentile - Alternative minus Ex. Cond. | - | -21 | -23 | -21 | -21 | -21 |
| 75th percentile - Alternative minus Ex. Cond. | - | -27 | -17 | -19 | -19 | -27 |
| 25th percentile - Alternative minus Ex. Cond. | - | -4 | -5 | 0 | -1 | -4 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-52a. Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 283 | 281 | 282 | 283 | 282 | 281 |
| 50th percentile (Median) | 289 | 287 | 288 | 288 | 287 | 287 |
| 75th percentile | 320 | 322 | 322 | 315 | 321 | 322 |
| 90th percentile | 408 | 421 | 421 | 416 | 416 | 421 |
| Median - Alternative minus Ex. Cond. | - | -2 | -1 | -1 | -2 | -2 |
| 90th percentile - Alternative minus Ex. Cond. | - | 13 | 13 | 8 | 8 | 13 |
| 75th percentile - Alternative minus Ex. Cond. | - | 2 | 2 | -5 | 1 | 2 |
| 25th percentile - Alternative minus Ex. Cond. | - | -2 | -1 | 0 | -1 | -2 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-52b. Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 196 | 209 | 208 | 208 | 208 | 209 |
| 50th percentile (Median) | 210 | 218 | 218 | 217 | 219 | 218 |
| 75th percentile | 232 | 241 | 241 | 241 | 238 | 241 |
| 90th percentile | 361 | 370 | 373 | 378 | 367 | 370 |
| Median - Alternative minus Ex. Cond. | - | 8 | 8 | 7 | 9 | 8 |
| 90th percentile - Alternative minus Ex. Cond. | - | 9 | 12 | 17 | 6 | 9 |
| 75th percentile - Alternative minus Ex. Cond. | - | 9 | 9 | 9 | 6 | 9 |
| 25th percentile - Alternative minus Ex. Cond. | - | 13 | 12 | 12 | 12 | 13 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-52c. Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 204 | 207 | 206 | 206 | 206 | 207 |
| 50th percentile (Median) | 210 | 219 | 217 | 217 | 218 | 219 |
| 75th percentile | 278 | 264 | 264 | 265 | 264 | 264 |
| 90th percentile | 420 | 398 | 407 | 411 | 413 | 398 |
| Median - Alternative minus Ex. Cond. | - | 9 | 7 | 7 | 8 | 9 |
| 90th percentile - Alternative minus Ex. Cond. | - | -22 | -13 | -9 | -7 | -22 |
| 75th percentile - Alternative minus Ex. Cond. | - | -14 | -14 | -13 | -14 | -14 |
| 25th percentile - Alternative minus Ex. Cond. | - | 3 | 2 | 2 | 2 | 3 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-52d. Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 219 | 230 | 227 | 225 | 230 | 230 |
| 50th percentile (Median) | 245 | 256 | 257 | 255 | 256 | 256 |
| 75th percentile | 296 | 303 | 308 | 297 | 300 | 303 |
| 90th percentile | 335 | 340 | 338 | 336 | 342 | 339 |
| Median - Alternative minus Ex. Cond. | - | 11 | 12 | 10 | 11 | 11 |
| 90th percentile - Alternative minus Ex. Cond. | - | 5 | 3 | 1 | 7 | 4 |
| 75th percentile - Alternative minus Ex. Cond. | - | 7 | 12 | 1 | 4 | 7 |
| 25th percentile - Alternative minus Ex. Cond. | - | 11 | 8 | 6 | 11 | 11 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-52e. Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 240 | 243 | 243 | 243 | 241 | 245 |
| 50th percentile (Median) | 279 | 296 | 296 | 299 | 293 | 296 |
| 75th percentile | 349 | 339 | 342 | 339 | 332 | 339 |
| 90th percentile | 427 | 421 | 421 | 421 | 421 | 421 |
| Median - Alternative minus Ex. Cond. | - | 17 | 17 | 20 | 14 | 17 |
| 90th percentile - Alternative minus Ex. Cond. | - | -6 | -6 | -6 | -6 | -6 |
| 75th percentile - Alternative minus Ex. Cond. | - | -10 | -7 | -10 | -17 | -10 |
| 25th percentile - Alternative minus Ex. Cond. | - | 3 | 3 | 3 | 1 | 5 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-52f. Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 202 | 203 | 203 | 203 | 203 | 203 |
| 50th percentile (Median) | 226 | 228 | 227 | 229 | 228 | 228 |
| 75th percentile | 312 | 327 | 333 | 329 | 329 | 327 |
| 90th percentile | 421 | 420 | 427 | 427 | 419 | 420 |
| Median - Alternative minus Ex. Cond. | - | 2 | 1 | 3 | 2 | 2 |
| 90th percentile - Alternative minus Ex. Cond. | - | -1 | 6 | 6 | -2 | -1 |
| 75th percentile - Alternative minus Ex. Cond. | - | 15 | 21 | 17 | 17 | 15 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-53a. Channels around Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 5 | 5 | 5 | 5 | 5 | 5 |
| 75th percentile | 13 | 13 | 13 | 13 | 13 | 13 |
| 90th percentile | 15 | 15 | 15 | 15 | 15 | 15 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-53b. Channels around Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 2 | 2 | 2 | 2 | 2 | 2 |
| 50th percentile (Median) | 5 | 5 | 5 | 5 | 5 | 5 |
| 75th percentile | 12 | 11 | 12 | 11 | 12 | 11 |
| 90th percentile | 14 | 13 | 13 | 13 | 14 | 13 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | -1 | -1 | -1 | 0 | -1 |
| 75th percentile - Alternative minus Ex. Cond. | - | -1 | 0 | -1 | 0 | -1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-53c. Channels around Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 3 | 3 | 3 | 3 | 3 | 3 |
| 50th percentile (Median) | 5 | 5 | 5 | 5 | 5 | 5 |
| 75th percentile | 11 | 9 | 11 | 11 | 11 | 9 |
| 90th percentile | 12 | 12 | 12 | 12 | 12 | 12 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | -2 | 0 | 0 | 0 | -2 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-53d. Channels around Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 3 | 3 | 3 | 3 | 3 | 3 |
| 50th percentile (Median) | 4 | 4 | 4 | 4 | 4 | 4 |
| 75th percentile | 7 | 6 | 6 | 6 | 6 | 6 |
| 90th percentile | 10 | 10 | 10 | 10 | 10 | 10 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | -1 | -1 | -1 | -1 | -1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-53e. Channels around Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 3 | 3 | 3 | 3 | 3 | 3 |
| 50th percentile (Median) | 4 | 4 | 4 | 4 | 4 | 4 |
| 75th percentile | 6 | 6 | 6 | 6 | 6 | 6 |
| 90th percentile | 9 | 8 | 8 | 9 | 9 | 8 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | -1 | -1 | 0 | 0 | -1 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-53f. Channels around Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 3 | 3 | 3 | 3 | 3 | 3 |
| 50th percentile (Median) | 5 | 5 | 5 | 5 | 5 | 5 |
| 75th percentile | 6 | 6 | 6 | 6 | 6 | 6 |
| 90th percentile | 8 | 8 | 8 | 8 | 8 | 8 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-54a. San Joaquin River near Venice Island, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 90 | 88 | 88 | 88 | 88 | 88 |
| 50th percentile (Median) | 130 | 129 | 129 | 130 | 128 | 129 |
| 75th percentile | 154 | 157 | 157 | 156 | 154 | 157 |
| 90th percentile | 187 | 187 | 188 | 185 | 186 | 187 |
| Median - Alternative minus Ex. Cond. | - | -1 | -1 | 0 | -2 | -1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 1 | -2 | -1 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 3 | 3 | 2 | 0 | 3 |
| 25th percentile - Alternative minus Ex. Cond. | - | -2 | -2 | -2 | -2 | -2 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-54b. San Joaquin River near Venice Island, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 71 | 79 | 79 | 79 | 79 | 79 |
| 50th percentile (Median) | 87 | 98 | 98 | 98 | 98 | 98 |
| 75th percentile | 104 | 121 | 122 | 117 | 122 | 121 |
| 90th percentile | 170 | 166 | 164 | 164 | 169 | 166 |
| Median - Alternative minus Ex. Cond. | - | 11 | 11 | 11 | 11 | 11 |
| 90th percentile - Alternative minus Ex. Cond. | - | -4 | -6 | -6 | -1 | -4 |
| 75th percentile - Alternative minus Ex. Cond. | - | 17 | 18 | 13 | 18 | 17 |
| 25th percentile - Alternative minus Ex. Cond. | - | 8 | 8 | 8 | 8 | 8 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-54c. San Joaquin River near Venice Island, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 81 | 81 | 81 | 81 | 81 | 81 |
| 50th percentile (Median) | 94 | 99 | 98 | 98 | 98 | 99 |
| 75th percentile | 131 | 131 | 133 | 133 | 131 | 131 |
| 90th percentile | 197 | 205 | 206 | 202 | 204 | 205 |
| Median - Alternative minus Ex. Cond. | - | 5 | 4 | 4 | 4 | 5 |
| 90th percentile - Alternative minus Ex. Cond. | - | 8 | 9 | 5 | 7 | 8 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 2 | 2 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-54d. San Joaquin River near Venice Island, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 92 | 96 | 94 | 96 | 96 | 96 |
| 50th percentile (Median) | 115 | 129 | 128 | 128 | 128 | 129 |
| 75th percentile | 159 | 160 | 160 | 159 | 160 | 160 |
| 90th percentile | 181 | 187 | 189 | 187 | 187 | 187 |
| Median - Alternative minus Ex. Cond. | - | 14 | 13 | 13 | 13 | 14 |
| 90th percentile - Alternative minus Ex. Cond. | - | 6 | 8 | 6 | 6 | 6 |
| 75th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 0 | 1 | 1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 4 | 2 | 4 | 4 | 4 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-54e. San Joaquin River near Venice Island, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 104 | 106 | 106 | 106 | 105 | 106 |
| 50th percentile (Median) | 143 | 147 | 147 | 147 | 146 | 147 |
| 75th percentile | 188 | 195 | 191 | 194 | 191 | 194 |
| 90th percentile | 234 | 227 | 226 | 228 | 226 | 226 |
| Median - Alternative minus Ex. Cond. | - | 4 | 4 | 4 | 3 | 4 |
| 90th percentile - Alternative minus Ex. Cond. | - | -7 | -8 | -6 | -8 | -8 |
| 75th percentile - Alternative minus Ex. Cond. | - | 7 | 3 | 6 | 3 | 6 |
| 25th percentile - Alternative minus Ex. Cond. | - | 2 | 2 | 2 | 1 | 2 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-54f. San Joaquin River near Venice Island, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 82 | 82 | 82 | 82 | 82 | 82 |
| 50th percentile (Median) | 105 | 104 | 105 | 106 | 105 | 104 |
| 75th percentile | 165 | 181 | 197 | 182 | 181 | 181 |
| 90th percentile | 225 | 229 | 231 | 228 | 230 | 229 |
| Median - Alternative minus Ex. Cond. | - | -1 | 0 | 1 | 0 | -1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 4 | 6 | 3 | 5 | 4 |
| 75th percentile - Alternative minus Ex. Cond. | - | 16 | 32 | 17 | 16 | 16 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-55a. Mokelumne River, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 6 | 6 | 6 | 6 | 6 | 6 |
| 50th percentile (Median) | 6 | 6 | 6 | 6 | 6 | 6 |
| 75th percentile | 7 | 7 | 7 | 7 | 7 | 7 |
| 90th percentile | 49 | 48 | 48 | 47 | 48 | 48 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | -1 | -1 | -2 | -1 | -1 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-55b. Mokelumne River, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 50th percentile (Median) | 6 | 6 | 6 | 6 | 6 | 6 |
| 75th percentile | 33 | 33 | 33 | 33 | 33 | 33 |
| 90th percentile | 43 | 44 | 44 | 48 | 44 | 44 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 5 | 1 | 1 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-55c. Mokelumne River, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 4 | 4 | 4 | 4 | 4 | 4 |
| 50th percentile (Median) | 6 | 6 | 6 | 6 | 6 | 6 |
| 75th percentile | 25 | 25 | 25 | 25 | 25 | 25 |
| 90th percentile | 47 | 52 | 52 | 50 | 52 | 52 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 5 | 5 | 3 | 5 | 5 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-55d. Mokelumne River, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 4 | 3 | 3 | 3 | 3 | 3 |
| 50th percentile (Median) | 6 | 6 | 6 | 6 | 6 | 6 |
| 75th percentile | 36 | 40 | 40 | 40 | 40 | 40 |
| 90th percentile | 52 | 52 | 52 | 52 | 52 | 52 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 4 | 4 | 4 | 4 | 4 |
| 25th percentile - Alternative minus Ex. Cond. | - | -1 | -1 | -1 | -1 | -1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-55e. Mokelumne River, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 5 | 5 | 5 | 5 | 5 | 5 |
| 50th percentile (Median) | 8 | 7 | 7 | 8 | 8 | 7 |
| 75th percentile | 26 | 26 | 26 | 26 | 26 | 26 |
| 90th percentile | 56 | 60 | 60 | 60 | 60 | 60 |
| Median - Alternative minus Ex. Cond. | - | -1 | -1 | 0 | 0 | -1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 4 | 4 | 4 | 4 | 4 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-55f. Mokelumne River, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 6 | 6 | 6 | 6 | 6 | 6 |
| 50th percentile (Median) | 8 | 9 | 8 | 9 | 9 | 9 |
| 75th percentile | 13 | 15 | 19 | 19 | 18 | 15 |
| 90th percentile | 53 | 52 | 52 | 49 | 49 | 52 |
| Median - Alternative minus Ex. Cond. | - | 1 | 0 | 1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | -1 | -1 | -4 | -4 | -1 |
| 75th percentile - Alternative minus Ex. Cond. | - | 2 | 6 | 6 | 5 | 2 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-56a. Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 619 | 615 | 620 | 614 | 615 | 615 |
| 50th percentile (Median) | 629 | 628 | 628 | 628 | 627 | 628 |
| 75th percentile | 685 | 687 | 691 | 687 | 687 | 687 |
| 90th percentile | 779 | 773 | 783 | 773 | 774 | 773 |
| Median - Alternative minus Ex. Cond. | - | -1 | -1 | -1 | -2 | -1 |
| 90th percentile - Alternative minus Ex. Cond. | - | -6 | 4 | -6 | -5 | -6 |
| 75th percentile - Alternative minus Ex. Cond. | - | 2 | 6 | 2 | 2 | 2 |
| 25th percentile - Alternative minus Ex. Cond. | - | -4 | 1 | -5 | -4 | -4 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-56b. Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 456 | 482 | 479 | 478 | 482 | 482 |
| 50th percentile (Median) | 482 | 507 | 508 | 502 | 515 | 513 |
| 75th percentile | 533 | 570 | 573 | 577 | 555 | 570 |
| 90th percentile | 763 | 761 | 764 | 765 | 761 | 761 |
| Median - Alternative minus Ex. Cond. | - | 25 | 26 | 20 | 33 | 31 |
| 90th percentile - Alternative minus Ex. Cond. | - | -2 | 1 | 2 | -2 | -2 |
| 75th percentile - Alternative minus Ex. Cond. | - | 37 | 40 | 44 | 22 | 37 |
| 25th percentile - Alternative minus Ex. Cond. | - | 26 | 23 | 22 | 26 | 26 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-56B. Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 472 | 478 | 478 | 477 | 478 | 478 |
| 50th percentile (Median) | 498 | 510 | 509 | 508 | 508 | 510 |
| 75th percentile | 639 | 620 | 623 | 624 | 620 | 620 |
| 90th percentile | 832 | 815 | 824 | 806 | 807 | 815 |
| Median - Alternative minus Ex. Cond. | - | 12 | 11 | 10 | 10 | 12 |
| 90th percentile - Alternative minus Ex. Cond. | - | -17 | -8 | -26 | -25 | -17 |
| 75th percentile - Alternative minus Ex. Cond. | - | -19 | -16 | -15 | -19 | -19 |
| 25th percentile - Alternative minus Ex. Cond. | - | 6 | 6 | 5 | 6 | 6 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-56d. Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 520 | 544 | 545 | 541 | 544 | 544 |
| 50th percentile (Median) | 575 | 608 | 597 | 605 | 609 | 605 |
| 75th percentile | 687 | 690 | 701 | 688 | 688 | 696 |
| 90th percentile | 764 | 775 | 772 | 772 | 775 | 775 |
| Median - Alternative minus Ex. Cond. | - | 33 | 22 | 30 | 34 | 30 |
| 90th percentile - Alternative minus Ex. Cond. | - | 11 | 8 | 8 | 11 | 11 |
| 75th percentile - Alternative minus Ex. Cond. | - | 3 | 14 | 1 | 1 | 9 |
| 25th percentile - Alternative minus Ex. Cond. | - | 24 | 25 | 21 | 24 | 24 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-56e. Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 568 | 570 | 570 | 574 | 570 | 574 |
| 50th percentile (Median) | 662 | 687 | 687 | 686 | 686 | 687 |
| 75th percentile | 759 | 760 | 758 | 759 | 759 | 760 |
| 90th percentile | 857 | 850 | 849 | 850 | 833 | 850 |
| Median - Alternative minus Ex. Cond. | - | 25 | 25 | 24 | 24 | 25 |
| 90th percentile - Alternative minus Ex. Cond. | - | -7 | -8 | -7 | -24 | -7 |
| 75th percentile - Alternative minus Ex. Cond. | - | 1 | -1 | 0 | 0 | 1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 2 | 2 | 6 | 2 | 6 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-56f. Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 470 | 474 | 475 | 471 | 471 | 474 |
| 50th percentile (Median) | 539 | 551 | 551 | 540 | 551 | 551 |
| 75th percentile | 689 | 733 | 736 | 732 | 733 | 733 |
| 90th percentile | 847 | 850 | 849 | 850 | 850 | 850 |
| Median - Alternative minus Ex. Cond. | - | 12 | 12 | 1 | 12 | 12 |
| 90th percentile - Alternative minus Ex. Cond. | - | 3 | 2 | 3 | 3 | 3 |
| 75th percentile - Alternative minus Ex. Cond. | - | 44 | 47 | 43 | 44 | 44 |
| 25th percentile - Alternative minus Ex. Cond. | - | 4 | 5 | 1 | 1 | 4 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-57a. Channels around Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 28 | 28 | 28 | 28 | 28 | 28 |
| 50th percentile (Median) | 51 | 52 | 52 | 52 | 52 | 52 |
| 75th percentile | 61 | 60 | 62 | 61 | 61 | 60 |
| 90th percentile | 69 | 70 | 71 | 68 | 71 | 70 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 1 | 2 | -1 | 2 | 1 |
| 75th percentile - Alternative minus Ex. Cond. | - | -1 | 1 | 0 | 0 | -1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-57b. Channels around Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 22 | 22 | 22 | 22 | 22 | 22 |
| 50th percentile (Median) | 27 | 28 | 28 | 28 | 28 | 28 |
| 75th percentile | 35 | 38 | 38 | 38 | 38 | 38 |
| 90th percentile | 41 | 44 | 43 | 43 | 44 | 44 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 3 | 2 | 2 | 3 | 3 |
| 75th percentile - Alternative minus Ex. Cond. | - | 3 | 3 | 3 | 3 | 3 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-57c. Channels around Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 20 | 21 | 21 | 21 | 20 | 21 |
| 50th percentile (Median) | 25 | 25 | 25 | 25 | 25 | 25 |
| 75th percentile | 34 | 35 | 35 | 35 | 35 | 35 |
| 90th percentile | 56 | 48 | 47 | 46 | 46 | 48 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | -8 | -9 | -10 | -10 | -8 |
| 75th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 0 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-57d. Channels around Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 21 | 22 | 23 | 22 | 22 | 22 |
| 50th percentile (Median) | 30 | 32 | 32 | 32 | 33 | 32 |
| 75th percentile | 48 | 52 | 52 | 52 | 52 | 52 |
| 90th percentile | 66 | 66 | 66 | 64 | 66 | 66 |
| Median - Alternative minus Ex. Cond. | - | 2 | 2 | 2 | 3 | 2 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | -2 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 4 | 4 | 4 | 4 | 4 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 2 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-57e. Channels around Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 28 | 28 | 28 | 27 | 28 | 28 |
| 50th percentile (Median) | 41 | 41 | 41 | 39 | 39 | 41 |
| 75th percentile | 66 | 68 | 68 | 70 | 70 | 68 |
| 90th percentile | 84 | 79 | 78 | 79 | 79 | 79 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | -2 | -2 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | -5 | -6 | -5 | -5 | -5 |
| 75th percentile - Alternative minus Ex. Cond. | - | 2 | 2 | 4 | 4 | 2 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | -1 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-57f. Channels around Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 26 | 25 | 26 | 26 | 25 | 26 |
| 50th percentile (Median) | 32 | 34 | 33 | 34 | 34 | 34 |
| 75th percentile | 50 | 58 | 58 | 54 | 58 | 58 |
| 90th percentile | 75 | 82 | 83 | 83 | 81 | 82 |
| Median - Alternative minus Ex. Cond. | - | 2 | 1 | 2 | 2 | 2 |
| 90th percentile - Alternative minus Ex. Cond. | - | 7 | 8 | 8 | 6 | 7 |
| 75th percentile - Alternative minus Ex. Cond. | - | 8 | 8 | 4 | 8 | 8 |
| 25th percentile - Alternative minus Ex. Cond. | - | -1 | 0 | 0 | -1 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-58a. Old River South of Clifton Court Forebay, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 71 | 68 | 69 | 68 | 68 | 68 |
| 50th percentile (Median) | 184 | 182 | 174 | 180 | 182 | 180 |
| 75th percentile | 417 | 392 | 411 | 413 | 413 | 392 |
| 90th percentile | 643 | 654 | 649 | 651 | 652 | 654 |
| Median - Alternative minus Ex. Cond. | - | -2 | -10 | -4 | -2 | -4 |
| 90th percentile - Alternative minus Ex. Cond. | - | 11 | 6 | 8 | 9 | 11 |
| 75th percentile - Alternative minus Ex. Cond. | - | -25 | -6 | -4 | -4 | -25 |
| 25th percentile - Alternative minus Ex. Cond. | - | -3 | -2 | -3 | -3 | -3 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-58b. Old River South of Clifton Court Forebay, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 108 | 115 | 115 | 114 | 115 | 115 |
| 50th percentile (Median) | 368 | 333 | 325 | 339 | 333 | 333 |
| 75th percentile | 593 | 553 | 562 | 581 | 551 | 553 |
| 90th percentile | 693 | 676 | 680 | 668 | 663 | 676 |
| Median - Alternative minus Ex. Cond. | - | -35 | -43 | -29 | -35 | -35 |
| 90th percentile - Alternative minus Ex. Cond. | - | -17 | -13 | -25 | -30 | -17 |
| 75th percentile - Alternative minus Ex. Cond. | - | -40 | -31 | -12 | -42 | -40 |
| 25th percentile - Alternative minus Ex. Cond. | - | 7 | 7 | 6 | 7 | 7 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-58c. Old River South of Clifton Court Forebay, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 136 | 135 | 134 | 135 | 135 | 135 |
| 50th percentile (Median) | 342 | 340 | 324 | 335 | 333 | 340 |
| 75th percentile | 654 | 641 | 631 | 642 | 646 | 641 |
| 90th percentile | 718 | 716 | 723 | 716 | 716 | 716 |
| Median - Alternative minus Ex. Cond. | - | -2 | -18 | -7 | -9 | -2 |
| 90th percentile - Alternative minus Ex. Cond. | - | -2 | 5 | -2 | -2 | -2 |
| 75th percentile - Alternative minus Ex. Cond. | - | -13 | -23 | -12 | -8 | -13 |
| 25th percentile - Alternative minus Ex. Cond. | - | -1 | -2 | -1 | -1 | -1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-58d. Old River South of Clifton Court Forebay, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 227 | 189 | 201 | 176 | 176 | 189 |
| 50th percentile (Median) | 318 | 310 | 311 | 314 | 309 | 310 |
| 75th percentile | 332 | 337 | 334 | 337 | 336 | 337 |
| 90th percentile | 344 | 349 | 348 | 351 | 349 | 349 |
| Median - Alternative minus Ex. Cond. | - | -8 | -7 | -4 | -9 | -8 |
| 90th percentile - Alternative minus Ex. Cond. | - | 5 | 4 | 7 | 5 | 5 |
| 75th percentile - Alternative minus Ex. Cond. | - | 5 | 2 | 5 | 4 | 5 |
| 25th percentile - Alternative minus Ex. Cond. | - | -38 | -26 | -51 | -51 | -38 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-58e. Old River South of Clifton Court Forebay, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 50 | 50 | 50 | 50 | 50 | 50 |
| 50th percentile (Median) | 74 | 74 | 73 | 72 | 73 | 74 |
| 75th percentile | 88 | 88 | 89 | 84 | 84 | 88 |
| 90th percentile | 118 | 112 | 112 | 113 | 112 | 112 |
| Median - Alternative minus Ex. Cond. | - | 0 | -1 | -2 | -1 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | -6 | -6 | -5 | -6 | -6 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 1 | -4 | -4 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-58f. Old River South of Clifton Court Forebay, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 65 | 65 | 64 | 64 | 65 | 65 |
| 50th percentile (Median) | 83 | 84 | 83 | 82 | 84 | 84 |
| 75th percentile | 170 | 194 | 187 | 193 | 193 | 193 |
| 90th percentile | 368 | 320 | 301 | 353 | 331 | 319 |
| Median - Alternative minus Ex. Cond. | - | 1 | 0 | -1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | -48 | -67 | -15 | -37 | -49 |
| 75th percentile - Alternative minus Ex. Cond. | - | 24 | 17 | 23 | 23 | 23 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | -1 | -1 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-59a. Middle River from Woodward Island to Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, June**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 24 | 24 | 24 | 24 | 24 | 24 |
| 50th percentile (Median) | 31 | 32 | 32 | 31 | 32 | 32 |
| 75th percentile | 38 | 38 | 38 | 38 | 38 | 38 |
| 90th percentile | 58 | 52 | 57 | 52 | 52 | 52 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 0 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | -6 | -1 | -6 | -6 | -6 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-59b. Middle River from Woodward Island to Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, July**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 15 | 16 | 16 | 16 | 16 | 16 |
| 50th percentile (Median) | 18 | 19 | 20 | 19 | 19 | 19 |
| 75th percentile | 24 | 24 | 25 | 25 | 25 | 25 |
| 90th percentile | 51 | 51 | 54 | 51 | 51 | 51 |
| Median - Alternative minus Ex. Cond. | - | 1 | 2 | 1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 0 | 3 | 0 | 0 | 0 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 1 | 1 | 1 | 1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-59c. Middle River from Woodward Island to Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, August**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 16 | 16 | 16 | 16 | 16 | 16 |
| 50th percentile (Median) | 21 | 21 | 21 | 20 | 21 | 21 |
| 75th percentile | 27 | 28 | 29 | 27 | 27 | 28 |
| 90th percentile | 52 | 55 | 61 | 55 | 54 | 55 |
| Median - Alternative minus Ex. Cond. | - | 0 | 0 | -1 | 0 | 0 |
| 90th percentile - Alternative minus Ex. Cond. | - | 3 | 9 | 3 | 2 | 3 |
| 75th percentile - Alternative minus Ex. Cond. | - | 1 | 2 | 0 | 0 | 1 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-59d. Middle River from Woodward Island to Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, September**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 17 | 18 | 18 | 18 | 18 | 18 |
| 50th percentile (Median) | 22 | 23 | 23 | 23 | 24 | 23 |
| 75th percentile | 28 | 31 | 31 | 31 | 31 | 31 |
| 90th percentile | 38 | 39 | 39 | 39 | 38 | 39 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 2 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 0 | 1 |
| 75th percentile - Alternative minus Ex. Cond. | - | 3 | 3 | 3 | 3 | 3 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-59e. Middle River from Woodward Island to Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, October**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 19 | 20 | 20 | 19 | 19 | 20 |
| 50th percentile (Median) | 24 | 25 | 25 | 25 | 25 | 25 |
| 75th percentile | 31 | 31 | 31 | 31 | 29 | 31 |
| 90th percentile | 45 | 49 | 48 | 48 | 47 | 49 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 1 | 1 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 4 | 3 | 3 | 2 | 4 |
| 75th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | -2 | 0 |
| 25th percentile - Alternative minus Ex. Cond. | - | 1 | 1 | 0 | 0 | 1 |

Alt = Alternative, Ex. Cond. = existing conditions.

**Table 6B.1-59f. Middle River from Woodward Island to Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location, November**

| Statistic | Ex. Cond. | Alts 1, 3 | Alts 2a, 4a | Alts 2b, 4b | Alts 2c, 4c | Alt 5 |
|---|---|---|---|---|---|---|
| 25th percentile | 13 | 13 | 13 | 13 | 13 | 13 |
| 50th percentile (Median) | 18 | 19 | 19 | 18 | 18 | 19 |
| 75th percentile | 24 | 29 | 30 | 28 | 29 | 29 |
| 90th percentile | 47 | 49 | 49 | 47 | 49 | 49 |
| Median - Alternative minus Ex. Cond. | - | 1 | 1 | 0 | 0 | 1 |
| 90th percentile - Alternative minus Ex. Cond. | - | 2 | 2 | 0 | 2 | 2 |
| 75th percentile - Alternative minus Ex. Cond. | - | 5 | 6 | 4 | 5 | 5 |
| 25th percentile - Alternative minus Ex. Cond. | - | 0 | 0 | 0 | 0 | 0 |

Alt = Alternative, Ex. Cond. = existing conditions.

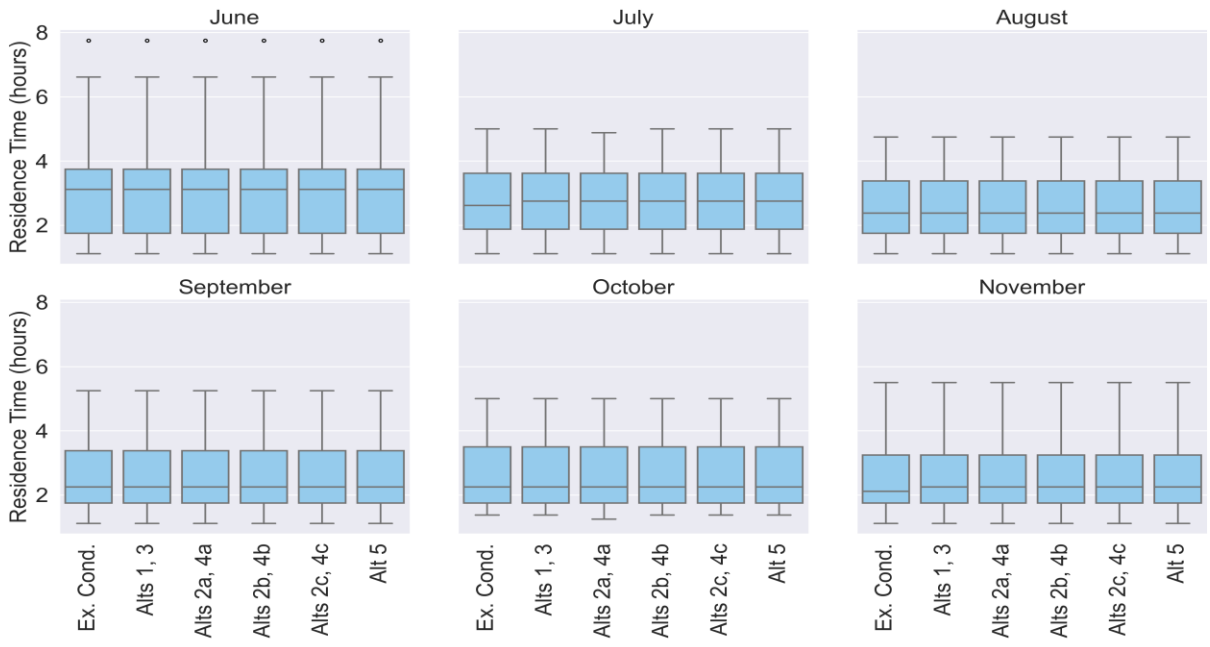



**Figure 6B.1-139. Brannan Island, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

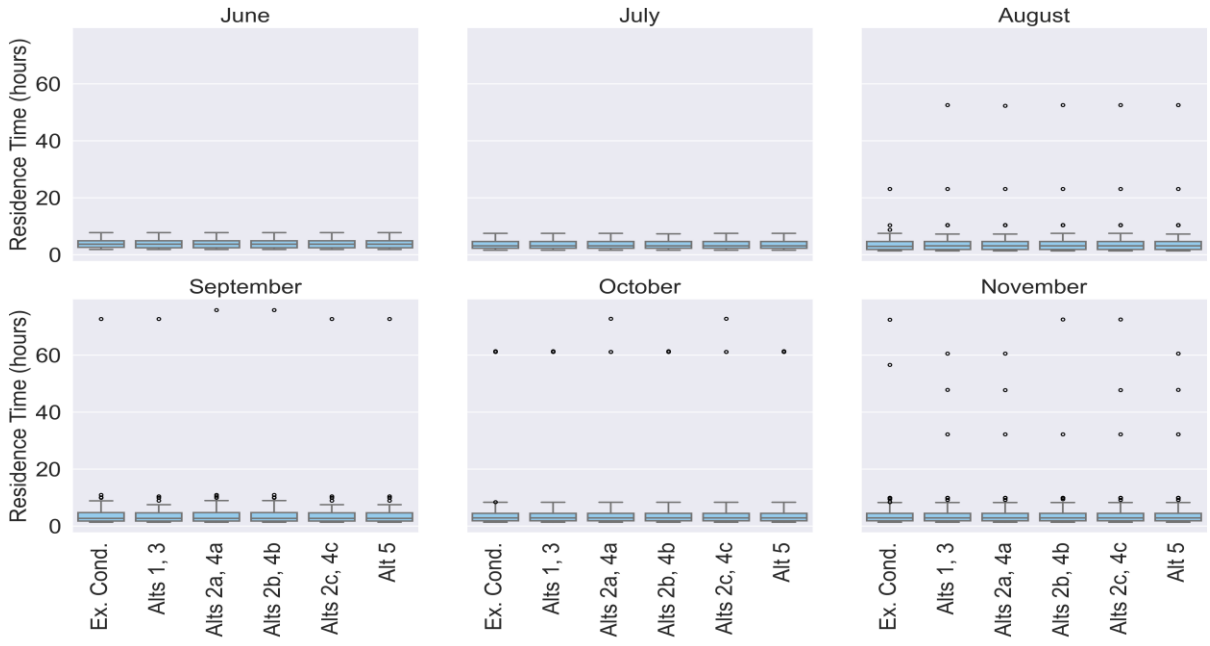



**Figure 6B.1-140. San Joaquin River at Jersey Point, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

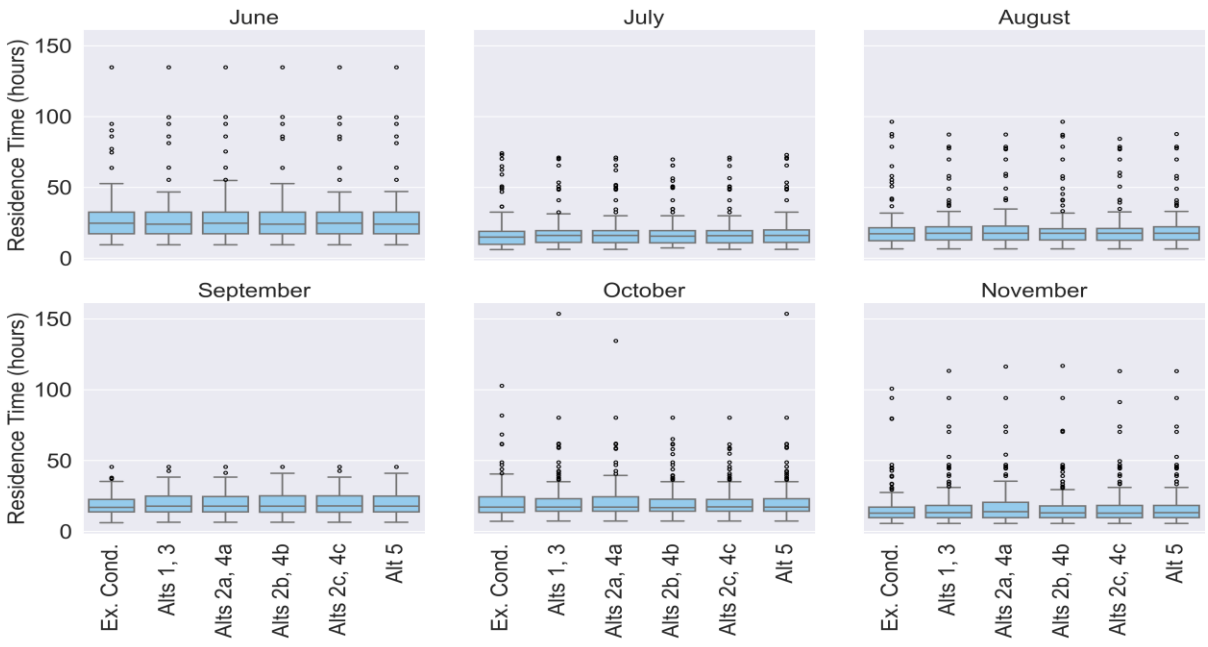



**Figure 6B.1-141. Old River at Rock Slough, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

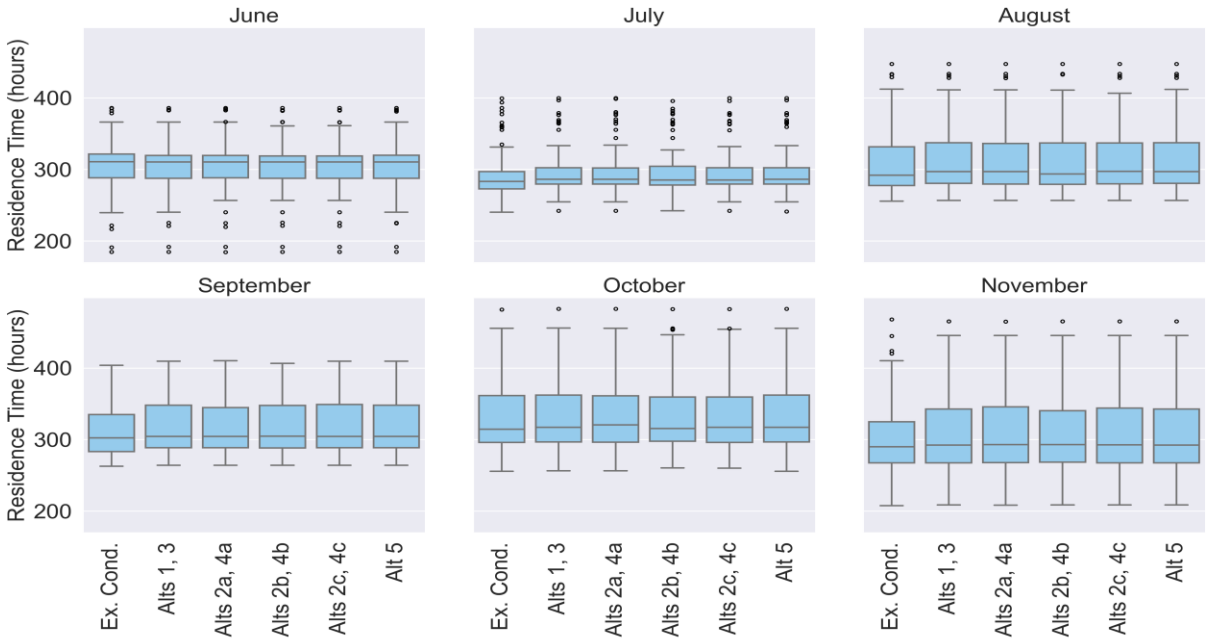



**Figure 6B.1-142. Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

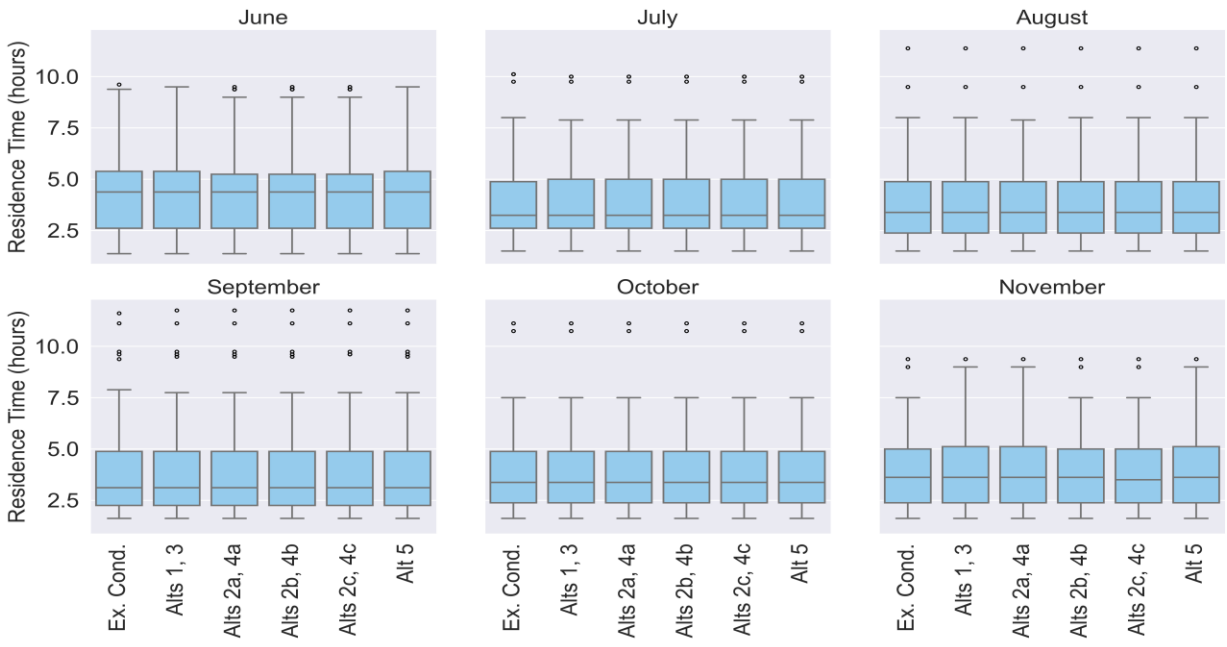



**Figure 6B.1-143. Channels around Franks Tract, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

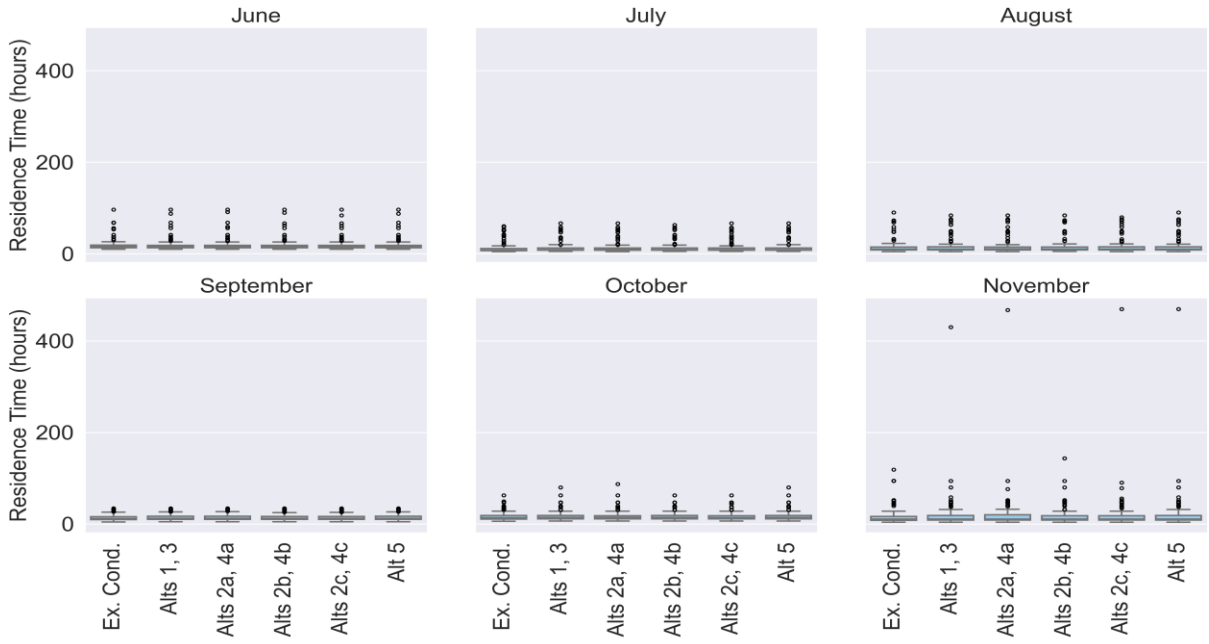



**Figure 6B.1-144a. Victoria Canal, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

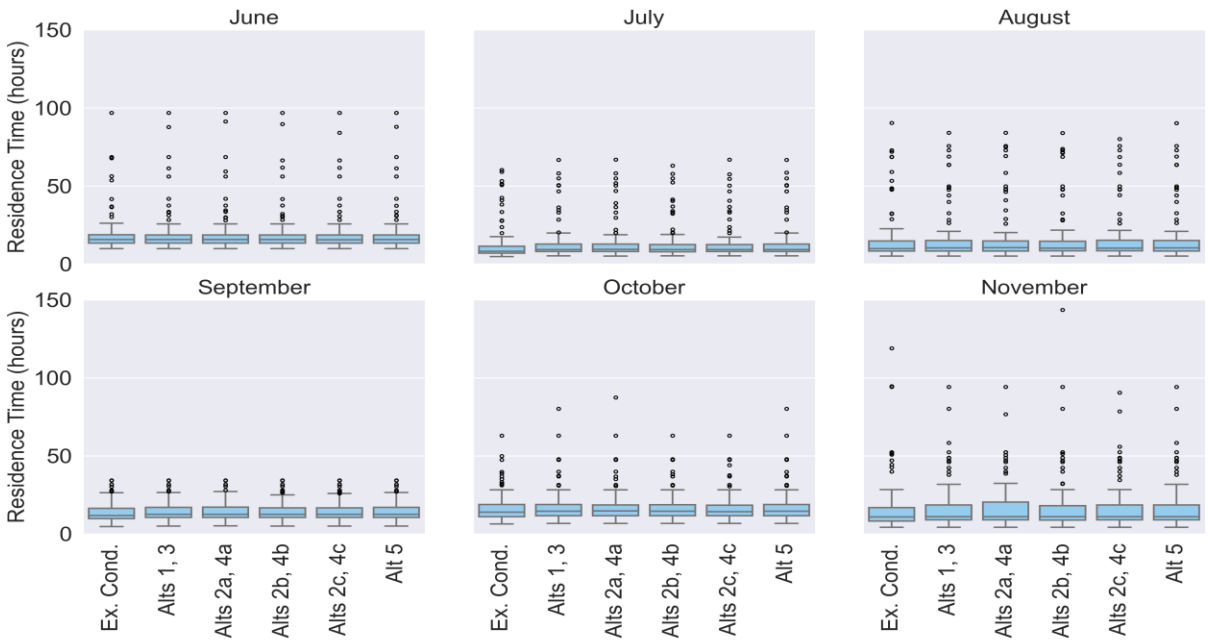



**Figure 6B.1-144b. Victoria Canal, Time (in hours) to Flush 90 Percent of Water from the Location by Month Zoomed in to Show Scale without November Outliers**

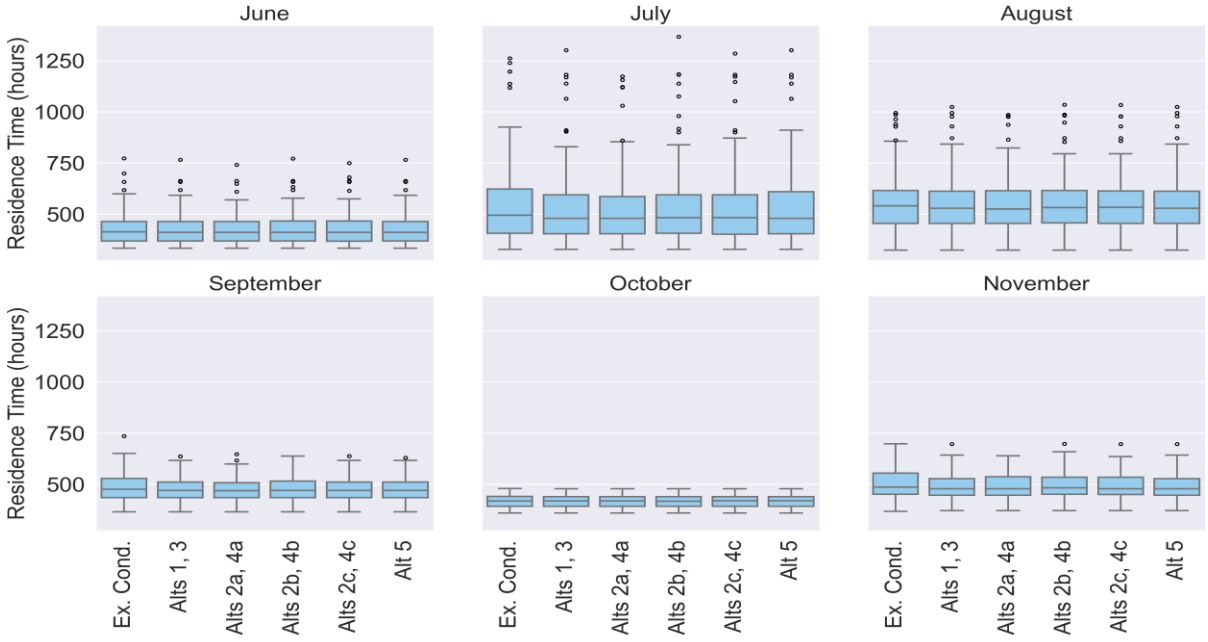



**Figure 6B.1-145. Stockton Deep Water Ship Channel, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

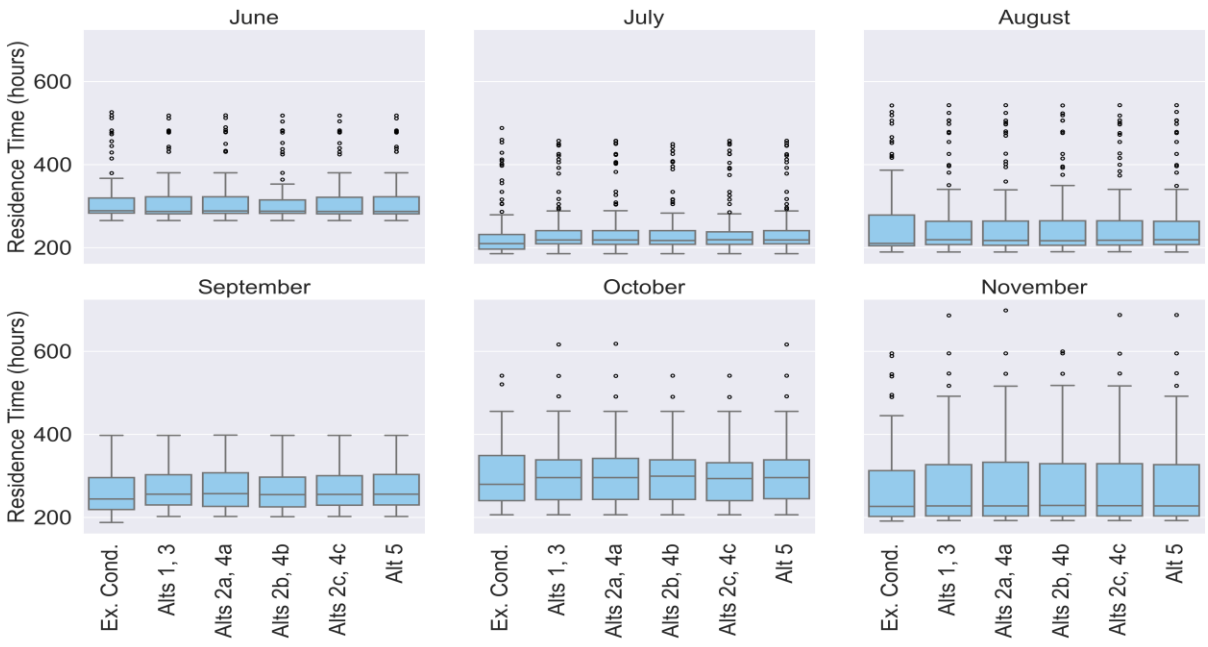



**Figure 6B.1-146. Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

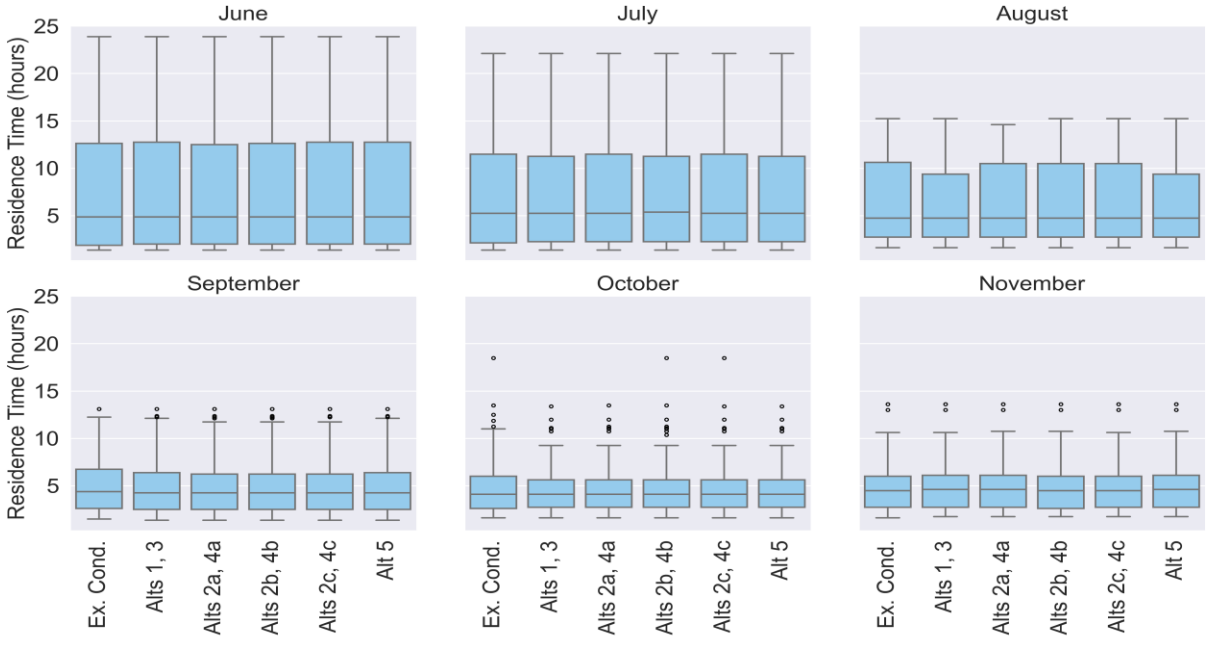



**Figure 6B.1-147. Channels around Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

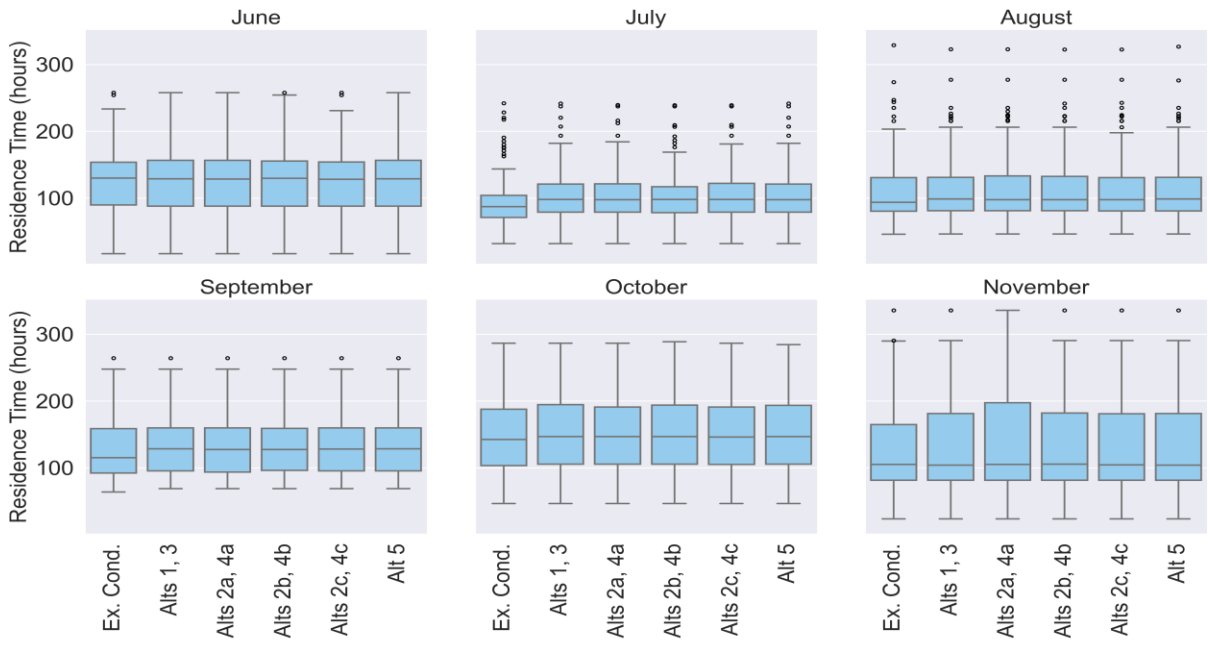



**Figure 6B.1-148. San Joaquin River near Venice Island, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

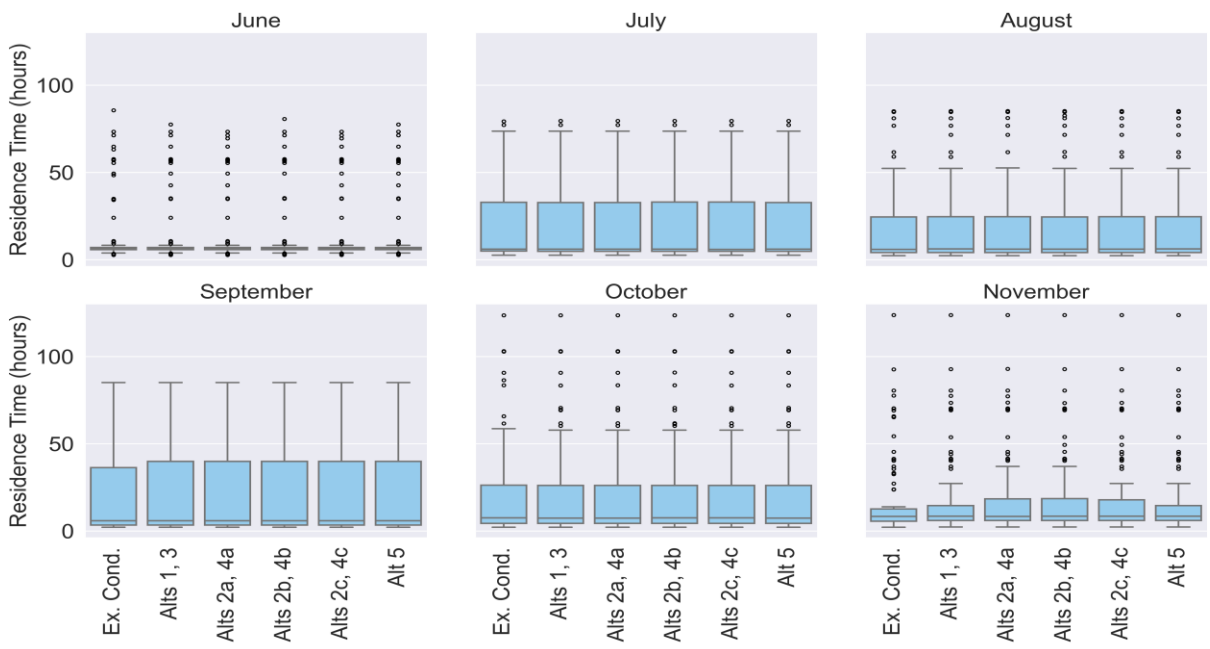



**Figure 6B.1-149. Mokelumne River, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

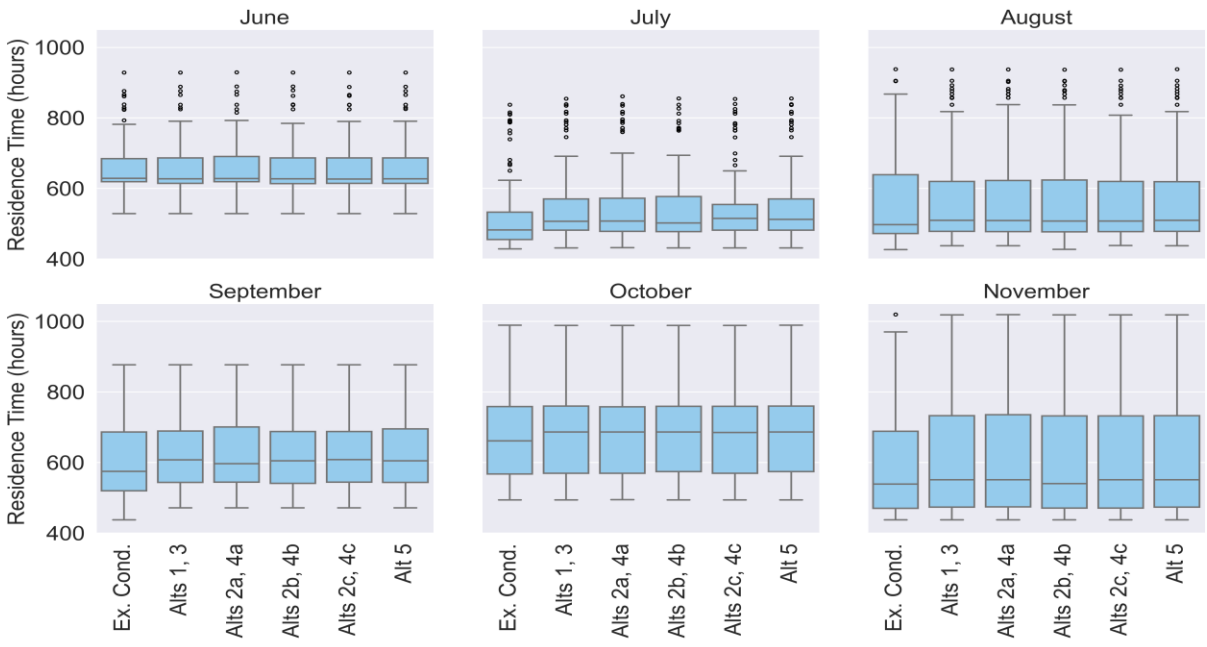



**Figure 6B.1-150. Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

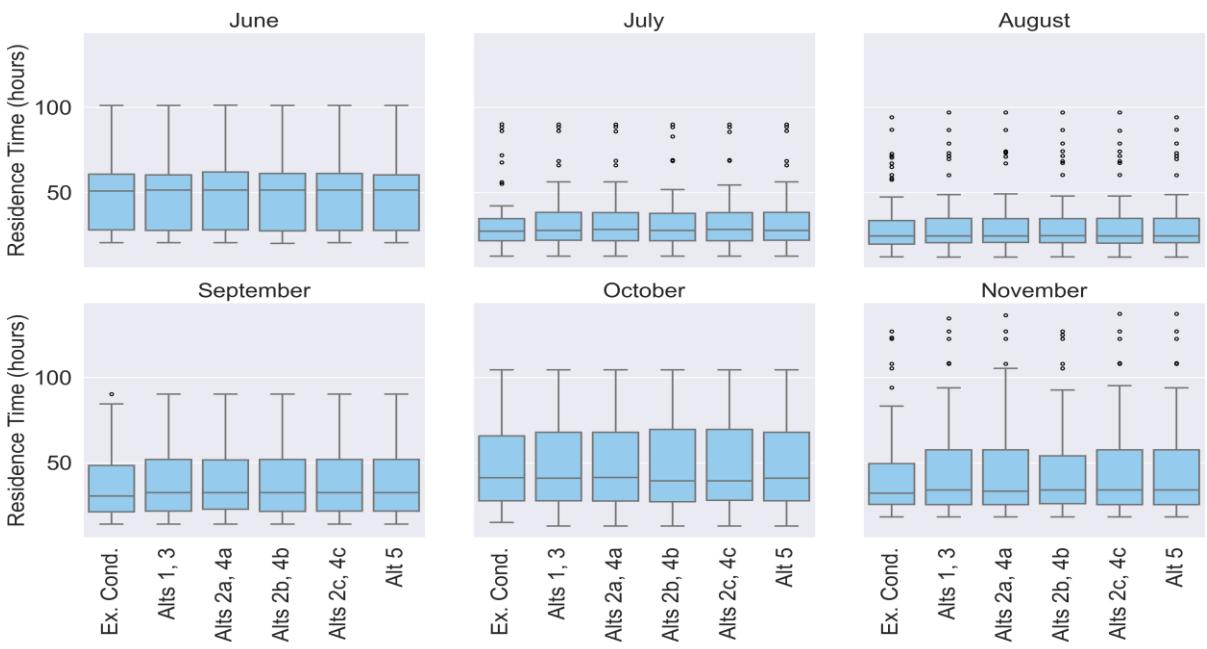



**Figure 6B.1-151. Channels around Discovery Bay, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

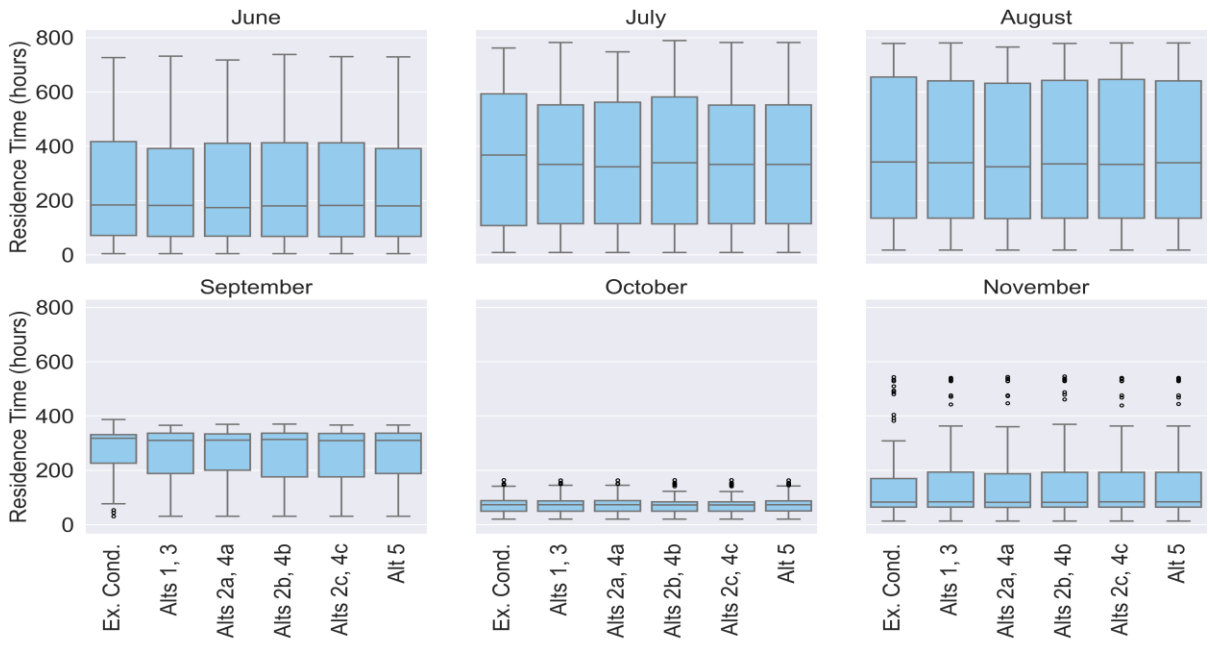



**Figure 6B.1-152. Old River South of Clifton Court Forebay, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

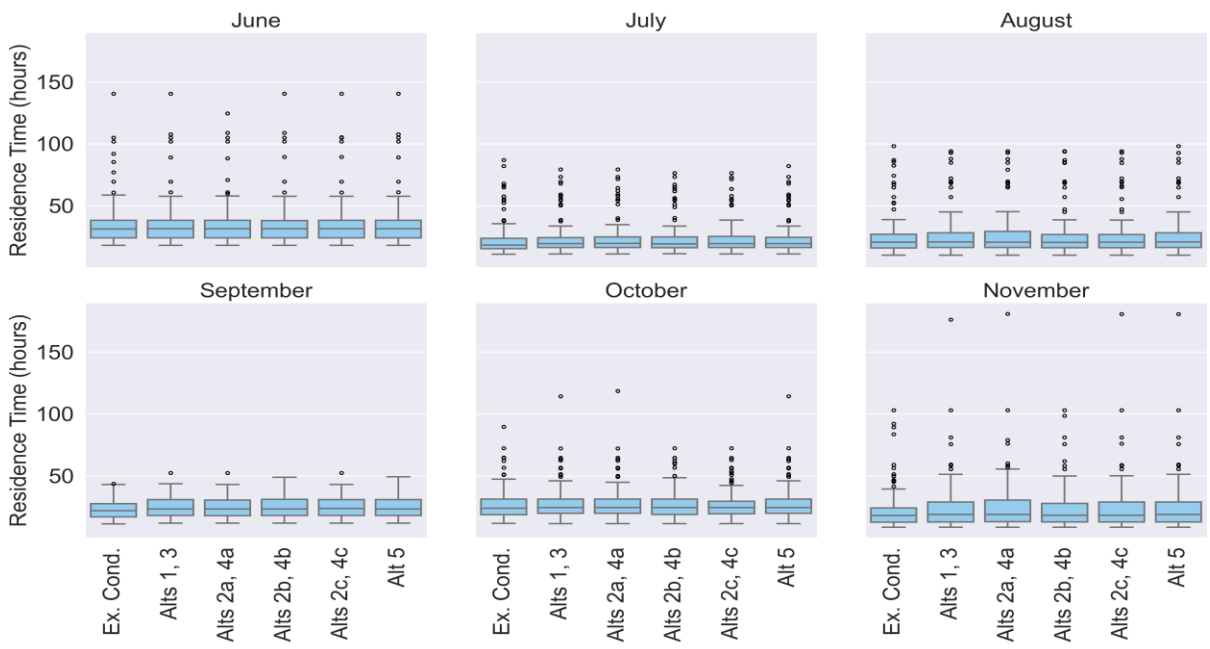



**Figure 6B.1-153. Middle River from Woodward Island to Mildred Island, Time (in hours) to Flush 90 Percent of Water from the Location by Month**

## 6B.1.1.2 Surface Water

### 6B.1.1.2.1 Changes to Sacramento River Basin Flows

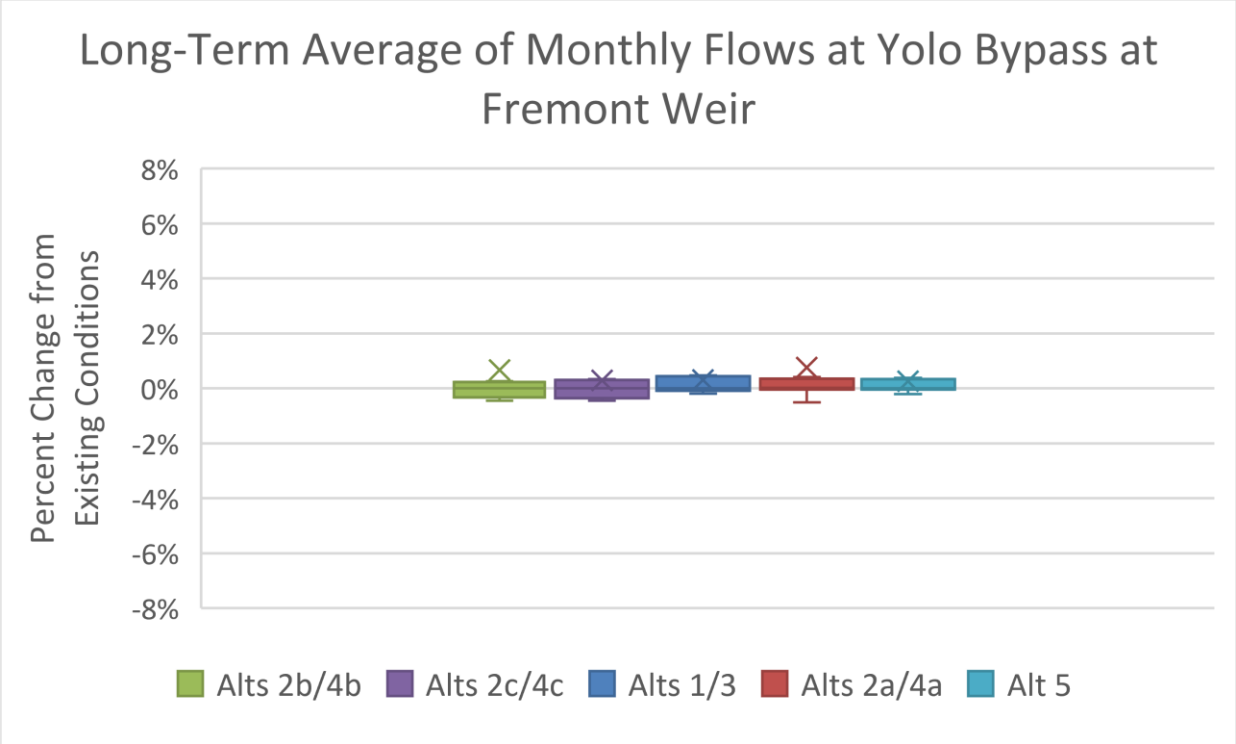



**Figure 6B.1-154. Long-Term Average of Monthly Flows at Yolo Bypass at Fremont Weir**

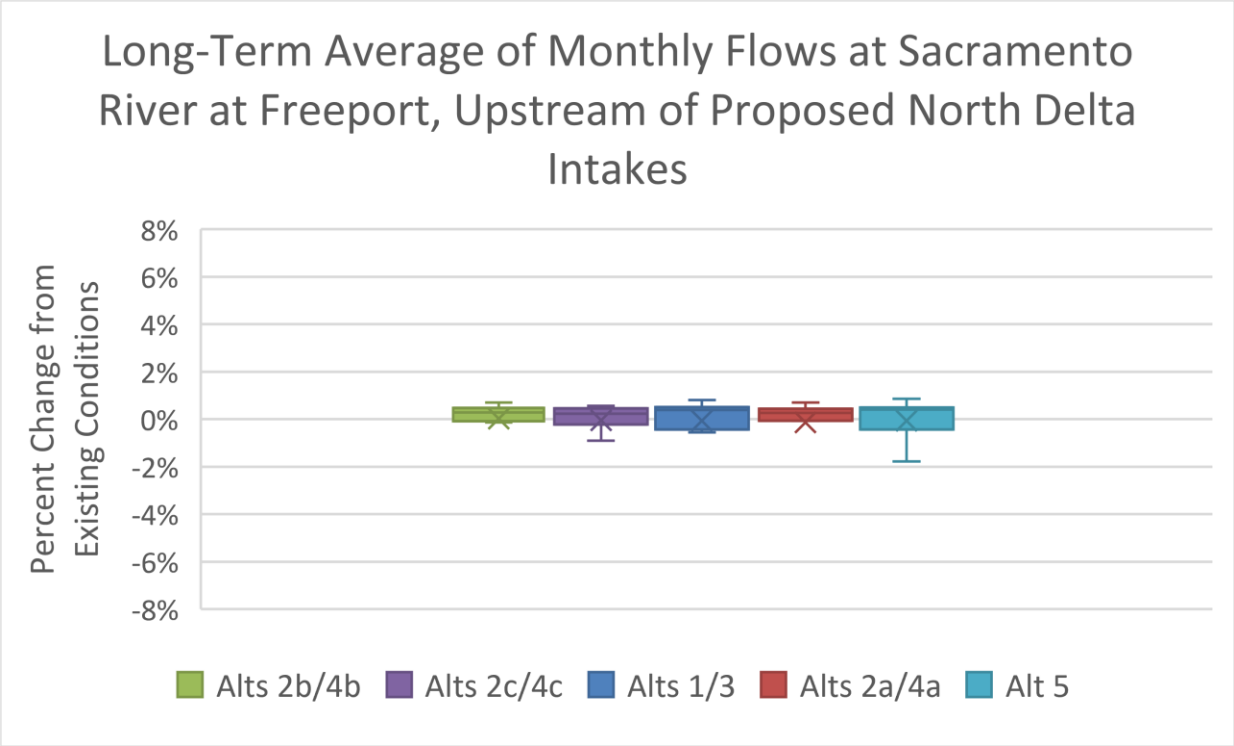



**Figure 6B.1-155. Long-Term Average of Monthly Flows at Sacramento River at Freeport, Upstream of Proposed North Delta Intakes**

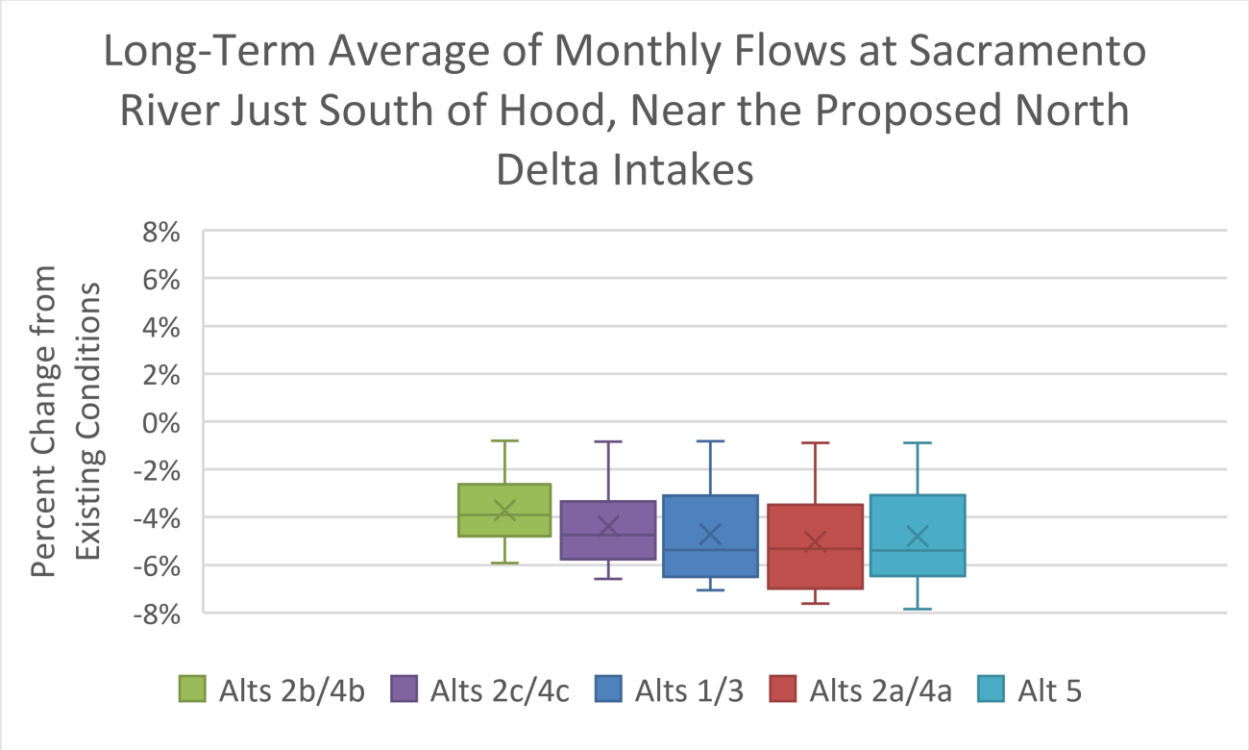



**Figure 6B.1-156. Long-Term Average of Monthly Flows at Sacramento River Just South of Hood, Downstream of the Proposed North Delta Intakes**

# 6B.1.1.3 References Cited

California Department of Water Resources. 2023. *Delta Conveyance Project Final Environmental Impact Report*. December. (ICF 103653.0.003.) Sacramento, CA. Prepared by ICF, Sacramento, CA.

Appendix 6C

# Operations and Maintenance Effects Analysis for Delta Smelt, Longfin Smelt, and Terrestrial Species

This appendix includes analyses to describe effects of the proposed action on species under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). Specifically, this appendix includes operations and maintenance effect analyses to inform programmatic consultation under Section 7(a)(1) of the Endangered Species Act. More information on the consultation strategy can be found in Section 1.7, *Consultation Approach*.

## 6C.1 Effects on Delta Smelt

Potential effects of the proposed action on delta smelt are discussed for operation activities and conservation measures. Cumulative effects are also discussed. Analyses were developed in consideration of habitat attributes believed to be of importance to the species based on existing conceptual models (e.g., Interagency Ecological Program Management, Analysis, and Synthesis Team 2015; see summary by California Department of Water Resources 2020:4-119) and best-available methods (e.g., ICF International 2016a; U.S. Fish and Wildlife Service 2017). Potential effects were also evaluated for Water Facility Maintenance; Conservation Measures; Monitoring Activities; and Cumulative Effects.

Throughout the delta smelt analysis, impacts based on life stage (migrating adults, spawning adults, eggs/embryos, larvae/young juveniles, and juveniles) are discussed. Details related to delta smelt life stage and occurrences can be found in Chapter 4, *Action Area and Environmental Baseline*, Section 4.4.7, *Delta Smelt*. Table 4.4.7-1 summarizes the average annual frequency of delta smelt occurrence by life stage and location, based on a review of historical monitoring data.

### 6C.1.1 Effects of Water Facility Operations and Maintenance on Delta Smelt

#### 6C.1.1.1 Introduction

Potential effects of the proposed action on delta smelt are discussed in terms of near-field effects (i.e., in the immediate proximity) of north Delta exports and south Delta exports (e.g., entrainment), in addition to far-field habitat effects (e.g., changes to food availability and other factors potentially linked to changes in water operations). Analyses were developed in consideration of habitat attributes believed to be of importance to the species, based on existing conceptual models (e.g., Interagency Ecological Program Management, Analysis, and Synthesis Team 2015; see summary by California Department of Water Resources 2020:4–119) and best-available methods (e.g., ICF International 2016a; U.S. Fish and Wildlife Service 2017; California Department of Water Resources 2020). A summary of quantitative methods is provided in Appendix 5D, *Bay-Delta Methods and Results*.

#### 6C.1.1.2 North Delta Exports

The reach of the Sacramento River where the proposed intakes would be built is considered to be near the northern extent of where delta smelt occur. Surveys conducted within the Sacramento River reach of the proposed intake locations indicate few delta smelt are found in that vicinity. On one occasion, the species has been found as far upstream as Knights Landing (Vincik et al. 2012). Thus, there is the potential for negative effects to delta smelt at the proposed intake. For the effects analysis below, population-level effects were considered in light of survey data in the general vicinity of the proposed intakes that were examined to inform the extent of exposure of the species. Table 6C.1-1 illustrates number of delta smelt captured via beach seines relative to proposed intake locations.

**Table 6C.1-1. Number of Delta Smelt Collected by Beach Seining in the Sacramento River between River Miles 12 and 80, January–June 2012–2021, with Frequency of Years with Collection of at Least One Individual Compared to 1994–2014**

| Station | Location Relative to North Delta Intakes | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | Frequency (2012–2021) | Frequency (1994–2014) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SR012W (Sandy Beach) | Downstream | 5 | 4 | 46 | 29 | 2 | 4 | 0 | 0 | 0 | 0 | 0.60 | 0.86 |
| SR014W (Rio Vista) | Downstream | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.20 | 0.90 |
| SR017E (Isleton) | Downstream | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.38 |
| SR024E (Koket) | Downstream | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 | 0.62 |
| XC001N (Delta Cross Channel) | Downstream | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.05 |
| GS010E (Georgiana Slough) | Downstream | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 | 0.19 |
| SS011N (Steamboat Slough (mouth) | Downstream | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 | 0.43 |
| SR043W (Clarksburg) | Across river from Intake B | 9 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.20 | 0.71 |
| SR049E (Garcia Bend) | Upstream | 33 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.20 | 0.76 |
| SR055E (Sherwood Harbor) | Upstream | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.00 |
| SR057E (Miller Park) | Upstream | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.10 |
| SR060E (Discovery Park) | Upstream | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 | 0.19 |
| AM001S (American River) | Upstream | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.05 |
| SR062E (Sand Cove) | Upstream | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 | 0.10 |
| SR071E (Elkhorn) | Upstream | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.10 |
| SR080E (Verona) | Upstream | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.10 |

Sources: 2012–2021 data from U.S. Fish and Wildlife Service (2021; 1994–2014 frequency summary from U.S. Fish and Wildlife Service (2017:153).
Note: Station codes on the Sacramento River indicate river miles upstream of the confluence the Sacramento and San Joaquin Rivers; the north Delta intakes are at approximately River Miles 37–41.

The analyses of the potential effects of north Delta exports on delta smelt that are presented in this section are limited to the near-field effects of the proposed intake (i.e., entrainment, impingement/ screen contact, and predation).

## Upstream Migration Effects and Predation

The north Delta intakes could reduce the potential for migrating adult delta smelt to migrate upstream to spawning areas in the northern Delta based on replacement of low-velocity nearshore habitat at the north Delta intake locations with fish screens and associated structures. Previous analyses demonstrated that the tidal surfing behavior typically employed by adult delta smelt elsewhere in the Delta (Bennett and Burau 2015) would not allow passage upstream of the north Delta intakes because of the primarily downstream flow in the intake reach (ICF International 2016a:6–75). More recent analyses exploring a variety of tidal migration and other behaviors also found that all investigated behaviors would result in minimal numbers of fish entering the Sacramento River above Rio Vista (Gross et al. 2021); therefore, active swimming is required. As described by USFWS (2017:318), for a delta smelt to swim upstream at all, river velocity must be less than delta smelt sustainable swimming speeds. Assuming that the river velocity at Freeport is representative of the river velocity near the north Delta intakes (which would be designed to have adequate sweeping velocity to meet downstream juvenile salmon-migration requirements), the distance that a delta smelt can swim over a sustainable swimming period of 1 hour can be calculated based on maximum sustainable swimming speed (0.91 ft/s; Swanson et al. 1998). Methods for the upstream migration analysis are described in more detail in Appendix 5D, *Bay-Delta Methods and Results*, Section 5D.9, *Delta Smelt Upstream Migration Past North Delta Diversions*. Note that the method is applicable to fish in close proximity to the screens under the assumption that fish are swimming along the screens; as discussed further below, areas of low velocity that occur near the river bottom or channel margins could also be used for migration.

Based on the methods described in Appendix 5D, Section 5D.9, *Delta Smelt Upstream Migration Past North Delta Diversions*, historical water-velocity data during the main upstream migration period (December–March) indicate that downstream velocity would be sufficiently low for adult delta smelt to migrate upstream successfully within an hour past a single, approximately 30-foot cylindrical tee screen unit[1] at Intakes B and C, just under 15% of the time and just under 10% of the time for a combined screen length of 900 feet (i.e., the approximate screen unit length of each of Intakes B and C with 3,000-cubic square feet [cfs] capacity). The results for the 900-foot screen unit lengths may also be representative of conditions along the vertical wall behind the cylindrical tee fish screens, should delta smelt occur in that area, rather than along the fish screens.

Application of the results of laboratory investigations to velocity data from a relatively low-flow historical migration period (February 1991; see description in Appendix 5D, Section 5D.9, *Delta Smelt Upstream Migration Past North Delta Diversions*) suggest that adult delta smelt passing close to the north Delta intake screens when velocity is sufficiently low for upstream migration could contact the fish screens and result in somewhat-reduced survival (92%–93% survival for screen lengths of

[1] Calculations for a single fish screen were included to illustrate potential effects if fish only encountered one of the screens and not any others while swimming upstream (e.g., if they had otherwise occupied a different portion of the water column away from the fish screens). In combination with the full length of fish screens, this illustrates the range of potential effects for fish in close proximity to the screens. The cylindrical fish screen units would actually be 29.33 feet long and separated by a gap of 1 foot; each screen unit would include 7.66 feet of manifold between the two screens comprising each unit, so there actually would be 21.67 feet length of screen per screen unit.

30–900 feet; see Appendix 5D). Combined with the screen lengths that could be passed within a 1-hour sustainable swimming period, the analysis suggests that adult delta smelt passing close to the intakes would have a passage probability of 9% for a single 30-foot screen, 7% for a combined screen length of 450 feet, and 5% for a combined screen length of 900 feet. These results primarily derive from the downstream river velocity combined with the screen length, as opposed to survival effects of screen contact, and have uncertain application to the proposed cylindrical fish screens because the foundational studies were based on flat-plate screens that fish were required to be in close proximity to at all times. The potential for reduction of upstream passage by the north Delta intakes may be proportional to the overall screen length and, therefore, the overall capacity of the proposed action. As such, the potential reduction in upstream passage may be less under the proposed action (6,000-cfs capacity).

It is uncertain what proportion of upstream-migrating adult delta smelt occurring in the Sacramento River would experience the potential reduction in upstream passage by the north Delta intakes suggested by the above analysis. Although a suitably low velocity for upstream migration, based on Freeport channel velocity, may occur during a relatively low proportion of time, it is possible that upstream migration would be concentrated during these limited periods. In addition, 2D hydraulic modeling conducted to illustrate potential north Delta intake effects on river hydrodynamics shows that there is a considerable extent of sufficiently low-velocity habitat on the opposite (west/right) bank of the Sacramento River from the north Delta intakes, although the greatest extent is on the east/left bank (the same side as the proposed intakes), particularly during higher flows (Delta Conveyance Design and Construction Authority 2022d). USFWS (2017:318) considered that it is unlikely that delta smelt could exclusively use the west bank to migrate past the north Delta intakes because the Sacramento River makes six major bends between Isleton and Freeport. This would shunt the highest-velocity parts of the river cross section back and forth across the channel, requiring fish to change banks to avoid being swept downstream. In addition, USFWS (2017:318) considered that it seems unlikely that delta smelt could keep swimming up one bank of the river to areas upstream because they would eventually need to avoid a predator or be displaced off the shoreline at night, when they lose visual reference and become less active. Although these factors may increase the risk of passage delay by the north Delta intakes, the cylindrical tee fish screens and their associated manifolds, as well as the support piles for the log-boom structure, may provide velocity refuge for upstream-migrating adult delta smelt occurring near the intakes, thereby reducing the extent of the potential negative effect. Low-velocity habitat for migration may also occur near the riverbed, and field studies have shown delta smelt use of the bottom half of the water column, such as on ebb tides (Feyrer et al. 2013). In addition, if encountering high-velocity habitat at the proposed intakes, delta smelt could also switch banks to seek low-velocity habitat, thereby avoiding complete passage blockage and only perhaps resulting in some migration delay. Historical beach seine data at Clarksburg illustrate use of the opposite bank from Intake B (Table 6C.1-1).

Statistical analysis of the Freeport Regional Water Authority intake in the north Delta did not find evidence that the intake reduced upstream occurrence of delta smelt during and following construction, in comparison to the preconstruction period (Appendix 5D, Section 5D.18, *Delta Smelt Occurrence Upstream of Freeport Regional Water Authority Intake*). Although the Freeport intake is shorter and has a different (i.e., flat-plate) screen design than the proposed north Delta intakes, the analysis suggests that delta smelt are able to pass this intake to migrate upstream. In addition, the statistical analysis of delta smelt occurrence upstream of Freeport did not find a significant relationship between mean December–March Sacramento River at Freeport flow and delta smelt probability of occurrence upstream of Freeport (Appendix 5D, Section 5D.18, *Delta Smelt Occurrence Upstream of Freeport Regional Water Authority Intake*). In their paper describing the occurrence of a

single delta smelt in the rotary screw trap at Knights Landing in March 2010, Vincik et al. (2012) suggested that the hydrologically dry water year could have driven delta smelt farther upstream in the system, but acknowledged that they could not ascertain exactly what conditions led to migration so far upstream. Thus, although in theory diversions at the north Delta intakes could enhance the far-field, riverscape scale potential for upstream migration by adult delta smelt occurring in the north Delta riverine reaches based on lower velocity, and decrease potential migration based on near-field effects from the fish screens, there is uncertainty in the extent to which either effect would occur. Uncertainty in the potential effects on upstream passage of adult delta smelt would be addressed by field studies involving methods such as beach seining or environmental DNA.

The north Delta intakes may provide predatory fish with low-velocity ambush locations, given the association of some species with anthropogenic features (e.g., Sabal et al. 2016). This could increase exposure of delta smelt to predation risk, although the increase in in-water structure would be small, representing a relatively minor increase to the limited extent of in-water structures within the Delta (Lehman et al. 2019). Although not specific to delta smelt, and not within the Delta, studies in the Sacramento River have not provided evidence for statistically significant effects that either cylindrical tee fish screens (Demetras et al. 2013) or intake structures (Henderson et al. 2019) generally may have on the survival of migrating small fish. Field studies would be undertaken to assess predator association with the north Delta intakes and inform the need for adaptive management.

## Entrainment and Impingement

The north Delta intakes would be screened to fishery agency standards, including 0.2-feet-per-second approach velocities for delta smelt protection and 1.75-millimeter openings to limit the potential for entrainment or impingement. Delta smelt eggs and embryos are demersal and adhesive, attaching to substrates with an adhesive stalk formed by the outer layer of the egg (Bennett 2005), and therefore are not believed to be highly mobile following spawning (U.S. Fish and Wildlife Service 2019:100), so they generally would not be susceptible to entrainment or impingement.[2] Based on delta smelt body-depth to body-length ratios, and using the screening effectiveness analysis described in Appendix 5D, the proposed north Delta intake screen opening of 1.75 millimeters would prevent delta smelt greater than the standard length of around 20–21 millimeters (approximately 90 days old; Hobbs et al. 2007) from being entrained through the fish screens. Therefore, only delta smelt smaller than 20–21 millimeters (i.e., larvae/early juveniles) would be vulnerable to entrainment. 0.

The proportion of water diverted by the north Delta intakes during the months of young delta smelt vulnerability (i.e., March–June, especially April–May) provides a coarse indicator of entrainment/ impingement risks of the small proportion of delta smelt occurring near the north Delta intakes, assuming that the proportion of water diverted is proportional to intake exposure for young life stages moving downstream. CalSim modeling suggests that the median percentage of flow diverted would be 7% in March (range: 0%–21%), 0% in April (range: 0%–16%), 0% in May (range: 0%–

[2] To the extent that delta smelt eggs attached to sand are resuspended by water flow, the assessment of percentage of flow diverted by the north Delta intakes for larvae provides some context for entrainment risk. Note, however, that there is no information about the probability of resuspended eggs surviving resuspension, which, based on inferences made for other smelt species, may be low because of displacement to areas of less-suitable habitat than those selected by spawning adults (Brown and Taylor 1995). Note also that the proportion of the total delta smelt population's eggs that may be subject to entrainment risk would be low, based on the species' distribution information provided earlier in this section.

20%), and 0% in June (range: 0%–19%) (Table 6C.1-2). The percentage of young delta smelt being entrained or impinged on the north Delta intake screens likely would be less than these percentages because field studies in the Delta have shown that cylindrical tee fish screens may exclude a considerably greater proportion of delta smelt than would be expected based solely on theoretical calculations (Nobriga et al. 2004). Mechanisms contributing to these observations may include the hydraulic bypass effect created by moving water encountering the end of the cylindrical tee fish screens and forming a "bow wave," which physically keeps organisms away from the screens, as well as detection and avoidance of the bow wave, as suggested for cylindrical screens in the Columbia River (Coutant 2021; albeit with the caveats previously described for winter-run Chinook salmon in Chapter 5, *Effects Analysis for Chinook Salmon, Central Valley Steelhead, Green Sturgeon, and Killer Whale*). The small, early life stages of delta smelt tend to be distributed off the bottom and are pelagic, mostly near the surface of the water column prior to swim-bladder development (Bennett 2005:18; Wang 2007:7), whereas following swim-bladder development, there is evidence for changes in distribution from the upper to lower water column, depending on the time of the day (see summary by Bennett 2005:20, which notes that different studies have found different times of the day for occurrence in the upper water column). Occurrence in the upper half of the water column would result in potential exposure to the north Delta intakes much of the time for these individuals occurring near the intakes, based on the proportion of time that the tops of the screens would be in the upper half of the water column (Table 6C.1-3 and Table 6C.1-4). The overall proportion of the delta smelt population that could be exposed to such effects would be small, given that the main distribution of the species is farther downstream in the Delta and elsewhere (see the discussion in Chapter 6, Section 6.1.1, *Effects of Construction Activities on Delta Smelt*).

**Table 6C.1-2. Percentage of Sacramento River Flow Diverted by the North Delta Diversions, March–June**

| | Proposed Action | | | |
|---|---|---|---|---|
| **Percentile** | **March** | **April** | **May** | **June** |
| Minimum | 0% | 0% | 0% | 0% |
| 10% | 0% | 0% | 0% | 0% |
| 20% | 0% | 0% | 0% | 0% |
| 30% | 1% | 0% | 0% | 0% |
| 40% | 3% | 0% | 0% | 0% |
| 50% | 7% | 0% | 0% | 0% |
| 60% | 11% | 0% | 0% | 0% |
| 70% | 13% | 0% | 1% | 2% |
| 80% | 15% | 0% | 3% | 5% |
| 90% | 17% | 7% | 7% | 12% |
| Maximum | 21% | 16% | 20% | 19% |

**Table 6C.1-3. Water Column Position (U = Upper 50%; L = Lower 50%) of Top of Cylindrical Tee Screens at Intake B during Various Monthly Water Surface Elevation Exceedance Percentiles**

| Month | 1% | 5% | 25% | 50% | 75% | 95% | 99% |
|---|---|---|---|---|---|---|---|
| Jan | L | L | U | U | U | U | U |
| Feb | L | L | U | U | U | U | U |
| Mar | L | L | U | U | U | U | U |
| Apr | L | L | U | U | U | U | U |
| May | L | U | U | U | U | U | U |
| Jun | U | U | U | U | U | U | U |
| Jul | U | U | U | U | U | U | U |
| Aug | U | U | U | U | U | U | U |
| Sep | U | U | U | U | U | U | U |
| Oct | U | U | U | U | U | U | U |
| Nov | U | U | U | U | U | U | U |
| Dec | L | U | U | U | U | U | U |

Source: Based on elevation data in Table 12-33 and data sources in Delta Conveyance Design and Construction Authority (2022c).
Note: Percentiles indicate water surface elevation that would be exceeded 1%, 5%, etc., of the time, so, for example, an "L" in the 5% column indicates that the top of the cylindrical tee screens would be in the lower 50% of the water column 5% of the time.

**Table 6C.1-4. Water Column Position (U = Upper 50%; L = Lower 50%) of Top of Cylindrical Tee Screens at Intake C during Various Monthly Water Surface Elevation Exceedance Percentiles**

| Month | 1% | 5% | 25% | 50% | 75% | 95% | 99% |
|---|---|---|---|---|---|---|---|
| Jan | L | L | L | U | U | U | U |
| Feb | L | L | L | U | U | U | U |
| Mar | L | L | L | U | U | U | U |
| Apr | L | L | L | U | U | U | U |
| May | L | L | L | U | U | U | U |
| Jun | L | L | U | U | U | U | U |
| Jul | L | L | U | U | U | U | U |
| Aug | L | L | U | U | U | U | U |
| Sep | L | U | U | U | U | U | U |
| Oct | U | U | U | U | U | U | U |
| Nov | L | U | U | U | U | U | U |
| Dec | L | L | L | U | U | U | U |

Source: Based on elevation data in Table 12-33 and data sources in Delta Conveyance Design and Construction Authority (2022c).
Note: Percentiles indicate water surface elevation that would be exceeded 1%, 5%, etc., of the time, so, for example, an "L" in the 25% column indicates that the top of the cylindrical tee screens would be in the lower 50% of the water column 25% of the time.

### 6C.1.1.3 South Delta Exports

Old and Middle River flows are an important indicator of adult (December–March) and larval/early juvenile (March–June) delta smelt entrainment risk at the south Delta export facilities (Grimaldo et

al. 2009, 2021; U.S. Fish and Wildlife Service 2019:Appendix 2). As described in Chapter 3, *Description of the Proposed Action*, the existing facilities in the south Delta would be governed by applicable regulatory requirements, such as those specified under the State Water Resources Control Board *Bay-Delta Water Quality Control Plan*, federal BiOps (National Marine Fisheries Service 2019; U.S. Fish and Wildlife Service 2019), California Endangered Species Act Incidental Take Permit for State Water Project (SWP) (California Department of Fish and Wildlife 2020), and USACE Clifton Court diversion limits. The CalSim modeling for existing conditions and the proposed action includes representation of these requirements, although not all real-time requirements, such as those based on monitoring of fish presence, are represented. The risk of delta smelt entrainment under existing conditions and the proposed action would be minimized by the inclusion of the various existing regulatory requirements. Although there are some differences in modeled Old and Middle River flows between existing conditions and the proposed action, generally reflecting less south Delta exports under the proposed action because of north Delta exports, the magnitude and signs of the absolute estimates are similar sufficiently to suggest that there would be similar levels of delta smelt entrainment risk under the proposed action and existing conditions (Table 6C.1-5 through Table 6C.1-11).

**Table 6C.1-5. Mean Old and Middle River Flow (cubic feet per second) by Water Year Type, December**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | -5,229 | -5,035 (4%) |
| Above normal | -6,900 | -6,527 (5%) |
| Below normal | -6,249 | -6,064 (3%) |
| Dry | -5,666 | -5,115 (10%) |
| Critically dry | -4,281 | -4,182 (2%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

**Table 6C.1-6. Mean Old and Middle River Flow (cubic feet per second) by Water Year Type, January**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | -2,972 | -2,902 (2%) |
| Above normal | -4,274 | -4,274 (0%) |
| Below normal | -4,393 | -4,374 (0%) |
| Dry | -4,812 | -4,680 (3%) |
| Critically dry | -4,303 | -4,209 (2%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

### Table 6C.1-7. Mean Old and Middle River Flow (cubic feet per second) by Water Year Type, February

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | -3,029 | -2,652 (12%) |
| Above normal | -3,712 | -3,725 (0%) |
| Below normal | -4,460 | -4,374 (2%) |
| Dry | -4,516 | -4,658 (-3%) |
| Critically dry | -4,350 | -4,266 (2%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

### Table 6C.1-8. Mean Old and Middle River Flow (cubic feet per second) by Water Year Type, March

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | -1,289 | -840 (35%) |
| Above normal | -2,916 | -2,902 (0%) |
| Below normal | -3,383 | -3,375 (0%) |
| Dry | -3,292 | -3,293 (0%) |
| Critically dry | -3,001 | -2,898 (3%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

### Table 6C.1-9. Mean Old and Middle River Flow (cubic feet per second) by Water Year Type, April

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | -951 | -522 (45%) |
| Above normal | -1,531 | -1,393 (9%) |
| Below normal | -1,715 | -1,717 (0%) |
| Dry | -1,813 | -1,826 (-1%) |
| Critically dry | -1,181 | -1,212 (-3%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

### Table 6C.1-10. Mean Old and Middle River Flow (cubic feet per second) by Water Year Type, May

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | -1,555 | -1,656 (-7%) |
| Above normal | -2,397 | -2,445 (-2%) |
| Below normal | -1,882 | -2,000 (-6%) |
| Dry | -2,028 | -2,005 (1%) |
| Critically dry | -1,710 | -1,672 (2%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

**Table 6C.1-11. Mean Old and Middle River Flow (cubic feet per second) by Water Year Type, June**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | -4,411 | -4,404 (0%) |
| Above normal | -4,953 | -4,942 (0%) |
| Below normal | -4,899 | -4,920 (0%) |
| Dry | -4,750 | -4,730 (0%) |
| Critically dry | -2,084 | -2,102 (-1%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

Particle tracking modeling was used to provide additional assessment of potential delta smelt entrainment effects (for method, see Appendix 5D, Section 5D.14, *Delta Smelt Larval Entrainment (DSM2 Particle Tracking Model)*). The results of this modeling generally gave little difference between the proposed action and existing conditions (Table 6C.1-12), in agreement with the examination of Old and Middle River flows discussed above.

**Table 6C.1-12. Entrainment of Particles at the South Delta Export Facilities and North Bay Aqueduct from Delta Simulation Model II Particle Tracking Modeling, Weighted by Delta Smelt Larval/Early Juvenile Distribution**

| Water Year Type | March | | April | | May | | June | |
|---|---|---|---|---|---|---|---|---|
| | EC | Proposed Action | EC | Proposed Action | EC | Proposed Action | EC | Proposed Action |
| Wet | 4.22 | 4.27 (1%) | 3.82 | 3.55 (-7%) | 7.82 | 8.52 (9%) | 16.40 | 16.54 (1%) |
| Above normal | 6.90 | 6.97 (1%) | 6.44 | 6.58 (2%) | 13.03 | 14.12 (8%) | 27.00 | 26.80 (-1%) |
| Below normal | 18.21 | 18.43 (1%) | 9.55 | 9.45 (-1%) | 10.26 | 10.80 (5%) | 27.61 | 27.71 (0%) |
| Dry | 16.90 | 16.98 (1%) | 9.19 | 9.23 (0%) | 11.91 | 11.92 (0%) | 27.91 | 27.87 (0%) |
| Critically dry | 18.44 | 18.10 (-2%) | 8.13 | 8.33 (2%) | 12.73 | 12.50 (-2%) | 13.13 | 13.29 (1%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

## 6C.1.1.4 Habitat Effects

### Sediment Entrainment

The Interagency Ecological Program Management, Analysis, and Synthesis Team (IEP MAST) (2015:87–89) conceptual model identifies predation risk as a habitat attribute affecting delta smelt survival; flows interact with erodible sediment supply to affect turbidity and, in general, greater turbidity is thought to lower the risk of predation on delta smelt (Bennett 2005; Moyle et al. 2016). Sandy sediment is also an important substrate for spawning (Lindberg et al. 2020). Large amounts of sediment enter the Delta from winter and spring storm runoff, with resuspension caused by tidal and wind action (Schoellhamer et al. 2014; Bever et al. 2016). Wright and Schoellhamer (2005) found that approximately 66% of the sediment entered the Delta from the Sacramento River. The

north Delta intakes would entrain sediment, with annual mean entrainment estimates of this suspended sediment otherwise destined to move downstream in the Sacramento River ranging from 3% to 7% and an overall total during the 1922–2015 CalSim modeling period of 5% (Table 6C.1-13).[3] A recent analysis examining future climate scenarios predicts significant increases in large flow events and sediment loading to the Delta from the Sacramento River over the next century for two representative greenhouse gas concentration pathways, which may increase turbidity (Stern et al. 2020). The magnitude of the projected increases in sediment loading relative to existing conditions (+33%–38% by 2040–2069; +39%–69% by 2070–2099) is appreciably greater than the estimated reduction in sediment loading as a result of north Delta intake entrainment. In addition, the increase in sediment would have the potential to largely reverse the ~50% reduction in sediment loading from the Sacramento River estimated to have occurred during the second half of the twentieth century (Wright and Schoellhamer 2004). The relatively small percentage of sediment entrained by the north Delta intakes indicates that the proposed action would likely have limited impacts on suspended sediment and turbidity for delta smelt. It is unlikely that water, and sediment, diversion would produce any immediate change in turbidity (or the concentration of suspended sediment), at or downstream of the intakes. Rather, the potential for an effect would be tied to the decrease in sediment load, which could be deposited and resuspended in areas delta smelt inhabit downstream of the intakes. Uncertainty in the potential for impacts, particularly in light of projected future trends in suspended sediment (Stern et al. 2020), would be addressed through AMM-15; the Sediment monitoring, Modeling, and Reintroduction Adaptive Management program (for more details see Appendix 3A, *General Avoidance and Minimization Measures*).

**Table 6C.1-13. Mean Annual Percentage of Suspended Sediment in the Sacramento River at Freeport Entrained by the North Delta Diversions by Water Year Type and Total Percentage Entrained over Full CalSim Modeling Period (Water Years 1922–2015)**

| Water Year Type | Proposed Action |
|---|---|
| Wet | 4% |
| Above normal | 7% |
| Below normal | 7% |
| Dry | 5% |
| Critically dry | 3% |
| Total | 5% |

## Food Availability

The IEP MAST (2015:88) conceptual model suggests that Delta exports of water could affect food availability for larval delta smelt. The mechanism for the impacts of Delta exports on food availability could be related to the hydrodynamic impacts of Delta outflow because a positive correlation exists between the density of the important delta smelt larval and juvenile zooplankton prey *Eurytemora affinis* in the LSZ and Delta outflow (as indexed by X2) during the spring (March–May; Kimmerer 2002a; Greenwood 2018). Other analyses have also found positive correlations between outflow and delta smelt calanoid copepod prey in spring (Hamilton et al. 2020), whereas

[3] Estimates of suspended-sediment entrainment by the north Delta intakes were made by multiplying historical median monthly suspended-sediment concentration in the Sacramento River at Freeport (Delta Conveyance Design and Construction Authority 2022b Figure 3) by the CalSim-modeled monthly mean Sacramento River flow and north Delta intake diversions.

some other analyses have not found statistically significant relationships between spring outflow and biomass per unit of sampling effort for other delta smelt prey (*Limnoithona tetraspina* and *Pseudodiaptomus forbesi*; California Department of Water Resources and Bureau of Reclamation 2021:2-11). To assess the magnitude of potential differences in *E. affinis* availability for larval/juvenile delta smelt, a regression of March–May X2 versus *E. affinis* density in the LSZ was used to compare existing conditions and the proposed action (see the methods description provided in Appendix 5D, Section 5D.11, *Eurytemora affinis–X2 Analysis*). This analysis suggested that the difference in *E. affinis* density in the LSZ between the proposed action and existing conditions would be small (1%–3%) (Table 6C.1-14). Such differences are much less than the range of the prediction intervals from this statistical model, which span several orders of magnitude (Table 5D.11 1) for results by individual year, including prediction intervals). This indicates very little potential for negative effects on delta smelt from the proposed action relative to existing conditions with respect to *E. affinis* food availability.

**Table 6C.1-14. Mean *Eurytemora affinis* Density (adults per cubic meter) in the Low Salinity Zone by Water Year Type**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 185 | 183 (-1%) |
| Above normal | 159 | 155 (-3%) |
| Below normal | 121 | 118 (-3%) |
| Dry | 102 | 100 (-2%) |
| Critically dry | 79 | 78 (-1%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent. This table only includes mean responses and does not consider model uncertainty. Results are not predictions of actual values and are intended only to compare the proposed action.
EC = existing conditions.

In addition to the importance of food availability in spring as discussed above, the IEP MAST (2015:88–89) conceptual model describes food availability and quality as key components of the transition probability of juvenile and subadult delta smelt to subsequent life stages through growth and survival of individuals. Analyses have shown that summer and fall (July–September) Delta outflow correlated positively with the subsidy of the delta smelt zooplankton prey *Pseudodiaptomus forbesi* to the LSZ from the freshwater Delta (Kimmerer et al. 2018a). Other analyses have found largely nonlinear relationships between outflow and calanoid copepod biomass in the Delta and Suisun Marsh/Bay, with potential for negative effects of greater September/October outflow on delta smelt prey at several locations (Hamilton et al. 2020). Polansky et al. (2021) found that delta smelt postlarval survival during June–August (further shown by Smith et al. 2021) correlated positively with prey abundance[4] and that prey abundance highly positively correlated with Delta outflow during these months. Detailed examination of a fall flow action in 2017 did not provide evidence for an increase in delta smelt prey with increased outflow resulting in X2 farther downstream (Schultz et al. 2019). The modeling results generally show similar or less Delta outflow under the proposed action than existing conditions during June–October (Table 6C.1-15 through

[4] As illustrated by plots of the predicted relationship with associated credible intervals from statistical modeling (Polansky et al. 2021:Figure C.1), there is appreciable statistical uncertainty in the relationship, which is based on annual mean values across water years. Life cycle modeling using the model developed by Smith et al. (2021) is presented in Section 6C.1.1.5, *Life Cycle Modeling*.

Table 6C.1-19) as a result of less outflow needed for meeting Delta salinity requirements under the proposed action. Given the range of relationships suggested by the available studies discussed above (Kimmerer et al. 2018b; Schultz et al. 2019; Hamilton et al. 2020), the extent to which differences in Delta outflow would result in changes in delta smelt prey is uncertain, but may be small relative to other factors, such as the high rate of foodweb material grazing by clams in the LSZ (Kayfetz and Kimmerer 2017; Kimmerer et al. 2019). In addition, an appreciable portion of delta smelt occur upstream of the LSZ (i.e., an average of 23% [range 2%–47%] during the 2005–2014 period [Bush 2017]) and would not experience any effects on prey availability in the LSZ. Recent analyses by California Department of Water Resources 2020:4-149–4-151) suggest that lower San Joaquin River flow (QWEST) may be an indicator of *P. forbesi* spatial subsidy potential, given entrainment of *P. forbesi* (Kimmerer et al. 2019). QWEST flow, particularly the frequency of positive QWEST flow, generally is similar between existing conditions and the proposed action (Table 6C.1-20 through Table 6C.1-24), indicating that *P. forbesi* prey availability based on this hypothesized mechanism would be similar between existing conditions and the proposed action.

**Table 6C.1-15. Mean Delta Outflow (cubic feet per second) by Water Year Type, June**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 22,071 | 20,750 (-6%) |
| Above normal | 14,252 | 12,245 (-14%) |
| Below normal | 6,679 | 6,527 (-2%) |
| Dry | 6,112 | 6,166 (1%) |
| Critically dry | 5,462 | 5,462 (0%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

**Table 6C.1-16. Mean Delta Outflow (cubic feet per second) by Water Year Type, July**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 9,821 | 9,423 (-4%) |
| Above normal | 8,038 | 7,230 (-10%) |
| Below normal | 6,397 | 5,520 (-14%) |
| Dry | 4,273 | 4,218 (-1%) |
| Critically dry | 3,566 | 3,544 (-1%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

### Table 6C.1-17. Mean Delta Outflow (cubic feet per second) by Water Year Type, August

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 5,696 | 5,546 (-3%) |
| Above normal | 5,246 | 5,268 (0%) |
| Below normal | 3,391 | 3,402 (0%) |
| Dry | 3,139 | 3,144 (0%) |
| Critically dry | 2,573 | 2,573 (0%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

### Table 6C.1-18. Mean Delta Outflow (cubic feet per second) by Water Year Type, September

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 10,347 | 10,181 (-2%) |
| Above normal | 9,682 | 9,740 (1%) |
| Below normal | 3,515 | 3,032 (-14%) |
| Dry | 2,641 | 2,477 (-6%) |
| Critically dry | 2,608 | 2,609 (0%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

### Table 6C.1-19. Mean Delta Outflow (cubic feet per second) by Water Year Type, October

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 8,004 | 8,034 (0%) |
| Above normal | 6,084 | 6,167 (1%) |
| Below normal | 5,981 | 5,849 (-2%) |
| Dry | 5,168 | 5,209 (1%) |
| Critically dry | 4,068 | 3,974 (-2%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

### Table 6C.1-20. Percentage of Years with Positive QWEST Flow, July–October

| Month | EC | Proposed Action |
|---|---|---|
| July | 28% | 31% (12%) |
| August | 29% | 26% (-11%) |
| September | 45% | 49% (10%) |
| October | 47% | 48% (2%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions (these are percentage point differences as opposed to absolute percentage differences). Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions; QWEST = lower San Joaquin River flow.

### Table 6C.1-21. Mean QWEST (cubic feet per second) by Water Year Type, July

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 227 | 491 (116%) |
| Above normal | -1,903 | -919 (52%) |
| Below normal | -2,779 | -2,090 (25%) |
| Dry | -2,660 | -2,579 (3%) |
| Critically dry | 1,240 | 1,222 (-1%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions; QWEST = lower San Joaquin River flow.

### Table 6C.1-22. Mean QWEST (cubic feet per second) by Water Year Type, August

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | -1,656 | -1,568 (5%) |
| Above normal | -2,926 | -2,516 (14%) |
| Below normal | -3,568 | -3,206 (10%) |
| Dry | -408 | -549 (-34%) |
| Critically dry | 1,378 | 1,278 (-7%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions; QWEST = lower San Joaquin River flow.

### Table 6C.1-23. Mean QWEST (cubic feet per second) by Water Year Type, September

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 729 | 784 (8%) |
| Above normal | 972 | 1,155 (19%) |
| Below normal | -2,511 | -1,670 (33%) |
| Dry | -372 | -209 (44%) |
| Critically dry | 447 | 542 (21%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions; QWEST = lower San Joaquin River flow.

### Table 6C.1-24. Mean QWEST (cubic feet per second) by Water Year Type, October

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | -148 | -255 (-72%) |
| Above normal | 814 | 626 (-23%) |
| Below normal | -815 | -377 (54%) |
| Dry | -88 | -75 (14%) |
| Critically dry | -39 | 43 (211%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions; QWEST = lower San Joaquin River flow.

In situ production of phytoplankton carbon within the Delta is several times greater than inputs from freshwater inflow (Jassby et al. 2002) and is the dominant supply to the planktonic foodweb that includes delta smelt (Sobczak et al. 2002). Phytoplankton and zooplankton are the base of the foodweb supporting delta smelt. As highlighted by Arthur et al. (1996), Jassby and Cloern (2000), Jassby et al. (2002), and USFWS (2008:228), SWP and Central Valley Project water exports directly entrain phytoplankton and zooplankton. Recent analyses suggest that the combination of clam grazing and south Delta exports have negatively affected pelagic productivity in the San Francisco Estuary (Hammock et al. 2019)[5]. Entrainment of phytoplankton and zooplankton by the south Delta export facilities generally would be somewhat less under the proposed action, but the north Delta intakes would add a new source of loss along the Sacramento River under the proposed action. The impact of this was examined using an assessment of phytoplankton carbon entrained, based on chlorophyll, a concentration data for Hood (representing the load of entrained phytoplankton), in relation to the biomass of phytoplankton in the Delta (taken from Antioch chlorophylla data, multiplied up to the volume of the Delta). The methods for this analysis are presented in Appendix 5D, Section 5D.12, *Phytoplankton Carbon Entrainment by North Delta Diversions*. This analysis essentially is an approximation of potential entrainment of phytoplankton carbon load that could be entrained by the north Delta intakes. Factors that could offset any potential effects to delta smelt include the *in situ* productivity of phytoplankton carbon within the Delta, which could be relatively large, and reduced entrainment of phytoplankton carbon by the south Delta export facilities under the proposed action. In addition, per the analysis by Hammock et al. (2019), increases in hydraulic residence time could affect phytoplankton production. These factors are discussed qualitatively below.

The analysis of potential north Delta intake entrainment of phytoplankton carbon estimated that the proposed intake could entrain between 0% and just over 7% of the Delta standing stock of phytoplankton carbon; the upper estimates are during December under the assumption of a minimum Delta phytoplankton carbon stock size (Table 6C.1-25). Overall, the estimates of potential phytoplankton carbon entrained were low, and on the basis of the 95th percentiles, entrainment would rarely be more than 5% of the standing stock under the proposed action. This low level of entrainment of phytoplankton carbon entering the Delta, coupled with observations that in situ production of phytoplankton carbon within the Delta is several times greater than inputs from freshwater inflow (Jassby et al. 2002) and is the dominant supply to the planktonic foodweb that includes delta smelt (Sobczak et al. 2002), suggests that the potential for effects on delta smelt would be very limited, particularly given the larger scale of losses to the foodweb including clams (Jassby et al. 2002). In addition, less south Delta exports under the proposed action would allow a greater proportion of San Joaquin River water to reach the western Delta and Suisun Bay, which could result in an increase in productivity because San Joaquin River water entering the Delta has a much higher load of organic matter than the Sacramento River (Jassby and Cloern 2000), but this contribution likely would be small because San Joaquin River water generally comprises a very small proportion of the water in the portions of the Delta where delta smelt are more likely to

[5] Note that Hammock et al.'s (2019b) analysis simulated a scenario of historical water operations, including south Delta exports compared to scenarios of historical water operations and excluding south Delta exports or limiting south Delta exports to very low levels observed during the 1977 drought; however, the analysis did not account for other changes in water operations that would be associated with cessation or limitation of south Delta exports, in particular reductions in Delta inflow given ceased or limited demand for south Delta exports. Note also that Hammock et al. (2019b) focused more residence time effects as opposed to direct entrainment.

occur.[6] Jassby et al. (2002) estimated that on average during spring through fall, the Delta produces 44 metric tons per day of phytoplankton carbon and another 12 metric tons per day flows into the Delta from its tributaries. Of that 56 tons per day, the south Delta export facilities remove approximately 8 metric tons per day, or about 14% (Jassby et al. 2002). However, as noted above in relation to QWEST flows, differences between the proposed action and existing conditions would be small.

**Table 6C.1-25. Estimated 5th, 50th, and 95th Percentile Entrainment of Phytoplankton Carbon at the North Delta Diversions Based on Minimum and Maximum Delta Phytoplankton Carbon Stock Size, Proposed Action**

| Month | Min. Stock Size: 5th Percentile Entrainment | Min. Stock Size: 50th Percentile Entrainment | Min. Stock Size: 95th Percentile Entrainment | Max. Stock Size: 5th Percentile Entrainment | Max. Stock Size: 50th Percentile Entrainment | Max. Stock Size: 95th Percentile Entrainment |
|---|---|---|---|---|---|---|
| January | 0.0% | 0.7% | 3.9% | 0.0% | 0.3% | 1.7% |
| February | 0.0% | 0.6% | 3.3% | 0.0% | 0.3% | 1.9% |
| March | 0.0% | 0.5% | 2.4% | 0.0% | 0.2% | 1.1% |
| April | 0.0% | 0.0% | 1.6% | 0.0% | 0.0% | 0.5% |
| May | 0.0% | 0.0% | 1.9% | 0.0% | 0.0% | 0.4% |
| June | 0.0% | 0.0% | 1.8% | 0.0% | 0.0% | 0.8% |
| July | 0.0% | 0.0% | 1.6% | 0.0% | 0.0% | 0.7% |
| August | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% | 0.2% |
| September | 0.0% | 0.0% | 1.3% | 0.0% | 0.0% | 0.4% |
| October | 0.0% | 0.0% | 0.9% | 0.0% | 0.0% | 0.2% |
| November | 0.0% | 0.0% | 1.8% | 0.0% | 0.0% | 0.7% |
| December | 0.0% | 0.9% | 7.4% | 0.0% | 0.2% | 1.4% |

Note: Max. and min. stock size = maximum and minimum stock size based on multiplying observed maximum and minimum phytoplankton carbon density at Antioch by the volume of the Delta. Entrainment percentiles represent the range of entrainment based on modeled north Delta intake diversion rates (Appendix 5D, Section 5D.12, *Phytoplankton Carbon Entrainment by North Delta Diversions*).

As previously noted, increases in residence time have been correlated with increases in phytoplankton, although this relationship may vary depending on the amount of Sacramento River flow (Hammock et al. 2019b). Lower Sacramento River flow downstream of the north Delta intakes under the proposed action would be expected to increase residence time relative to existing conditions, although the extent to which this might translate to increases in phytoplankton is uncertain. As shown in the *Delta Conveyance Project Final Environmental Impact Report* (Final EIR) Chapter 9, *Water Quality*, modeled increases in residence time (Table 9-47 in Chapter 9) were not determined to result in significant increases in cyanobacterial harmful algal blooms (CHABs) (California Department of Water Resources 2023).

[6] For example, the Delta Simulation Model II fingerprinting analysis used in the *Selenium* analysis described below had water year-type means of San Joaquin River percentage of water at Chipps Island ranging from a minimum of 0.02% to a maximum of 7.5% for existing conditions; the proposed action had minima of 0.03% and maxima of 7.8% during these periods, indicating that San Joaquin River water would be limited under existing conditions and the proposed action.

## Summer–Fall Low-Salinity Habitat Extent and Related Factors

The IEP MAST (2015) conceptual model posits that delta smelt abundance, survival, and growth are affected by the size and location of the LSZ during fall, with IEP MAST (2015:142) concluding: "The limited amount of available data provides some evidence in support of this hypothesis, but additional years of data and investigations are needed." Others have found that LSZ habitat may not be a good predictor of delta smelt survival (ICF International 2017), with the recent life cycle modeling effort by Polansky et al. (2021 finding that the area of low-salinity habitat was not among the predictors with highest evidence for relationships to trends in delta smelt population-abundance indices. As described by DWR (2020:4-156), an additional argument in support of summer–fall habitat actions potentially being of importance to delta smelt is that having a broader distribution provides bet-hedging against the effects of environmental stressors. For example, if a species' distribution is too constrained, the risk of a population not being able to persist is elevated compared to a broader distribution (Thorson et al. 2014). Hence, habitat actions that help support a broad distribution can have long-term population benefits. This logic is somewhat different from the goal of maximizing physical habitat area. The issue of the area of low-salinity habitat extent or related parameters, such as Delta outflow, and X2 and their relationship to delta smelt population dynamics is controversial and has been investigated by a number of authors (e.g., Feyrer et al. 2011; Miller et al. 2012; Manly et al. 2015; Feyrer et al. 2015; Murphy and Weiland 2019). Hamilton and Murphy's (2018) review of prior studies noted that freshwater flow had not been found to have a direct association with delta smelt abundance. However, the recent state-space nonlinear modeling investigation by Polansky et al. (2021) found relatively strong statistical support for June–August Delta outflow being positively correlated to June–August survival (further shown by Smith et al. 2021) and September–November X2 being negatively correlated to the subsequent year's recruitment (adult to larval survival)[7]. Life cycle modeling using the model developed by Smith et al. (2021) is presented in Section 6C.1.1.5, *Life Cycle Modeling*.

Existing conditions and the proposed action include structured decision-making to implement the Delta Smelt Summer–Fall Habitat Action (i.e., an assumed continuation of the existing program), which is intended to improve delta smelt food supply and habitat, thereby contributing to the recruitment, growth, and survival of the species. The potential effects of the Summer–Fall Habitat Action on delta smelt were recently analyzed by DWR (2020:5-123–5-125), which found that the extent of low-salinity habitat for delta smelt would not be lower under the adopted project than under the then existing condition (i.e., management to the 2008 USFWS BiOp [National Marine Fisheries Service 2008]). Continuation of the Delta Smelt Summer–Fall Habitat Action under the proposed action would continue the provision of low-salinity habitat to a similar extent as existing conditions. An additional indicator of delta smelt summer–fall habitat is provided by the frequency of occurrence of X2 less than 85 kilometers, indicating that low-salinity water (i.e., 0.5 to 6 parts per thousand salinity; Delta Modeling Associates 2014) would overlap larger habitat areas in Honker Bay (U.S. Fish and Wildlife Service 2017:307–317). CalSim modeling indicates that the frequency of occurrence of low-salinity water in Honker Bay under the proposed action generally would be similar to existing conditions, with minor (2%–5%) reductions in October–December (Table 6C.1-26) caused by less outflow needed for meeting Delta salinity requirements under the proposed action.

[7] As illustrated by plots of the predicted relationship with associated credible intervals from statistical modeling (Polansky et al. 2021:Figures 1 and C.1), there is appreciable statistical uncertainty in the relationships, which are based on annual mean values across water years.

**Table 6C.1-26. Percentage of Years with X2 Less than 85 kilometers (Low Salinity Zone within Honker Bay), June–December**

| Month | EC | Proposed Action |
|---|---|---|
| June | 94% | 94% (0%) |
| July | 77% | 76% (-1%) |
| August | 45% | 45% (0%) |
| September | 45% | 45% (0%) |
| October | 49% | 48% (-2%) |
| November | 41% | 39% (-5%) |
| December | 50% | 49% (-2%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions (these are percentage point differences as opposed to absolute percentage differences). Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

As previously described, the recent investigation by Polansky et al. (2021) found relatively strong statistical support for June–August Delta outflow being positively correlated to June–August survival and September–November X2 being negatively correlated to the subsequent year's recruitment (adult to larval survival)[8]. As previously described in the analysis of food-availability effects, Delta outflow tends to be similar or lower under the proposed action compared to existing conditions (Table 6C.1-15, Table 6C.1-16, and Table 6C.1-17) as a result of less outflow needed for meeting Delta salinity requirements under the proposed action. Mean September–November X2 under the proposed action is similar to or up to 0.8 mile (1.3 kilometers) upstream of the proposed action relative to existing conditions (Table 6C.1-27), again as a result of less outflow needed for meeting Delta salinity requirements under the proposed action.

**Table 6C.1-27. Mean September–November X2 By Water Year Type**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 79.0 | 79.3 (0.4) |
| Above normal | 80.5 | 80.6 (0.1) |
| Below normal | 87.6 | 88.3 (0.8) |
| Dry | 91.1 | 91.4 (0.3) |
| Critically dry | 93.1 | 93.2 (0.1) |

Note: Values in parentheses indicate differences of the proposed action compared to existing conditions.
EC = existing conditions.

## Predation

As previously noted above in the discussion of sediment entrainment, the IEP MAST conceptual model (Interagency Ecological Program Management, Analysis, and Synthesis Team 2015:87–89) suggests that the probability of delta smelt surviving to subsequent life stages is influenced by predation risk, which may involve different factors, such as turbidity, water temperature, and predators. With respect to turbidity, as discussed above, although the north Delta intakes would

[8] As previously noted and as illustrated by plots of the predicted relationship with associated credible intervals from statistical modeling (Polansky et al. 2021:Figures 1 and C.1), there is appreciable statistical uncertainty in the relationships, which are based on annual mean values across water years.

entrain sediment, effects may be limited by future increases in sediment entering the Delta relative to existing conditions. Water operations, such as reservoir releases or diversions, have limited potential to affect water temperature in the Delta (Kimmerer 2004; Wagner et al. 2011); see Table 6C.1-28, Table 6C.1-29, and Table 6C.1-30), thereby resulting in differences in water operations between existing conditions and water temperature having limited potential to affect predation risk as a result of temperature effects.

**Table 6C.1-28. Mean Water Temperature (degrees Celsius) by Water Year Type and Month from Delta Simulation Model II-QUAL Modeling, Sacramento River Immediately Downstream of Intake C**

| Water Year Type | Month | EC | Proposed Action |
|---|---|---|---|
| Wet | Jan | 9.4 | 9.4 (0.0) |
| Wet | Feb | 10.8 | 10.8 (0.0) |
| Wet | Mar | 12.6 | 12.6 (0.0) |
| Wet | Apr | 14.7 | 14.7 (0.0) |
| Wet | May | 17.7 | 17.7 (0.0) |
| Wet | Jun | 19.5 | 19.5 (0.0) |
| Wet | Jul | 20.9 | 20.9 (0.0) |
| Wet | Aug | 20.7 | 20.7 (0.0) |
| Wet | Sep | 19.6 | 19.6 (0.0) |
| Wet | Oct | 16.5 | 16.5 (0.0) |
| Wet | Nov | 12.7 | 12.7 (0.0) |
| Wet | Dec | 10.0 | 10.0 (0.0) |
| Above normal | Jan | 9.4 | 9.4 (0.0) |
| Above normal | Feb | 10.6 | 10.6 (0.0) |
| Above normal | Mar | 12.8 | 12.9 (0.0) |
| Above normal | Apr | 15.0 | 15.0 (0.0) |
| Above normal | May | 17.8 | 17.8 (0.0) |
| Above normal | Jun | 19.6 | 19.6 (0.0) |
| Above normal | Jul | 21.2 | 21.2 (0.0) |
| Above normal | Aug | 20.7 | 20.7 (0.0) |
| Above normal | Sep | 19.6 | 19.6 (0.0) |
| Above normal | Oct | 16.8 | 16.8 (0.0) |
| Above normal | Nov | 12.1 | 12.1 (0.0) |
| Above normal | Dec | 9.4 | 9.4 (0.0) |
| Below normal | Jan | 8.7 | 8.7 (0.0) |
| Below normal | Feb | 10.3 | 10.3 (0.0) |
| Below normal | Mar | 12.5 | 12.5 (0.0) |
| Below normal | Apr | 15.1 | 15.1 (0.0) |
| Below normal | May | 17.3 | 17.3 (0.0) |
| Below normal | Jun | 19.7 | 19.7 (0.0) |
| Below normal | Jul | 21.0 | 21.0 (0.0) |
| Below normal | Aug | 20.5 | 20.5 (0.0) |

| Water Year Type | Month | EC | Proposed Action |
|---|---|---|---|
| Below normal | Sep | 19.3 | 19.3 (0.0) |
| Below normal | Oct | 16.6 | 16.6 (0.0) |
| Below normal | Nov | 12.4 | 12.4 (0.0) |
| Below normal | Dec | 9.2 | 9.2 (0.0) |
| Dry | Jan | 8.4 | 8.4 (0.0) |
| Dry | Feb | 10.4 | 10.4 (0.0) |
| Dry | Mar | 12.7 | 12.7 (0.0) |
| Dry | Apr | 15.0 | 15.0 (0.0) |
| Dry | May | 17.3 | 17.3 (0.0) |
| Dry | Jun | 19.7 | 19.7 (0.0) |
| Dry | Jul | 20.7 | 20.7 (0.0) |
| Dry | Aug | 20.3 | 20.3 (0.0) |
| Dry | Sep | 19.1 | 19.1 (0.0) |
| Dry | Oct | 16.2 | 16.2 (0.0) |
| Dry | Nov | 12.2 | 12.2 (0.0) |
| Dry | Dec | 9.2 | 9.1 (0.0) |
| Critically dry | Jan | 8.7 | 8.7 (0.0) |
| Critically dry | Feb | 10.8 | 10.8 (0.0) |
| Critically dry | Mar | 13.1 | 13.1 (0.0) |
| Critically dry | Apr | 14.9 | 14.9 (0.0) |
| Critically dry | May | 17.1 | 17.1 (0.0) |
| Critically dry | Jun | 19.3 | 19.3 (0.0) |
| Critically dry | Jul | 21.0 | 21.0 (0.0) |
| Critically dry | Aug | 20.3 | 20.3 (0.0) |
| Critically dry | Sep | 19.2 | 19.2 (0.0) |
| Critically dry | Oct | 16.7 | 16.7 (0.0) |
| Critically dry | Nov | 12.6 | 12.6 (0.0) |
| Critically dry | Dec | 9.0 | 9.0 (0.0) |

Note: Values in parentheses indicate absolute differences of the proposed action compared to existing conditions.
EC = existing conditions.

### Table 6C.1-29. Mean Water Temperature (degrees Celsius) by Water Year Type and Month from Delta Simulation Model II-QUAL Modeling, Sacramento River at Rio Vista

| Water Year Type | Month | EC | Proposed Action |
|---|---|---|---|
| Wet | Jan | 9.3 | 9.2 (0.0) |
| Wet | Feb | 10.9 | 10.9 (0.0) |
| Wet | Mar | 12.8 | 12.8 (0.0) |
| Wet | Apr | 14.7 | 14.7 (0.0) |
| Wet | May | 17.4 | 17.4 (0.0) |
| Wet | Jun | 19.1 | 19.1 (0.0) |
| Wet | Jul | 20.8 | 20.8 (0.0) |
| Wet | Aug | 20.5 | 20.5 (0.0) |

| Water Year Type | Month | EC | Proposed Action |
|---|---|---|---|
| Wet | Sep | 19.2 | 19.2 (0.0) |
| Wet | Oct | 16.1 | 16.1 (0.0) |
| Wet | Nov | 12.8 | 12.8 (0.0) |
| Wet | Dec | 9.8 | 9.8 (0.0) |
| Above normal | Jan | 9.1 | 9.1 (0.0) |
| Above normal | Feb | 10.6 | 10.6 (0.0) |
| Above normal | Mar | 13.1 | 13.1 (0.0) |
| Above normal | Apr | 14.9 | 14.9 (0.0) |
| Above normal | May | 17.4 | 17.4 (0.0) |
| Above normal | Jun | 19.1 | 19.1 (0.0) |
| Above normal | Jul | 21.2 | 21.2 (0.0) |
| Above normal | Aug | 20.5 | 20.5 (0.0) |
| Above normal | Sep | 19.2 | 19.2 (0.0) |
| Above normal | Oct | 16.6 | 16.7 (0.0) |
| Above normal | Nov | 12.3 | 12.3 (0.0) |
| Above normal | Dec | 9.0 | 9.0 (0.0) |
| Below normal | Jan | 8.1 | 8.1 (0.0) |
| Below normal | Feb | 10.2 | 10.2 (0.0) |
| Below normal | Mar | 12.7 | 12.7 (0.0) |
| Below normal | Apr | 14.8 | 14.8 (0.0) |
| Below normal | May | 16.6 | 16.6 (0.0) |
| Below normal | Jun | 19.2 | 19.2 (0.0) |
| Below normal | Jul | 20.9 | 20.9 (0.0) |
| Below normal | Aug | 20.3 | 20.2 (0.0) |
| Below normal | Sep | 19.0 | 18.9 (0.0) |
| Below normal | Oct | 16.3 | 16.3 (0.0) |
| Below normal | Nov | 12.6 | 12.6 (0.0) |
| Below normal | Dec | 8.9 | 8.8 (0.0) |
| Dry | Jan | 7.6 | 7.6 (0.0) |
| Dry | Feb | 10.2 | 10.2 (0.0) |
| Dry | Mar | 12.9 | 12.9 (0.0) |
| Dry | Apr | 14.8 | 14.8 (0.0) |
| Dry | May | 16.6 | 16.6 (0.0) |
| Dry | Jun | 19.1 | 19.1 (0.0) |
| Dry | Jul | 20.4 | 20.4 (0.0) |
| Dry | Aug | 19.9 | 19.9 (0.0) |
| Dry | Sep | 18.7 | 18.6 (0.0) |
| Dry | Oct | 15.8 | 15.8 (0.0) |
| Dry | Nov | 12.4 | 12.4 (0.0) |
| Dry | Dec | 8.8 | 8.8 (0.0) |
| Critically dry | Jan | 8.1 | 8.0 (0.0) |

| Water Year Type | Month | EC | Proposed Action |
|---|---|---|---|
| Critically dry | Feb | 10.7 | 10.7 (0.0) |
| Critically dry | Mar | 13.5 | 13.5 (0.0) |
| Critically dry | Apr | 14.5 | 14.5 (0.0) |
| Critically dry | May | 16.5 | 16.5 (0.0) |
| Critically dry | Jun | 18.8 | 18.8 (0.0) |
| Critically dry | Jul | 21.2 | 21.2 (0.0) |
| Critically dry | Aug | 20.5 | 20.5 (0.0) |
| Critically dry | Sep | 19.2 | 19.2 (0.0) |
| Critically dry | Oct | 16.6 | 16.6 (0.0) |
| Critically dry | Nov | 12.9 | 12.9 (0.0) |
| Critically dry | Dec | 8.6 | 8.6 (0.0) |

Note: Values in parentheses indicate absolute differences of the proposed action compared to existing conditions.
EC = existing conditions.

### Table 6C.1-30. Mean Water Temperature (degrees Celsius) by Water Year Type and Month from Delta Simulation Model II-QUAL Modeling, San Joaquin River at Jersey Point

| Water Year Type | Month | EC | Proposed Action |
|---|---|---|---|
| Wet | Jan | 8.9 | 8.9 (0.0) |
| Wet | Feb | 10.9 | 10.9 (0.0) |
| Wet | Mar | 13.1 | 13.1 (0.0) |
| Wet | Apr | 14.8 | 14.8 (0.0) |
| Wet | May | 17.2 | 17.1 (0.0) |
| Wet | Jun | 18.9 | 18.9 (0.0) |
| Wet | Jul | 20.6 | 20.6 (0.0) |
| Wet | Aug | 20.5 | 20.5 (0.0) |
| Wet | Sep | 19.0 | 19.0 (0.0) |
| Wet | Oct | 16.0 | 16.0 (0.0) |
| Wet | Nov | 13.1 | 13.1 (0.0) |
| Wet | Dec | 9.8 | 9.8 (0.0) |
| Above normal | Jan | 8.7 | 8.7 (0.0) |
| Above normal | Feb | 10.5 | 10.4 (0.0) |
| Above normal | Mar | 13.4 | 13.5 (0.0) |
| Above normal | Apr | 14.8 | 14.8 (0.0) |
| Above normal | May | 17.0 | 17.0 (0.0) |
| Above normal | Jun | 18.8 | 18.8 (0.0) |
| Above normal | Jul | 21.0 | 21.0 (0.0) |
| Above normal | Aug | 20.5 | 20.5 (0.0) |
| Above normal | Sep | 18.9 | 18.9 (0.0) |
| Above normal | Oct | 16.7 | 16.7 (0.0) |
| Above normal | Nov | 12.7 | 12.7 (0.0) |
| Above normal | Dec | 8.9 | 8.9 (0.0) |
| Below normal | Jan | 7.6 | 7.6 (0.0) |

| Water Year Type | Month | EC | Proposed Action |
|---|---|---|---|
| Below normal | Feb | 9.7 | 9.7 (0.0) |
| Below normal | Mar | 12.8 | 12.8 (0.0) |
| Below normal | Apr | 14.6 | 14.6 (0.0) |
| Below normal | May | 16.3 | 16.3 (0.0) |
| Below normal | Jun | 18.9 | 18.9 (0.0) |
| Below normal | Jul | 20.8 | 20.8 (0.0) |
| Below normal | Aug | 20.1 | 20.1 (0.0) |
| Below normal | Sep | 18.9 | 18.9 (0.0) |
| Below normal | Oct | 16.3 | 16.3 (0.0) |
| Below normal | Nov | 12.9 | 12.9 (0.0) |
| Below normal | Dec | 8.9 | 8.9 (0.0) |
| Dry | Jan | 7.0 | 7.0 (0.0) |
| Dry | Feb | 9.8 | 9.8 (0.0) |
| Dry | Mar | 13.0 | 13.0 (0.0) |
| Dry | Apr | 14.8 | 14.8 (0.0) |
| Dry | May | 16.3 | 16.3 (0.0) |
| Dry | Jun | 18.9 | 18.9 (0.0) |
| Dry | Jul | 20.3 | 20.3 (0.0) |
| Dry | Aug | 19.9 | 19.9 (0.0) |
| Dry | Sep | 18.6 | 18.6 (0.0) |
| Dry | Oct | 15.8 | 15.8 (0.0) |
| Dry | Nov | 12.8 | 12.8 (0.0) |
| Dry | Dec | 8.9 | 8.9 (0.0) |
| Critically dry | Jan | 7.5 | 7.4 (0.0) |
| Critically dry | Feb | 10.2 | 10.2 (0.0) |
| Critically dry | Mar | 13.6 | 13.6 (0.0) |
| Critically dry | Apr | 14.5 | 14.5 (0.0) |
| Critically dry | May | 16.3 | 16.3 (0.0) |
| Critically dry | Jun | 18.6 | 18.6 (0.0) |
| Critically dry | Jul | 21.2 | 21.2 (0.0) |
| Critically dry | Aug | 20.6 | 20.6 (0.0) |
| Critically dry | Sep | 19.2 | 19.2 (0.0) |
| Critically dry | Oct | 16.6 | 16.6 (0.0) |
| Critically dry | Nov | 13.2 | 13.2 (0.0) |
| Critically dry | Dec | 8.7 | 8.7 (0.0) |

Note: Values in parentheses indicate absolute differences of the proposed action compared to existing conditions.
EC = existing conditions.

Detection of predation on delta smelt embryos and larvae is rare, which reduces the certainty of any conclusions for analyses of predation, although Mississippi silversides (*Menidia beryllina*) have been found with delta smelt DNA in their guts during the delta smelt larval period (Schreier et al. 2016). Two recent statistical examinations found support for Mississippi silverside abundance negatively affecting delta smelt survival and abundance (Hamilton and Murphy 2018; Polansky et al. 2021). For

this impact assessment, inference of potential effects from the proposed action on Mississippi silversides is made using multivariate relationships identified by Mahardja et al. (2016), which showed summer (June–September) Delta inflow and spring (March–May) south Delta exports had the strongest correlations with Mississippi silverside cohort strength. Both relationships were negative. Mahardja et al. (2016:12) cautioned that the relationships are not meant to imply causality, given that the mechanisms could not be identified, and that further investigation is merited. Nonetheless, March–May south Delta exports under the proposed action generally would be similar or slightly lower (in wet years) than under existing conditions (Table 6C.1-31), which could result in similar or slightly higher Mississippi silverside cohort strength than existing conditions, based on the results of Mahardja et al. (2016). June–September Delta inflow under the proposed action is similar to existing conditions (Table 6C.1-32). Differences in south Delta exports may have the potential to increase Mississippi silverside cohort strength under the proposed action relative to existing conditions in wet years, although, as noted above, there is appreciable uncertainty given that the relationship is correlative, rather than causal, and the differences in outflow are not very large; higher-flow conditions during sampling could have caused lower-capture efficiency or a shift of the species downstream, out of the sampling area, rather than lower population abundance, for example (Mahardja et al. 2016:12–13). If there were increases in Mississippi silversides as a result of changes in south Delta exports under the proposed action, this could also affect prey for delta smelt, given the overlap in prey between delta smelt and Mississippi silversides (e.g., *E. affinis*; Cohen and Bollens 2008).

**Table 6C.1-31. Mean South Delta Exports (cubic feet per second) by Water Year Type, March–May**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 7,104 | 6,831 (-4%) |
| Above normal | 5,309 | 5,277 (-1%) |
| Below normal | 4,229 | 4,274 (1%) |
| Dry | 3,673 | 3,675 (0%) |
| Critically dry | 3,024 | 2,986 (-1%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

**Table 6C.1-32. Mean Delta Inflow (cubic feet per second) by Water Year Type, June–September**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 25,915 | 25,809 (0%) |
| Above normal | 22,444 | 22,182 (-1%) |
| Below normal | 18,053 | 17,806 (-1%) |
| Dry | 14,306 | 14,372 (0%) |
| Critically dry | 10,061 | 10,112 (1%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent. The Sacramento River flow term in the Delta inflow calculation is downstream of the proposed intake.
EC = existing conditions.

### Cyanobacteria Harmful Algal Blooms

The IEP MAST (2015:88–89) conceptual model posits a linkage between various factors (nutrients, summer hydrology, and air temperature) and toxicity from CHABs to delta smelt and their prey. Analyses conducted for Impact WQ-14: *Effects on Cyanobacteria Harmful Algal Blooms Resulting from Facility Operations and Maintenance* in the Final EIR Chapter 9 showed that operational changes in CHABs are concluded to be less than significant and, therefore, would not significantly affect delta smelt or their prey (California Department of Water Resources 2023).

### Selenium

The increase in the proportion of San Joaquin River water entering the Delta because of fewer south Delta exports under the proposed action relative to existing conditions would be expected to increase the selenium concentration in Delta water because the San Joaquin River is relatively high in selenium (see additional discussion of selenium in the Final EIR Chapter 9 [California Department of Water Resources 2023]). The potential for this change to affect delta smelt through body deformities resulting from feeding on contaminated prey was investigated using the results of Delta Simulation Model II volumetric fingerprinting estimates, Delta water source selenium-input concentrations, conversions of water selenium concentration to particulate selenium concentration, and trophic transfer factors to estimate the concentration of selenium from delta smelt copepod prey to delta smelt tissue (see method description in Appendix 5D, Section 5D.13, *Delta Smelt Selenium Bioaccumulation*). As described in Appendix 5D, this analysis has a number of assumptions leading to uncertainty in the results, including that the selenium toxicity threshold for Sacramento splittail (7.2 micrograms per gram [µg/g] selenium whole-body tissue concentration; Rigby et al. (2010) is representative of delta smelt and the uncertainty around the concentration of selenium in the diet that results in toxic effects.

The results of the analysis indicated that although there could be very minor increases in selenium body tissue concentration as a result of the proposed action (e.g., differences in mean tissue concentration of less than 0.01 µg/g), there would be no exceedances of the 7.2-µg/g selenium whole-body tissue concentration used to assess the potential for deformities. The maximum estimated selenium concentration at the conservatively high selenium particulate to water ratio ($K_d$) of 6,000 resulted in maximum whole-body selenium concentration for existing conditions and the proposed action ranging from 1.5 µg/g in the San Joaquin River at Antioch to 2.0 µg/g at Cache Slough at Ryer Island, indicating that even maximum selenium tissue estimates were several times lower than the threshold for potential deformities to occur. This indicates very little potential for negative effects on delta smelt.

## 6C.1.1.5 Life Cycle Modeling

The Delta Smelt Life Cycle Model with Entrainment (LCME), as described by Smith et al. (2021), was applied to compare delta smelt population growth rate under the proposed action to the population growth rate under existing conditions. As described further in Attachment 5D.4, *Delta Smelt Life Cycle Modeling*, the LCME includes five OMR covariates representing entrainment risk's effect on probability of transition to the next life stage for five different life stages covering the period from early subadults in December–January to late postlarvae in June. The LCME also includes June–August Delta outflow, representing a general indicator of outflow-related habitat influencing the transition from postlarval to juvenile life stages.

The results of the LCME modeling are described in detail in Attachment 5D.4 and showed that median population growth rate generally ranged from similar to 8% lower under the proposed action compared to existing conditions, with the proportion of the proposed action population growth rate posterior distribution that was lower than existing conditions generally being close to 0.500. Such differences were largely caused by differences in June–August Delta outflow (Attachment 5D.4, Table 5D.4-3) previously discussed above in the context of food availability (Section 6C.1.1.4, *Habitat Effects,* under *Food Availability*, Table 6C.1-15, Table 6C.1-16, and Table 6C.1-17), which generally reflect less outflow being needed to meet Delta salinity requirements under the proposed action than existing conditions.

#### 6C.1.1.6 Maintenance Effects

Maintenance of the north Delta intake facilities for the proposed action would have very limited effects on the adjacent aquatic environment and, hence, very little potential for effects on delta smelt. According to the Intakes Operations and Maintenance Equipment and Facility Needs Technical Memorandum (Delta Conveyance Design and Construction Authority 2022a:11), for cleaning purposes, the cylindrical tee screens would be lifted out of the water with the intake's gantry crane and may be fixed at the top of the guide rail before being washed with a high-pressure, mobile-power washer. This process would occur approximately every 6 months and last approximately 15 days at each 3,000-cfs intake, with approximately 1 hour of washing for each screen at each intake. This washing process may cause removed sediment and aquatic growth or vegetation to reenter the river, resulting in redistribution by river currents, and minimal effects to the river and species such as delta smelt because of the very small amount of material compared to the size of the receiving waterbody. In general, the velocity through the cylindrical tee screen system and piping should be sufficient to keep diverted sediment moving until it reaches the settling basins (Delta Conveyance Design and Construction Authority 2022a:13). Sediment jetting would only be required at the base of the screen structure to help keep sediment from accumulating beneath the screens; this jetting would be performed frequently (hourly to daily, depending on needs), thereby resulting in minimal changes to suspended sediment/turbidity, with sediment jetted from the screen dispersing rapidly within the river channel and, therefore, having very limited or no effects on any delta smelt occurring in the vicinity. Before the screen units are lifted up to the deck for cleaning, solid panels would be installed behind the screen in the back guide rail for the unit being cleaned. These panels would seal off that unit's intake area from diversions, so there would be no potential to divert water through an unscreened area while the screen is being cleaned and, therefore, no risk of fish entrainment.

## 6C.1.2 Effects of Water Facility Operations and Maintenance on Delta Smelt Critical Habitat

The assessment of effects from water facility operations and maintenance on delta smelt critical habitat presented in this section follows the basic structure of the analyses of Individual-Level and Population-Level effects presented in Sections 6.1.2, *Effects of Construction Activities on Delta Smelt Critical Habitat*, and 6C.1.1, *Effects of Water Facility Operations and Maintenance on Delta Smelt*.

### 6C.1.2.1 North Delta Exports

#### PCE 1: Physical Habitat (Spawning Substrate)

The potential effect of north Delta exports on spawning substrate could occur only if Intakes B and C remove enough sand from the inflowing sediment load (over several decades of operation) to significantly change the location or quantity of existing sandy beaches, as discussed further in PCE 3: *River Flow (Facilitiating Movement)*, below. The ability of migrating adult delta smelt to access spawning substrate upstream of the proposed intakes could be affected by changes in river flow/velocity near the proposed intakes, although as noted above in the *Upstream Migration Effects and Predation* discussion of Section 6C.1.1.2, *North Delta Exports*, 2D hydraulic modeling conducted to illustrate potential north Delta intake effects on river hydrodynamics shows that there is a considerable extent of sufficiently low-velocity habitat on the opposite (west/right) bank of the Sacramento River from the north Delta intakes. As also previous discussed, the cylindrical tee fish screens and their associated manifolds, as well as the support piles for the log-boom structure, may provide velocity refuge for upstream-migrating adult delta smelt occurring near the intakes, thereby reducing the extent of the potential negative effect. As previously discussed, another possible factor reducing the potential for negative effects is migration close to the riverbed where velocity is lower.

#### PCE 2: Water (Quality)

Water that otherwise would be of suitable quality for delta smelt may be affected by the loss of low-velocity habitat near Intakes B and C, which make delta smelt susceptible to injury or death by entrainment, impingement, or screen contact, and could affect access to habitat at and upstream of the new intakes. This is discussed further in relation to PCE 3. In addition, enhanced predation along the new intakes could affect the function of PCE 2, although as noted above in the *Upstream Migration Effects and Predation* discussion of Section 6C.1.1.2, such effects would be small. Potential effects to other aspects of PCE 2, such as sediment removal (potentially influencing water clarity by removal of sediment that could otherwise subsequently be resuspended and increase turbidity) and entrainment of foodweb materials, are discussed in detail in Section 6C.1.1.4. For sediment removal, the relatively small percentage of sediment entrained by the north Delta intakes indicates that the proposed action would likely have limited impacts on suspended sediment and turbidity for delta smelt (Table 6C.1-13). Uncertainty in the potential for sediment impacts, particularly in light of projected future trends in suspended sediment (Stern et al. 2020), would be addressed through AMM-15; the Sediment Monitoring, Modeling, and Reintroduction Adaptive Management program (for more details see Appendix 3A). In regard to entrainment of foodweb effects, the analysis suggested that the difference in *E. affinis* density in the LSZ between the proposed action and existing conditions would be small (1%–3%) (Table 6C.1-14). This indicates limited potential for negative effects on delta smelt from the proposed action relative to existing conditions with respect to *E. affinis* food availability.

#### PCE 3: River Flow (Facilitating Movement)

The proposed intakes would affect the river flow PCE 3 by changing water velocity in the vicinity of the north Delta intake fish screens, potentially making delta smelt susceptible to entrainment (smaller life stages), impingement, or screen contact, which could, in turn, result in injury or death, although the potential for delta smelt to occur in the vicinity of Intakes B and C in appreciable numbers is very low. Any effects would be avoided and minimized by the location of the intakes (upstream from locations where most delta smelt are found), as well as by screen design and

operational criteria (e.g., 0.2-feet per second approach velocity), with final design subject to review and approval by the fish and wildlife agencies (i.e., USFWS, NMFS, and CDFW). As assessed in Section 6C.1.1.2, the higher velocity habitat along the screens of the proposed intakes has the potential to reduce, along the eastern bank of the Sacramento River, the probability of migrating adult delta smelt accessing upstream designated critical habitat, which for delta smelt extends to the upstream boundary of the statutory Delta at the I Street Bridge in Sacramento. 2D hydraulic modeling conducted to illustrate potential north Delta intake effects on river hydrodynamics shows that there is a considerable extent of sufficiently low-velocity habitat on the opposite (west/right) bank of the Sacramento River from the north Delta intakes and, as previously noted, the screen design (cylindrical screens with manifolds) and potential delta smelt behavior (e.g., migration near the riverbed in lower-velocity water) have the potential to limit negative effects to PCE 3. Due to these considerations, the proposed action is considered to have limited potential for negative effects to PCE 3.

#### PCE 4: Salinity (Low Salinity Zone)

The location and extent of the LSZ is determined by Delta outflow, which would be affected by north and south Delta exports combined. In summary, the proposed action is not expected to affect the LSZ. Existing conditions and the proposed action include decision-making to implement the Delta Smelt Summer–Fall Habitat Action. The potential effects of this action on delta smelt were recently analyzed by DWR (2020:5-123–5-125), which found that the extent of low-salinity habitat for delta smelt would not be lower under the adopted project than under the then existing condition (i.e., management to the 2008 USFWS BiOp). Continuation of the Delta Smelt Summer–Fall Habitat Action under the proposed action would continue the provision of low-salinity habitat to a similar extent as existing conditions. An additional indicator of delta smelt summer–fall habitat is provided by the frequency of occurrence of X2 less than 85 kilometers, indicating that low-salinity water (i.e., 0.5 to 6 parts per thousand salinity; Delta Modeling Associates 2014) would be overlapping physically larger habitat areas in Honker Bay (U.S. Fish and Wildlife Service 2017:307–317). CalSim modeling indicates that the frequency of occurrence of low-salinity water in Honker Bay under the proposed action generally would be similar to existing conditions, with minor (2%–5%) reductions in October–December (Table 6C.1-26) caused by less outflow needed for meeting Delta salinity requirements under the proposed action. See the detailed discussion related to PCE 4 in Section 6C.1.1.4, under *Summer–Fall Low-Salinity Habitat Extent and Related Factors*.

### 6C.1.2.2 South Delta Exports

#### PCE 1: Physical Habitat (Spawning Substrate)

Spawning substrate would not be affected by operations of the south Delta export facilities.

#### PCE 2: Water (Quality)

Entrainment is expected to be similar under the proposed action and existing conditions and would not affect PCE 2. The risk of delta smelt entrainment under existing conditions and the proposed action would be minimized by the inclusion of the various existing regulatory requirements (see discussion in Section 6C.1.1.3, *South Delta Exports*). There would be similar levels of delta smelt entrainment risk under the proposed action and existing conditions (Table 6C.1-5 through Table 6C.1-7).

### PCE 3: River Flow (Facilitating Movement)

As discussed under PCE 2, Old and Middle River flows are not expected to change significantly from the proposed action compared to existing conditions.

### PCE 4: Salinity (Low Salinity Zone)

The location and extent of the LSZ is determined by Delta outflow, which would be affected by north and south Delta exports combined. See the discussion related to PCE 4 in Section 6C.1.2.1, *North Delta Exports*, under *PCE 4: Salinity (Low Salinity Zone)*.

## 6C.1.2.3 Habitat Effects

### PCE 1: Physical Habitat (Spawning Substrate)

As previously described above in Section 6C.1.2.1, sandy spawning substrate would only be modified by water operations if water operations remove enough sand from the inflowing sediment load (over several decades of operation) to change the location or quantity of existing sandy beaches significantly. Whether this would happen cannot be accurately estimated without use of a full suspended sediment model. As described in Section 6C.1.1.4, under *Sediment Entrainment*, the intakes would entrain a relatively small percentage of total sediment entrained by the north Delta intakes, and the proposed action likely would have limited impacts on suspended sediment and turbidity for delta smelt. Uncertainty in the potential for impacts, particularly in light of projected future trends in suspended sediment (Stern et al. 2020), would be addressed through AMM-15: *Sediment Monitoring, Modeling, and Reintroduction Adaptive Management* program (for more details see Appendix 3A).

### PCE 2: Water (Quality)

Water operations, such as reservoir releases or diversions, have limited potential to affect water temperature in the Delta (Kimmerer 2004; Wagner et al. 2011). Delta Simulation Model II-QUAL modeling shows no difference from the proposed action and existing conditions (Table 6C.1-28, Table 6C.1-29, and Table 6C.1-30).

Water transparency is a key habitat attribute for delta smelt. Thus, any reduction in sediment entering the Delta because of entrainment at the intakes that is sufficient to increase water clarity (by reducing sediment load for subsequent resuspension) would affect PCE 2. As noted for PCE 1, the intakes would entrain a small percentage of sediment, and AMM-15 would address uncertainty in potential effects.

Greater prevalence of CHABs due to the proposed action was analyzed. The analyses (Impact WQ-14: *Effects on Cyanobacteria Harmful Algal Blooms Resulting from Facility Operations and Maintenance* in the Final EIR, Chapter 9 [California Department of Water Resources 2023]) showed that operational changes in CHABs are concluded to not be significant and, therefore, would not significantly affect delta smelt or their prey; therefore, they would not affect PCE 2.

Analyses suggested that the difference in *E. affinis* density in the LSZ as a result of differences in Delta outflow/X2 between the proposed action and existing conditions would be small (1%–3%) (Table 6C.1-14). This indicates little potential for negative effects on delta smelt from the proposed action relative to existing conditions with respect to *E. affinis* food availability.

### PCE 3: River Flow (Facilitating Movement)

The potential effects to PCE 3 with respect to the winter/spring periods during which time delta smelt may be susceptible to entrainment, impingement, and other effects from north and south Delta exports were presented in Sections 6C.1.2.1, under *PCE 3: River Flow (Facilitating Movement)*, and 6.1.2.2, *South Delta Exports*.

### PCE 4: Salinity (Low Salinity Zone)

The location and extent of the LSZ is determined by Delta outflow, which would be affected by north and south Delta exports combined. See the discussion related to PCE 4 in Section 6C.1.2.1, under *PCE 4: Salinity (Low Salinity Zone)*.

## 6C.1.3 Effects of Conservation Measures on Delta Smelt

Implementation of the compensatory mitigation plan could result in impacts on delta smelt as analyzed in this section. Restoration of tidal perennial habitat or channel margin habitat as compensatory mitigation has the potential to affect delta smelt.

Following completion of compensatory mitigation, restored tidal habitat areas would have positive effects on delta smelt. Such effects include greater habitat extent (e.g., as shown for Liberty Island in the north Delta; Sommer and Mejia (2013) and greater food availability on-site or in nearby areas (Hammock et al. 2019a), but not at larger spatial scales, such as in other regions of the Delta (Herbold et al. 2014; Hartman et al. 2017; Kimmerer et al. 2018a). Efficacy monitoring would assess the degree to which positive effects occur and inform adjustment to sites, as necessary, to increase positive effects. Although monitoring activities at restoration sites have not been determined, they are not expected to include in-water work with any potential to harm delta smelt or any other listed fishes.

Other avoidance and mitigation measures proposed would have no impact on delta smelt during operations and maintenance of water conveyance facilities because these avoidance and mitigation measures would be limited to temporary activities during the construction phase. Refer to Chapter 3, Section 3.6, *Conservation Measures*, and Appendix 3A, that would be implemented if maintenance repairs require in-water construction. Therefore, implementation of avoidance and mitigation measures is unlikely to impact delta smelt during operation and maintenance, and there would be no effect.

### 6C.1.3.1 Effects of Conservation Measures on Delta Smelt Critical Habitat

#### PCE 1: Physical Habitat (Spawning Substrate)

Although minimal, if any, effects to spawning substrate are anticipated, restoration of tidal habitat and channel margin habitat would have the potential to offset losses in spawning substrate and other shallow-water habitat, as well as losses of tidal perennial habitat.

#### PCE 2: Water (Quality)

Construction-related effects to water quality (e.g., increases in suspended sediment during earth-moving activities) from conservation measures would be of similar nature to the construction-related effects described above, but would be limited in duration, occur during work windows to

minimize exposure of delta smelt, and be minimized with standard AMMs. Therefore, there would be limited effects on PCE 2.

Sediment disturbance and releases of contaminants (e.g., fuel spills) during construction/removal activities have the potential to result in effects on the PCE 2 (e.g., by liberating contaminants), but the implementation of AMMs and the limited duration of the work would minimize effects on this PCE, as concluded for the pilot projects (U.S. Fish and Wildlife Service 2011, 2014).

#### PCE 3: River Flow (Facilitating Movement)

None of the conservation measures would affect river flow.

#### PCE 4: Salinity (Low Salinity Zone)

None of the conservation measures would affect salinity.

## 6C.1.4 Cumulative Effects on Delta Smelt

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area (50 Code of Federal Regulations § 402.02). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the federal Endangered Species Act.

### 6C.1.4.1 Water Diversions

Water diversions for irrigated agriculture, municipal, and industrial use and managed wetlands are found throughout the Delta, and many of them remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions have the potential to entrain and kill many life stages of aquatic species, including delta smelt. However, the vast majority of private unscreened diversions in the Delta are small pipes in large channels that do not operate every day of the year. As a result, even where they do regularly co-occur with these diversions, delta smelt appear to have low vulnerability to entrainment (Nobriga et al. 2004). Most of the 370 water diversions operating in Suisun Marsh are likewise unscreened (Herren and Kawasaki 2001). However, the two major Suisun Marsh distribution systems, both part of the SWP, divert most of the water into the marsh that is subsequently redistributed further by the many smaller diversions. Of the two SWP distribution systems, Roaring River is screened, but Morrow Island is not. Delta smelt entrainment into the Morrow Island Distribution system is very low due to high salinity in western Suisun Marsh (Enos et al. 2007).

New municipal water diversions in the Delta are screened routinely per various biological opinions. Private irrigation diversions in the Delta are mostly unscreened, but the total amount of water diverted to Delta farms has remained very stable for decades (Culberson et al. 2008), so the cumulative impact should remain similar to baseline. Ongoing nonfederal diversions of water within the action area (e.g., municipal and industrial uses, as well as diversions through intakes serving numerous small, private agricultural lands) are not likely to entrain very many delta smelt, based on the results of a study by Nobriga et al. (2004), which reasoned that the littoral location and low-flow operational characteristics of these diversions reduced their risk of entraining delta smelt. A study of the Morrow Island Distribution System by DWR produced similar results, with one demersal species and one species that associates with structural environmental features, together accounting

for 97%–98% of entrainment; only one delta smelt was observed to be entrained during the 2 years of the study (Enos et al. 2007).

### 6C.1.4.2 Agricultural Practices

Farming occurs throughout the Delta, adjacent to waterways used by delta smelt. Agricultural practices introduce nitrogen, ammonium, and other nutrients into the watershed, which then flow into receiving waters, adding to other inputs, such as wastewater treatment (Lehman et al. 2014); however, wastewater treatment provides the bulk of ammonium loading (Jassby 2008). Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect delta smelt reproductive success and survival rates (Dubrovsky et al. 1998; Kuivila and Moon 2004; Scholz et al. 2012). Discharges occurring outside the action area that flow into the action area also contribute to cumulative effects of contaminant exposure.

### 6C.1.4.3 Increased Urbanization

The Delta Protection Commission's *Economic Sustainability Plan* for the Delta reported an urban growth rate of about 54% within the statutory Delta between 1990 and 2010, as compared with a 25% growth rate statewide during the same period (Delta Protection Commission 2012). The report also indicated that population growth had occurred in the Secondary Zone of the Delta, but not in the Primary Zone, and that population in the central and south Delta areas had decreased since 2000. Growth projections through 2050 indicate that all counties overlapping the Delta are projected to grow at a faster rate than the state as a whole. Total population in the Delta counties is projected to grow at an average annual rate of 1.2% through 2030 (California Department of Finance 2012). Table 6C.1-33 illustrates past, current, and projected population trends. As of 2010, the combined population of the Delta counties was approximately 3.8 million. Sacramento County contributed 37.7% of the population of the Delta counties, and Contra Costa County contributed 27.8%. Yolo County had the smallest population (200,849 or 5.3%) of all the Delta counties.

**Table 6C.1-33. Population by County and Area, 2010–2060**

| Area | 2010 Population (millions) | 2019 Population (millions) | 2030 Projected Population (millions) | 2035 Projected Population (millions) | 2060 Projected Population (millions) |
|---|---|---|---|---|---|
| **Delta Region** | **5.30** | **5.82** | **6.37** | **6.61** | **7.43** |
| Alameda County | 1.52 | 1.67 | 1.83 | 1.90 | 2.16 |
| Contra Costa County | 1.05 | 1.15 | 1.25 | 1.30 | 1.45 |
| Sacramento County | 1.42 | 1.55 | 1.70 | 1.75 | 1.94 |
| San Joaquin County | 0.69 | 0.77 | 0.88 | 0.92 | 1.09 |
| Solano County | 0.41 | 0.44 | 0.47 | 0.48 | 0.52 |
| Yolo County | 0.20 | 0.22 | 0.24 | 0.25 | 0.28 |
| **South Bay Area [a]** | **1.85** | **2.02** | **2.17** | **2.25** | **2.51** |
| San Benito County | 0.06 | 0.06 | 0.07 | 0.08 | 0.09 |
| Santa Clara County | 1.79 | 1.96 | 2.09 | 2.17 | 2.42 |
| **San Joaquin Valley** | **3.14** | **3.42** | **3.77** | **3.92** | **4.46** |
| Stanislaus County | 0.52 | 0.56 | 0.61 | 0.63 | 0.73 |

| Area | 2010 Population (millions) | 2019 Population (millions) | 2030 Projected Population (millions) | 2035 Projected Population (millions) | 2060 Projected Population (millions) |
|---|---|---|---|---|---|
| Merced County | 0.26 | 0.28 | 0.33 | 0.35 | 0.46 |
| Fresno County | 0.93 | 1.02 | 1.12 | 1.16 | 1.29 |
| Tulare County | 0.44 | 0.48 | 0.52 | 0.53 | 0.56 |
| Kings County | 0.15 | 0.15 | 0.17 | 0.18 | 0.20 |
| Kern County | 0.84 | 0.92 | 1.02 | 1.06 | 1.21 |
| **Central Coast** | **0.69** | **0.73** | **0.77** | **0.79** | **0.85** |
| San Luis Obispo County | 0.27 | 0.28 | 0.28 | 0.29 | 0.29 |
| Santa Barbara County | 0.42 | 0.45 | 0.49 | 0.50 | 0.56 |
| **Southern California** | **21.04** | **22.33** | **23.28** | **23.62** | **23.68** |
| Ventura County | 0.83 | 0.85 | 0.86 | 0.86 | 0.78 |
| Los Angeles County | 9.85 | 10.26 | 10.38 | 10.39 | 9.61 |
| Orange County | 3.02 | 3.22 | 3.39 | 3.47 | 3.70 |
| San Diego County | 3.10 | 3.36 | 3.53 | 3.60 | 3.74 |
| San Bernardino County | 2.05 | 2.20 | 2.40 | 2.47 | 2.68 |
| Riverside County | 2.20 | 2.44 | 2.72 | 2.84 | 3.18 |
| **California** | **37.37** | **39.96** | **42.26** | **43.20** | **45.30** |

Source: California Department of Finance 2020.
[a] The population estimates for the South Bay Area do not include Alameda County because this is included in the Delta region total.

Table 6C.1-34 presents more detailed information about populations of individual communities in the Delta.

**Table 6C.1-34. Statutory Delta Communities Population, 2010 and 2018**

| Community | 2010 | 2018 | Average Annual Growth Rate 2010–2018 |
|---|---|---|---|
| **Alameda County** | | | |
| ***Incorporated Cities and Towns*** | | | |
| Livermore [a] | 80,968 | 89,027 | 1.24% |
| **Contra Costa County** | | | |
| ***Incorporated Cities and Towns*** | | | |
| Antioch | 102,372 | 110,730 | 1.02% |
| Brentwood | 51,481 | 60,446 | 2.18% |
| Oakley | 35,432 | 40,669 | 1.85% |
| Pittsburg | 63,264 | 70,492 | 1.43% |
| ***Small or Unincorporated Communities*** | | | |
| Bay Point | 21,349 | 25,165 | 2.23% |
| Bethel Island | 2,137 | 2,010 | -0.74% |
| Byron | 1,277 | 1,348 | 0.69% |
| Discovery Bay | 13,352 | 15,981 | 2.46% |
| Knightsen | 1,568 | 1,500 | -0.54% |

| Community | 2010 | 2018 | Average Annual Growth Rate 2010–2018 |
|---|---|---|---|
| **Alameda County** | | | |
| ***Incorporated Cities and Towns*** | | | |
| Livermore [a] | 80,968 | 89,027 | 1.24% |
| **Sacramento County** | | | |
| ***Incorporated Cities and Towns*** | | | |
| Isleton | 804 | 583 | -3.44% |
| Sacramento | 466,488 | 495,011 | 0.76% |
| ***Small or Unincorporated Communities*** | | | |
| Courtland | 355 | 537 | 6.41% |
| Freeport | 38 | 81 | 14.14% |
| Hood | 271 | 303 | 1.48% |
| Walnut Grove | 1,542 | 1,300 | -1.96% |
| **San Joaquin County** | | | |
| ***Incorporated Cities and Towns*** | | | |
| Lathrop | 18,023 | 21,393 | 2.34% |
| Stockton | 291,707 | 306,283 | 0.62% |
| Tracy | 82,922 | 88,806 | 0.89% |
| ***Small or Unincorporated Communities*** | | | |
| Mountain House | 9,675 | 15,645 | 7.71% |
| Terminous | 381 | 411 | 0.98% |
| **Solano County** | | | |
| ***Incorporated Cities and Towns*** | | | |
| Rio Vista | 7,360 | 8,618 | 2.14% |
| **Yolo County** | | | |
| ***Incorporated Cities and Towns*** | | | |
| West Sacramento | 48,744 | 52,826 | 1.05% |
| ***Small or Unincorporated Communities*** | | | |
| Clarksburg | 418 | 442 | 0.72% |

Sources: U.S. Census Bureau 2011, 2018.
[a] Livermore is not in the statutory Delta but included because it is the closest community in Alameda County.

Increases in urbanization and housing developments can affect habitat by altering watershed characteristics and changing both water use and stormwater runoff patterns. Increased growth would place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions would not require federal permits and, thus, would not undergo review through the Section 7 consultation process.

Adverse effects on delta smelt and their critical habitat may result from urbanization-induced point- and nonpoint-source chemical-contaminant discharges within the action area. These contaminants include, but are not limited to, ammonia and free ammonium ion, numerous pesticides and herbicides, and oil- and gasoline-product discharges. Increased urbanization also is expected to result in increased recreational activities in the region.

### 6C.1.4.4 Wastewater Treatment Plants

Two wastewater treatment plants (one located on the Sacramento River near Freeport and the other on the San Joaquin River near Stockton) have received special attention because of the magnitude of their discharge of ammonia. The Sacramento Regional Wastewater Treatment Plant, in order to comply with Order R5-2013-0124, implemented compliance measures to reduce ammonia discharges. There were concerns that these discharges could be associated with direct ammonia toxicity to delta smelt and other species, prompting various studies (e.g., Werner et al. 2009). In addition to concerns about direct toxicity of ammonia to delta smelt, another important concern was that ammonium inputs affected the delta smelt foodweb by suppressing diatom blooms in the Delta and Suisun Bay (see summary of relevant literature by IEP MAST [2015:71]), although a recent study did not find evidence supporting this mechanism (Strong et al. 2021). To the extent that such direct (toxicity) and indirect (foodweb suppression) effects were previously occurring, the recent completion of upgrades at the Sacramento Regional Wastewater Treatment Plant largely eliminated ammonia discharge and, therefore, the potential for negative effects. Ammonia discharge concerns have also been expressed with respect to the City of Stockton Regional Water Quality Control Plant, but its remoteness from the parts of the estuary frequented by delta smelt and its recent upgrades suggest that it is more a potential issue for migrating salmonids than for delta smelt.

### 6C.1.4.5 Other Activities

Other future, nonfederal actions within the action area that are likely to occur and may adversely affect delta smelt and their critical habitat include: dumping of domestic and industrial garbage that decreases water quality; oil and gas development and production that may affect aquatic habitat and may introduce pollutants into the water; and state or local levee maintenance that may also destroy or adversely affect habitat and interfere with natural, long-term habitat-maintaining processes. However, these projects are likely to include BMPs and are regulated to avoid impacts on aquatic habitat.

### 6C.1.4.6 Climate Change

The anticipated effects of climate change on the San Francisco Estuary and watershed, such as warmer water temperatures, greater salinity intrusion, lesser snowpack contribution to spring outflows from the Delta, and the potential for frequent extreme drought (Knowles and Cayan 2002; Dettinger 2005), indicate challenges to maintaining a sustainable delta smelt population (Brown et al. 2013, 2016). Climate change is expected to affect delta smelt habitat and prey availability. The projected increase in sediment entering the Delta over time from future climate change has the potential to result in more sediment entering the Delta than existing conditions. Given the importance of sediment as a component of delta smelt habitat (particularly when resuspended to create greater turbidity), this may be beneficial to delta smelt. Climate change-related reductions in spring Delta outflow and sea level rise result in predictions of lower smelt zooplankton prey *E. affinis* than existing conditions. Water temperature would be higher, reflecting climate change assumptions, and would decrease habitat suitability for delta smelt (e.g., mean July temperature at Rio Vista at 2040 modeled climate would be more often above the 21.9°C threshold dividing adequate and unsuitable habitat per the affinity analysis of Hamilton and Murphy [2020]). More information on 2040 modeled climate can be found in Appendix 5E, *Fish and Aquatic Resources 2040 Analysis* (for the summary of analysis specific to delta smelt see Table 5E.1-58)

# 6C.2 Effects on Longfin Smelt

As with delta smelt, potential effects are discussed in terms of near-field effects of north Delta exports and south Delta exports (e.g., entrainment), in addition to far-field habitat effects (i.e., changes to food availability and Delta outflow-abundance effects). Analyses were developed in consideration of factors assessed to be of importance to the species based on available literature, including conceptual models (e.g., Baxter et al. 2010) and best available methods (e.g., ICF International 2016b; California Department of Water Resources 2020).

## 6C.2.1 Effects of Water Facility Operations and Maintenance on Longfin Smelt

### 6C.2.1.1 North Delta Exports

Longfin smelt could experience somewhat similar effects from the north Delta intakes as previously discussed for delta smelt, that is, reduction in potential to migrate upstream, predation, entrainment, and impingement leading to death or injury. (Longfin smelt adults are larger than delta smelt adults, however, and therefore probably would be less susceptible to reduction in upstream migration potential because of greater swimming ability.) However, should such effects occur, they would affect an even smaller proportion of the longfin smelt population than delta smelt because the species occurs farther downstream than delta smelt. The beach seine sampling discussed previously for delta smelt (Table 6C.1-3) collected only two longfin smelt during December–June 2012–2021, both at the farthest downstream station (SR012W [Sandy Beach]). This is consistent with previous analyses showing that longfin smelt have been infrequently collected in the vicinity of the north Delta intakes based on available sampling (ICF International 2016b:4-269–4-272).

### 6C.2.1.2 South Delta Exports

There is the potential for adult longfin smelt entrainment to occur at the south Delta export facilities under existing conditions and the proposed action, although take of adults is very limited relative to other life stages. Grimaldo et al. (2009) found that adult longfin smelt salvage at the south Delta export facilities was significantly negatively related to mean December–February OMR flows, but not to X2 (or other variables that were examined). As previously noted for delta smelt, modeled OMR flows are generally similar between existing conditions and the proposed action, suggesting generally similar longfin smelt entrainment risk (Table 6C.1-5 through Table 6C.1-7). Existing conditions and the proposed action include OMR management from December 1 through February 28, during which time additional real-time consideration of adult longfin smelt entrainment risk is undertaken by DWR in association with CDFW and the Water Operations Management Team to provide entrainment protection for adult longfin smelt under the CDFW ITP for the SWP (California Department of Fish and Wildlife 2020).

Larval longfin smelt entrainment by the south Delta export facilities and other diversions could occur under existing conditions and the project alternatives, and winter (January–March) is of particular concern. A DSM2-PTM (particle tracking model) analysis was undertaken using the methods provided in Appendix 5D, Section 5D.14, *Longfin Smelt Larval Entrainment (DSM2 Particle Tracking Model)*. Staff observations from preliminary longfin smelt culture efforts at the UC Davis Fish Conservation and Culture Laboratory have suggested that larvae may not be buoyant in freshwater, but field studies found that they are buoyant in brackish water (California Department

of Water Resources 2020:4-181), which may add some uncertainty to the results from PTM analysis. Analysis of surface and neutrally buoyant particles provides information on two plausible behaviors, recognizing that the estimates are only order-of-magnitude comparisons that are best used in a relative fashion to compare different operational scenarios.

The DSM2-PTM results suggested that there would be relatively minor differences in the potential for entrainment of longfin smelt larvae between existing conditions and the proposed action (Table 6C.2-35 and Table 6C.2-36). Flux of particles into the south Delta was also generally similar, with larger relative differences arising in February in above normal wet years and March in below normal years, because of the overall low absolute number of particles entering the south Delta (Table 6C.2-37 and Table 6C.2-38). Such differences in particle entrainment primarily reflect hydrodynamic differences between the proposed action and existing conditions in south Delta exports and Sacramento River inflow. Passage of particles past Chipps Island was also similar between the proposed action and existing conditions (Table 6C.2-39 and Table 6C.2-40). Real-time operational measures required under the CDFW ITP for the SWP (California Department of Fish and Wildlife 2020:81–84) are included in the existing conditions and the proposed action that manage OMR flows for the protection of longfin smelt. Although the estimates of entrainment are primarily intended to be used comparatively, the weightings applied in the modeling are intended to represent a realistic distribution of larvae in the Delta and downstream and therefore may provide some perspective on the magnitude of larval population loss, which is generally a low single-digit percentage (Table 6C.2-35 and Table 6C.2-36). Note that these estimates may overestimate entrainment loss in very wet years because the Smelt Larval Survey weighting for particle starting distributions does not sample the full extent of downstream areas where the species is occurring (Appendix 5D, Section 5D.14.3, *Note on Proportion of Larval Population outside the Delta and Suisun Marsh and Bay*).

**Table 6C.2-35. Entrainment of Neutrally Buoyant Particles at the South Delta Export Facilities and North Bay Aqueduct from DSM2 Particle Tracking Modeling, Weighted by Longfin Smelt Larval Distribution**

| | EC | Proposed Action | EC | Proposed Action | EC | Proposed Action |
|---|---|---|---|---|---|---|
| **Water Year Type** | **January** | | **February** | | **March** | |
| Wet | 1.76 | 1.85 (6%) | 1.23 | 1.25 (1%) | 0.82 | 0.82 (0%) |
| Above normal | 3.17 | 3.33 (5%) | 2.14 | 2.31 (8%) | 1.25 | 1.37 (10%) |
| Below normal | 5.97 | 6.22 (4%) | 3.73 | 3.81 (2%) | 2.32 | 2.49 (8%) |
| Dry | 8.72 | 8.90 (2%) | 4.28 | 4.74 (11%) | 2.97 | 3.08 (4%) |
| Critically dry | 8.47 | 8.61 (2%) | 5.25 | 5.20 (-1%) | 3.22 | 3.16 (-2%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

**Table 6C.2-36. Entrainment of Surface-Oriented Particles at the South Delta Export Facilities and North Bay Aqueduct from DSM2 Particle Tracking Modeling, Weighted by Longfin Smelt Larval Distribution**

| | EC | Proposed Action | EC | Proposed Action | EC | Proposed Action |
|---|---|---|---|---|---|---|
| **Water Year Type** | **January** | | **February** | | **March** | |
| Wet | 1.86 | 1.99 (7%) | 1.27 | 1.31 (3%) | 0.87 | 0.89 (2%) |
| Above normal | 3.35 | 3.67 (9%) | 2.26 | 2.51 (11%) | 1.32 | 1.47 (12%) |
| Below normal | 6.58 | 6.90 (5%) | 4.01 | 4.25 (6%) | 2.50 | 2.81 (13%) |
| Dry | 9.53 | 9.90 (4%) | 4.68 | 5.29 (13%) | 3.28 | 3.50 (7%) |
| Critically dry | 9.71 | 9.58 (-1%) | 5.83 | 5.90 (1%) | 3.51 | 3.68 (5%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

**Table 6C.2-37. South Delta Flux of Neutrally Buoyant Particles from DSM2 Particle Tracking Modeling, Weighted by Longfin Smelt Larval Distribution**

| | EC | Proposed Action | EC | Proposed Action | EC | Proposed Action |
|---|---|---|---|---|---|---|
| **Water Year Type** | **January** | | **February** | | **March** | |
| Wet | -0.43 | -0.33 (23%) | -0.97 | -0.95 (2%) | -1.24 | -1.23 (0%) |
| Above normal | 0.96 | 1.13 (18%) | -0.07 | 0.12 (279%) | -0.79 | -0.67 (15%) |
| Below normal | 3.89 | 4.13 (6%) | 1.67 | 1.77 (5%) | 0.34 | 0.54 (60%) |
| Dry | 6.57 | 6.78 (3%) | 2.35 | 2.83 (20%) | 1.18 | 1.30 (10%) |
| Critically dry | 7.00 | 7.14 (2%) | 3.84 | 3.80 (-1%) | 1.97 | 1.91 (-3%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

**Table 6C.2-38. South Delta Flux of Surface-Oriented Particles from DSM2 Particle Tracking Modeling, Weighted by Longfin Smelt Larval Distribution**

| | EC | Proposed Action | EC | Proposed Action | EC | Proposed Action |
|---|---|---|---|---|---|---|
| **Water Year Type** | **January** | | **February** | | **March** | |
| Wet | -0.32 | -0.19 (41%) | -0.92 | -0.88 (5%) | -1.18 | -1.16 (1%) |
| Above normal | 1.15 | 1.47 (28%) | 0.07 | 0.32 (393%) | -0.71 | -0.56 (22%) |
| Below normal | 4.49 | 4.81 (7%) | 1.96 | 2.21 (13%) | 0.53 | 0.87 (64%) |
| Dry | 7.36 | 7.75 (5%) | 2.76 | 3.38 (22%) | 1.52 | 1.74 (15%) |
| Critically dry | 8.19 | 8.11 (-1%) | 4.41 | 4.52 (2%) | 2.28 | 2.51 (10%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

**Table 6C.2-39. Passage Past Chipps Island of Neutrally Buoyant Particles from DSM2 Particle Tracking Modeling, Weighted by Longfin Smelt Larval Distribution**

| Water Year Type | EC | Proposed Action | EC | Proposed Action | EC | Proposed Action |
|---|---|---|---|---|---|---|
| | January | | February | | March | |
| Wet | 47.25 | 47.09 (0%) | 47.97 | 47.94 (0%) | 47.70 | 47.68 (0%) |
| Above normal | 44.60 | 43.83 (-2%) | 46.95 | 46.72 (0%) | 47.08 | 46.95 (0%) |
| Below normal | 39.03 | 38.45 (-1%) | 43.27 | 42.76 (-1%) | 45.35 | 45.22 (0%) |
| Dry | 33.90 | 33.15 (-2%) | 41.06 | 40.22 (-2%) | 43.86 | 43.55 (-1%) |
| Critically dry | 32.84 | 31.69 (-4%) | 37.06 | 36.23 (-2%) | 39.70 | 39.08 (-2%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

**Table 6C.2-40. Passage Past Chipps Island of Surface-Oriented Particles from DSM2 Particle Tracking Modeling, Weighted by Longfin Smelt Larval Distribution**

| Water Year Type | EC | Proposed Action | EC | Proposed Action | EC | Proposed Action |
|---|---|---|---|---|---|---|
| | January | | February | | March | |
| Wet | 47.74 | 47.72 (0%) | 48.58 | 48.78 (0%) | 48.33 | 48.54 (0%) |
| Above normal | 44.90 | 44.09 (-2%) | 47.32 | 47.28 (0%) | 47.57 | 47.64 (0%) |
| Below normal | 38.94 | 38.37 (-1%) | 43.57 | 42.96 (-1%) | 45.81 | 45.57 (-1%) |
| Dry | 33.59 | 32.63 (-3%) | 41.22 | 40.28 (-2%) | 44.12 | 43.84 (-1%) |
| Critically dry | 32.77 | 31.41 (-4%) | 36.96 | 36.16 (-2%) | 39.92 | 39.13 (-2%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent.
EC = existing conditions.

Grimaldo et al. (2009) found that juvenile longfin smelt salvage principally occurred in the months of April and May and was significantly negatively related to mean April–May OMR flow (and was not related to other factors such as X2). For this impacts analysis, an evaluation of potential differences in entrainment between the proposed action and existing conditions was evaluated by recreating and applying the Grimaldo et al. (2009) relationship between salvage and OMR flows (Appendix 5D). This analysis suggested that entrainment under the proposed action generally could be similar to or less than under existing conditions (Table 6C.2-41) as a result of less south Delta exports under the proposed action. As previously noted above, real-time operational measures required under the CDFW ITP for the SWP (California Department of Fish and Wildlife 2020:81–84) are included in the existing conditions and the proposed action; these operational measures manage OMR flows for the protection of longfin smelt. Entrainment of juvenile longfin smelt is likely to represent a low percentage of the overall juvenile longfin smelt population because a very small percentage of the juvenile population was estimated to have been entrained in recent years (2009 onward) (California Department of Water Resources 2020:4-187). Juvenile longfin smelt entrainment loss under existing conditions and the proposed action likely represents a low percentage of the overall juvenile longfin smelt population because the species is widely distributed in the San Francisco Bay and its tributaries, including the Napa and Petaluma Rivers, and South Bay tributaries (California Department of Water Resources 2020:5-144).

**Table 6C.2-41. Mean Juvenile Longfin Smelt April–May Salvage at the South Delta Export Facilities by Water Year Type, as Estimated by the Regression Including Mean Old and Middle River Flows**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 2,712 | 2,494 (-8%) |
| Above normal | 3,252 | 3,209 (-1%) |
| Below normal | 3,403 | 3,415 (0%) |
| Dry | 3,567 | 3,566 (0%) |
| Critically dry | 2,220 | 2,158 (-3%) |

Note: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent. Table only includes mean responses and does not consider model uncertainty (see Table 6C.2-42in Appendix 5D for results by individual year, including prediction intervals). Results are not future predictions and are intended only to compare the proposed action.
EC = existing conditions.

## 6C.2.1.3 Habitat Effects

### Food Availability

As described in Chapter 4, Section 4.4.8.2, *Life History and Habitat Requirements*, during the first few months of life (January–May), longfin smelt prey on calanoid copepods including *E. affinis* and *P. forbesi*, before switching to mysid prey when they are large enough (see also Jungbluth et al. 2021; Barros et al. 2022; California Department of Water Resources 2023:Appendix 12A). As discussed for delta smelt above, a regression of March–May X2 versus *E. affinis* density in the low salinity zone was used to compare the existing conditions and the proposed action (see the methods description provided in Appendix 5D, Section 5D.11.1, *Methods*). This analysis suggested that the difference in *E. affinis* density in the low salinity zone between the proposed action and existing conditions would be small (0%–3%). Such differences are much less than the range of the prediction intervals from this statistical model, which span several orders of magnitude (Table 5D.11-1in Appendix 5D). Mysid density is positively correlated with spring Delta outflow and negatively correlated with spring X2 (Mac Nally et al. 2010), although with a changing relationship to May–October X2 for the mysid *Neomysis mercedis* (negative prior to 1987, positive following 1987; Kimmerer 2002a). Collectively, this information suggests that there is very little potential for negative effects on longfin smelt from the proposed action relative to existing conditions with respect to food availability.

### Delta Outflow-Abundance

For longfin smelt, focus on estuarine flow has centered on the positive relationship found between winter and spring outflow and juvenile abundance during the fall (Rosenfield and Baxter 2007; Kimmerer et al. 2009). Specifically, as X2 shifts downstream during the winter and spring, the abundance index of longfin smelt in the following Fall Midwater Trawl Survey increases (Kimmerer 2002b; Kimmerer et al. 2009). The potential mechanisms underlying this relationship have been hypothesized but their relative importance is poorly understood; however, the significant X2-abundance relationship suggests that higher outflow (lower X2) or wetter hydrology produce conditions that enhance recruitment to juvenile life stages. Hypotheses about underlying mechanisms to this X2-abundance relationship include transport of larval longfin smelt out of the Delta to downstream rearing habitats (Moyle 2002; Rosenfield and Baxter 2007); increased extent of rearing habitat as X2 moves seaward (Kimmerer et al. 2009); retention of larvae in suitable rearing habitats (Kimmerer et al. 2009); increased food abundance under higher flows (Kimmerer

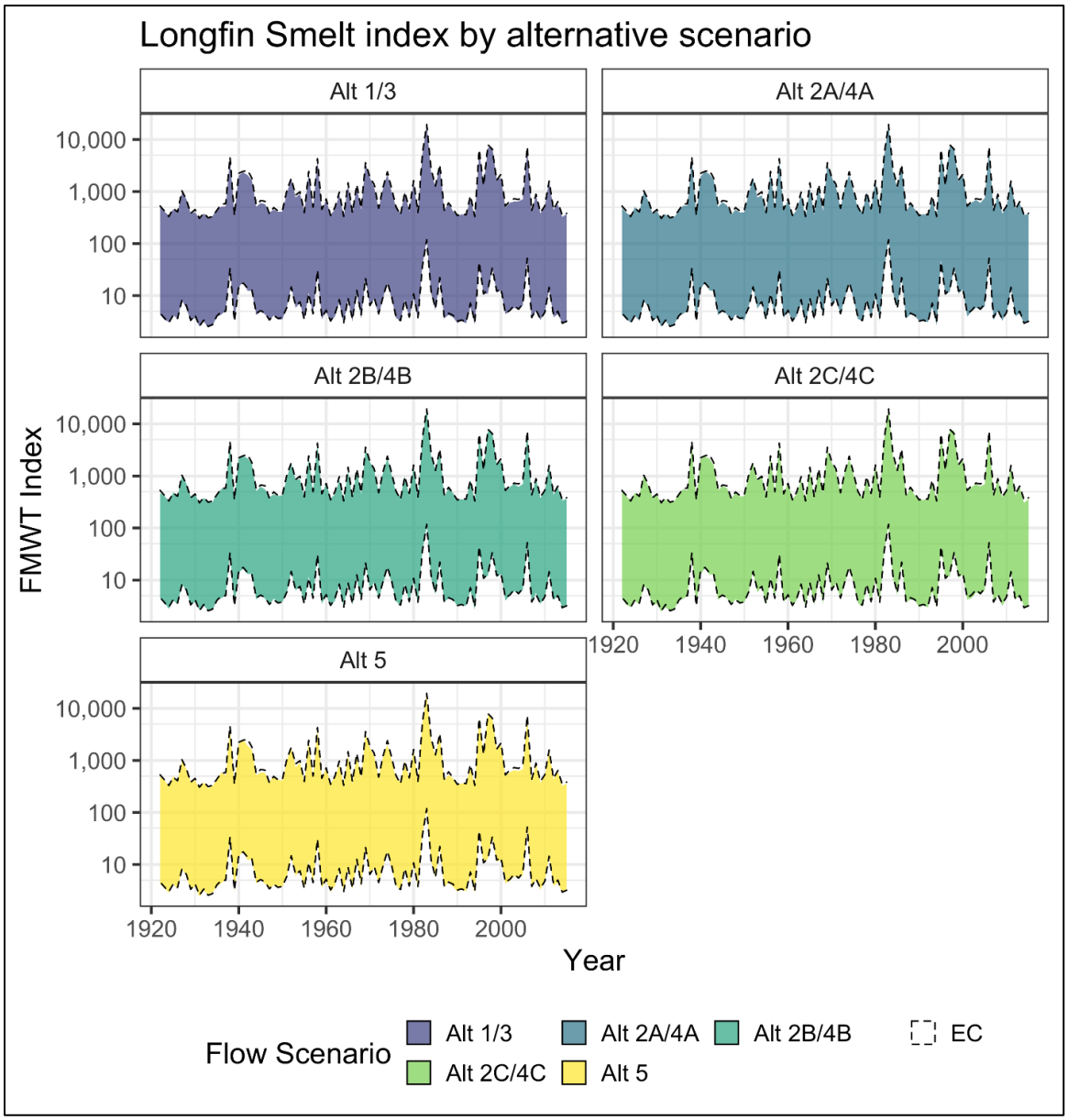
2002b); and tributary flows leading to greater spawning/recruitment in wetter years (Lewis et al. 2020; Grimaldo et al. 2020). Note that analyses relying on surveys such as the Fall Midwater Trawl index do not fully encompass the range of longfin smelt and do not reflect potential changes in catchability over time because of factors such as increased water clarity and gear avoidance (Latour 2016; Peterson and Barajas 2018) that are the subject of ongoing investigations.

With respect to habitat size for early life stages, new information indicates that the distribution of spawning and early life stages may be broader than previously thought, including areas with salinity ranging from 2 to 12 parts per thousand (Grimaldo et al. 2017). It has also been recognized that abundance of adults (spawners) is an important factor driving longfin smelt population dynamics (Baxter et al. 2010), with recent studies examining this link in detail (Maunder et al. 2015; Nobriga and Rosenfield 2016). A state-space modeling study by Maunder et al. (2015) found that multiple factors (i.e., flow, ammonium concentration, and water temperature) and density dependence were correlated to the survival of longfin smelt (represented by Bay Study abundance indices during 1980–2009). The flow factors included in their best models (i.e., Sacramento River October–July unimpaired runoff and Napa River runoff), however, cannot be affected by Delta water operations because of their geographic position in the watersheds. Nobriga and Rosenfield (2016) found that December–May Delta outflow had a positive association with recruits per spawner and that juvenile recruitment from age 0 to age 2 was density-dependent (lower survival with greater numbers of juveniles), but cautioned that the density-dependence in the model may be too strong; both recruits per spawner and juvenile recruitment were based on Bay Study sampling.

To assess potential effects of the proposed action, a population dynamics model estimating Fall Midwater Trawl index as a function of December–May Delta outflow (accounting for changes in this relationship because of the *Potamocorbula* clam invasion and the Pelagic Organism Decline) and parental stock size (the Fall Midwater Trawl index 2 years earlier) was developed. The model was used to compare the proposed action to existing conditions, using Delta outflow outputs from CalSim; additional detail on the method is provided in Appendix 5D, Section 5D.16, *Longfin Smelt Delta Outflow–Abundance Index Analysis*.

Existing conditions and the proposed action include export curtailments for spring (April 1–May 31) outflow per the requirements from the CDFW SWP ITP (California Department of Fish and Wildlife 2020:102–106), which limit Delta outflow differences in spring. There is generally less Delta outflow under the proposed action than existing conditions during December–March (see, for example, Tables 5A-B3.4.1.1 and B.4.1.5 in the Final EIR, Appendix 5A, *Modeling Technical Appendix*, Section B, Attachment 3, *CalSim 3 Model Results for Existing Condition and Alternatives at 2020* [California Department of Water Resources 2023]), which is reflected in the results of the Delta outflow–abundance index based on the December–May averaging period (California Department of Water Resources 2023). The results of the Delta outflow–abundance index analysis showed that differences in predicted Fall Midwater Trawl abundance index between existing conditions and the proposed action were very small relative to the variability in the predicted values, which spans several orders of magnitude (Figure 6C.1-1 and Figure 6C.2-1). Differences in mean estimates of Fall Midwater Trawl abundance index by water year type ranged from 1% to 9% less under the proposed action compared to existing conditions (Table 6C.2-43). The modeling results showed that the variability in Fall Midwater Trawl index predictions within each scenario was considerably greater than the differences between the scenarios. The mean probability of the Fall Midwater Trawl index being less under the proposed action than existing conditions was not greatly different from 0.500, i.e., close to an equal probability of the index being smaller or larger than existing conditions (Table 6C.2-41). The variability in abundance index predictions reflects the uncertainty in

parameter estimates, which in turn results in uncertainty in the extent to which operations-related differences in Delta outflow could affect longfin smelt. Specifically, variability in Delta outflow associated with overall hydrologic conditions (i.e., different water year types) is substantially larger than the relatively minor differences in Delta outflow associated with changes in water operations resulting from the proposed action. As described previously, Maunder et al. (2015) found that general hydrological conditions in the Sacramento River watershed and Napa River were a better explanation of population dynamics than Delta outflow. Compensatory mitigation consisting of tidal perennial habitat (Appendix 3B) is proposed to mitigate the effects of differences in Delta outflow under the proposed action.




Note: Alt = alternative; EC = existing conditions. Alt 5 = proposed action.

**Figure 6C.2-1. Time Series Plots of Predicted Longfin Smelt Fall Midwater Trawl Index from Application of the Delta Outflow-Abundance Index Method**

**Table 6C.2-43. Predicted Mean Longfin Smelt Fall Midwater Trawl Index Averaged by Water Year Type, Based on Delta Outflow-Abundance Index Method**

| Water Year Type | EC | Proposed Action |
|---|---|---|
| Wet | 382 | 358 (-6%) |
| Above normal | 109 | 99 (-9%) |
| Below normal | 62 | 58 (-6%) |
| Dry | 56 | 54 (-5%) |
| Critically dry | 44 | 43 (-2%) |

Notes: Percentage values in parentheses indicate differences of the proposed action compared to existing conditions. Absolute and percentage values are rounded; as a result, differences between absolutes and differences between percentages may not always appear consistent. Table only includes mean responses and does not consider model uncertainty.
Results are not future predictions and are intended only to compare the proposed action.
EC = existing conditions.

**Table 6C.2-44. Probability of Longfin Smelt Fall Midwater Trawl Index Smaller than Existing Conditions Averaged by Water Year Type, Based on Delta Outflow–Abundance Index Method**

| Water Year Type | Proposed Action |
|---|---|
| Wet | 0.557 |
| Above normal | 0.584 |
| Below normal | 0.550 |
| Dry | 0.535 |
| Critically dry | 0.519 |

Note: Probability of 0.500 indicates equal probability of Fall Midwater Trawl index being smaller or larger than existing conditions.

### 6C.2.1.4 Maintenance Effects

As described in more detail above for delta smelt (Section 6C.1.2*, Effects of Water Facility Operations and Maintenance on Delta Smelt Critical Habitat*), maintenance of the north Delta intake facilities for the proposed action would have very limited effects on the adjacent aquatic environment and hence very little potential for effects on longfin smelt. Screen pressure washing and sediment jetting would have very small impacts at the riverscape scale based on redistribution of sediment or accumulated vegetation and other materials.

## 6C.2.2 Effects of Conservation Measures on Longfin Smelt

The Compensatory Mitigation Plan could result in impacts on longfin smelt as analyzed under Section 6C.2.1, *Effects of Water Facility Operations and Maintenance on Longfin Smelt*. Following completion of compensatory mitigation, restored tidal habitat areas would have positive effects on longfin smelt such as increased habitat extent or greater food availability; relatively high abundance of longfin smelt has been observed in various restored habitats in the lower San Francisco Estuary (Lewis et al. 2020).

## 6C.2.3 Cumulative Effects on Longfin Smelt

Cumulative effects on longfin smelt would be the same as those for delta smelt discussed in Section 6C.1.4, *Cumulative Effects on Delta Smelt* (i.e., water diversions, agricultural practices, increased

urbanization, and climate change). Operational and maintenance effects related to other programs, projects, and policies could combine with the effects of operations and maintenance of the proposed action. For example, projects diverting water from the Sacramento River could affect fish and aquatic species in an analogous manner to that analyzed for the proposed action, e.g., by reducing river flow, thereby potentially affecting abundance of longfin smelt through-Delta, outflow-abundance relationships. Operational effects of many of the existing programs, projects, or policies are included in the modeling undertaken to assess the project alternatives, whereas others (e.g., Sites Reservoir Project) are not included in the modeling.

# 6C.3 Effects on San Joaquin Kit Fox

Appendix 6A, *Terrestrial Effects Analysis Methods*, describes the definitions, methods, and assumptions used to analyze the effects of the proposed action on terrestrial species, including impact categories, effect mechanisms, and habitat model development. Chapter 4, Section 4.4.9.6, *Suitable Habitat Definition*, and Section 4.4.9.7, *Species Habitat Suitability Model*, define suitable habitat and describe the habitat model for San Joaquin kit fox. Refer to Chapter 6, *Effects Analysis for Delta Smelt, Longfin Smelt, and Terrestrial Species*, Section 6.3, *Effects on San Joaquin Kit Fox,* for more information.

## 6C.3.1 Field Investigations

There would be no ongoing operations and maintenance associated with the field investigation activities; therefore, there would be no effect on San Joaquin kit fox.

## 6C.3.2 North Delta Intakes

The north Delta intake construction area does not overlap with San Joaquin kit fox modeled habitat and this activity would not have an adverse effect on the species (Figure 6.6-2).

## 6C.3.3 Tunnels

The tunnel alignment from the north Delta intakes to the Bethany Complex does not overlap with San Joaquin kit fox habitat.

## 6C.3.4 Tunnel Shafts

There are three types of tunnel shafts: launch shafts, maintenance shafts, and reception shafts. The purpose of the tunnel shafts is to launch, maintain, and remove TBMs at the intakes, along the tunnel alignment, and at the Bethany Complex. One reception shaft within the Bethany Reservoir surge basin overlaps with modeled San Joaquin kit fox habitat. That impact is discussed along with other construction-related impacts under Section 6C.7.6, *Bethany Complex*, below.

## 6C.3.5 Reusable Tunnel Material

RTM areas would not overlap with San Joaquin kit fox modeled habitat.

## 6C.3.6 Bethany Complex

Vehicles and heavy equipment used for operations and maintenance activities, including inspections, mowing, and vegetation removal, could injure or kill San Joaquin kit fox if individuals are present within the Bethany Complex right-of-way. Permanent facility lighting could spill over into adjacent habitats, potentially disrupting movement patterns or other typical behaviors such as foraging or breeding.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife*, which requires speed limits of 10 mph and traffic control structures on non-public, unpaved DWR facility access roads and 30 mph on non-public, paved roads. Permanent lighting at project facilities would be motion activated and therefore permanent facilities would remain dark the majority of the time at night. Permanent facility lighting would also be downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13, *Fencing and Lighting*) and thus, when lit, would minimize lighting habitat adjacent to the DWR facility. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

Refer to Chapter 6, Section 6.3.6*, Bethany Complex,* for more information.

## 6C.3.7 Access Roads

All access roads created or improved to support construction have potential to be used in support of operational and maintenance activities. Most access roads would also be used by the public, as they were in the existing condition. Operational activities on access roads include vehicular and equipment traffic and maintenance activities include grading, repaving, and vegetation removal.

Vehicular traffic, especially at night, could injure or kill San Joaquin kit fox moving across the road; however, operations traffic at night would be low and maintenance activities would occur primarily during daylight hours. Maintenance activities could produce noise, which could disrupt normal behaviors and result in increased energy expenditures. Permanent lighting installed at intersections or along roads could disrupt normal behaviors of San Joaquin kit fox if lighting spills over into adjacent habitats.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires posted speed limits of 10 mph and traffic control structures on non-public, unpaved DWR facility access roads; 30 mph speed limit on non-public, paved roads; and posted wildlife crossing signs on new or widened access roads that overlap with San Joaquin kit fox habitat. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities,* would reduce the potential effects of injury or mortality due to vehicles and equipment or disruption of behaviors by requiring spill prevention and containment plans; conducting a preconstruction environmental review; requiring preconstruction surveys, environmental resources work awareness training, and a biological monitor when appropriate; and implementing appropriate non-disturbance buffers, where applicable. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

Refer to Chapter 6, Section 6.3.7*, Access Roads,* for more information.

# 6C.3.8 Electrical and SCADA Facilities

DWR is not responsible for the operations and maintenance of electrical facilities. Operation and maintenance of electrical facilities would be the responsibility of the electrical providers—SMUD, WAPA, and PG&E. These companies would own and maintain their respective electrical facilities.

DWR is responsible for operation and maintenance activities associated with SCADA facilities; however, SCADA facilities do not have any associated operational activities. Vegetation management along SCADA line sections would not be required because underground SCADA lines occur within roadway rights-of-way (that are not vegetated) and aboveground SCADA lines all occur on existing poles that are being managed from vegetation in the existing conditions.

Maintenance activities on SCADA facilities would include emergency repair of underground or aboveground SCADA lines. There is potential for injury or mortality to San Joaquin kit fox where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife*, which requires speed limits of 10 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads and on non-public, paved roads during nighttime between November 1 and March 31. Otherwise, speed limits would be30 miles per hour on non-public paved roads (as described in Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential.

# 6C.3.9 Compensatory Mitigation Plan

## 6C.3.9.1 Channel Margin Enhancements

The channel margin creation and enhancement sites under the CMP do not overlap with San Joaquin kit fox modeled habitat; therefore, these activities would not have an adverse effect on the species.

## 6C.3.9.2 Tidal Perennial/Emergent Wetland Restoration

The tidal wetland creation and enhancement sites under the CMP do not overlap with San Joaquin kit fox modeled habitat; therefore, these activities would not have an adverse effect on the species.

## 6C.3.9.3 Site Protection Instruments

Site protection instruments for the following special-status species covered in EIR would primarily consist of the protection and management of agricultural areas but may also include protection and management of natural communities (e.g., grasslands or vernal pool complex) in the action area: greater sandhill crane, Swainson's hawk, and tricolored blackbird (Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*, Section 3F.4.2.2, *Site Protection Instruments,* and Attachment 3F.1, *Compensatory Mitigation Design Parameters*, Table 3F.1-3, CMP-18: *Sandhill Crane Roosting Habitat* CMP-19: *Swainson's Hawk Nesting Habitat and Foraging Habitat*, CMP-22: *Tricolored Blackbird Nesting* of the Final EIR [California Department of Water Resources 2023]). The need for a site protection instrument is not yet known. Nor is the location of the protection known. However, these beneficial activities could occur in areas with suitable habitat for San Joaquin kit fox.

Land management activities associated with site protection instruments could include ground disturbance, require some vehicle traffic and use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides, which could result in the injury, mortality, and disruption of normal behaviors of San Joaquin kit fox. The potential effects of injury or mortality due to vehicle collisions would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on unpaved access roads (as described in Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and containment plans. AMM-17 would also minimize impacts from land management activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). Overall, the adverse effects of operations and maintenance activities at site protection instruments are expected to be very low, and the beneficial effects of protection are expected to be very high, for San Joaquin kit fox.

# 6C.4 Effects on California Least Tern

Appendix 6A describes the definitions, methods, and assumptions used to analyze the effects of the proposed action on terrestrial species, including impact categories, effect mechanisms, and habitat model development. Chapter 4, Section 4.4.10.6, *Suitable Habitat Definition*, and Section 4.4.10.7, *Species Habitat Suitability Model*, define suitable habitat and describe the habitat model for San Joaquin kit fox. Refer to Chapter 6, Section 6.4, *Effects on California Least Tern,* for more information.

## 6C.4.1 Field Investigations

There would be no ongoing operations and maintenance associated with field investigations; therefore, there would be no effect on California least tern.

## 6C.4.2 North Delta Intakes

### 6C.4.2.1 Operations

Operational noise and presence of humans at the north Delta intakes could alter typical foraging behaviors. Because foraging habits are not limited and readily available, individual foraging birds are not expected to be affected by the loss of a small foraging area.

The potential for effects from increased exposure to methylmercury, CHABs, and selenium due to operation of the north Delta intakes is discussed in Appendix 6B, *Water Quality*. This analysis found that while modeling may predict some negligible increases in toxin concentrations over existing conditions, these increases are not large enough to result in a measurable adverse effect to California least tern individuals or the population. For the rationale and assumptions that support this finding, see Appendix 6B.

Given these reasons, the potential for adverse effects on foraging California least terns are extremely unlikely to occur and therefore insignificant.

#### 6C.4.2.2 Maintenance

Maintenance activities would generate noise and require the periodic presence of staff and vehicle traffic, which could disturb California least tern foraging behavior. Maintenance-related contaminants, such as gas, oil, pesticides, and herbicides, could accidentally be discharged into foraging habitat from near-water maintenance activities.

Foraging habits are not limited and readily available and therefore individual foraging birds are not expected to be affected by the temporary loss of a small foraging area during maintenance activities. Implementation of AMM-2: *Develop and Implement Hazardous Materials Management Plan* and AMM-3: *Develop and Implement Spill Prevention, Control, and Countermeasure Plans* (Appendix 3A) would minimize the potential for spills and contamination. Given these reasons, the potential for adverse effects on foraging California least terns are extremely unlikely to occur and therefore insignificant.

### 6C.4.3 Tunnels

Operations and maintenance associated with tunnels would either be subsurface or at the tunnel shafts, which are discussed in the section directly below; therefore, there would be no effect on California least tern.

### 6C.4.4 Tunnel Shafts

There are three types of tunnel shafts: launch shafts, maintenance shafts, and reception shafts. The purpose of the tunnel shafts is to launch, maintain, and remove TBMs at the intakes, along the tunnel alignment, and at the Bethany Complex. California least tern modeled habitat does not overlap with any tunnel shaft locations. Operations and maintenance for these facilities would not affect the species.

### 6C.4.5 Reusable Tunnel Material

RTM areas do not overlap with California least tern modeled habitat. Operations and maintenance for these facilities would not affect the species.

### 6C.4.6 Bethany Complex

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, aqueduct, and Bethany Reservoir Discharge Structure. Pumping plant operations would occur within an underground facility, and the aqueduct and discharge structure would be operated aboveground within the Bethany Complex. Operation of the Bethany Complex would involve periodic presence of humans and vehicle travel on access roads during day and night. The Bethany Complex includes the surface lands above the tunnel portion of the aqueduct that runs from the pumping plant facility to Bethany Reservoir. Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and associated facilities would involve periodic vegetation removal and repaving access roads within the Bethany Complex facilities every 15 years.

Use of vehicles and equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of least tern typical foraging behaviors. Because

foraging habits is not limited and readily available, individual foraging birds are not expected to be affected by the loss of a small foraging area.

Maintenance activities could also expose least tern to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality. Maintenance-related contaminants, such as gas, oil, steering fluid, herbicides, and pesticides, could accidentally be discharged into foraging habitat from near-water activities.

While these effect mechanisms would exist at the Bethany Complex, the likelihood of effects is minimal because California least tern is unlikely to be present because nesting habitat is over 25 miles from the Bethany Complex. Noise, visual disturbance, and contaminant effects from maintenance activities would be minimized with implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* (Appendix 3A). In addition, foraging habits are readily available and thus individual foraging birds are not expected to be affected by the temporary loss of a small patch of foraging area. Given these reasons, the potential for adverse effects on foraging California least tern is extremely unlikely to occur and therefore insignificant.

## 6C.4.7 Access Roads

Operations and maintenance-related contaminants, such as gas, oil, steering fluid, herbicides, and pesticides, could accidentally be discharged into foraging habitat from near-water activities. New and widened roads could include an increased risk of maintenance-related noise, and presence of humans could alter typical behaviors.

Nesting habitat is one mile from the nearest access road site and will not be affected. Noise, visual disturbance, and contaminant effects from maintenance activities on foraging habitat would be minimized with implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* (Appendix 3A). In addition, foraging habits are readily available and thus individual foraging birds are not expected to be affected by the temporary loss of a small patch of foraging area. Given these reasons, the potential for adverse effects on foraging California least terns are extremely unlikely to occur and therefore insignificant.

## 6C.4.8 Electrical and SCADA Facilities

DWR is not responsible for the operations and maintenance of electrical facilities. Operation and maintenance of electrical facilities would be the responsibility of the electrical providers—SMUD, WAPA, and PG&E. These companies would own and maintain their respective electrical facilities.

DWR is responsible for any operation and maintenance activities associated with SCADA facilities; however, SCADA facilities do not have any associated operational activities. Maintenance activities on SCADA facilities would include emergency repair of underground or aboveground SCADA lines. Vegetation management along SCADA line sections would not be required because underground SCADA lines occur within roadway rights-of-way (that are not vegetated) and aboveground SCADA lines all occur on existing poles that are being managed from vegetation in the existing conditions. Refer to Chapter 6, Section 6.4.8*, Electrical and SCADA Facilities,* for more information.

There is potential for injury or mortality to California least tern where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with

operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and containment plans (Appendix 3A).

## 6C.4.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[9] concrete and CLSM batch plants and park-and-ride lots. None of these features overlap with the California least tern modeled habitat, thus operations and maintenance associated with these facilities are not expected to affect the species

## 6C.4.10 Compensatory Mitigation Plan

Construction of habitat creation and enhancement at Bouldin Island and the I-5 ponds under the CMP would not overlap with modeled California least tern foraging habitat, and this activity would not have an adverse effect on the species.

### 6C.4.10.1 Initial Mitigation Sites: Bouldin Island and I-5 Ponds

Construction of habitat creation and enhancement at Bouldin Island and the I-5 ponds under the CMP would not overlap with modeled California least tern foraging habitat and this activity would not have an adverse effect on the species.

### 6C.4.10.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be used to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, and vernal pool tadpole shrimp. Lands protected for these species does not overlap with California least tern habitat and therefore the tern would not be adversely affected by implementation of this action.

### 6C.4.10.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.4.11.2, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. Non-bank sites are evaluated programmatically and would be subject to future, “step down” consultation when site-specific information becomes available. A non-bank site would protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat. These habitat types do not provide habitat for California least tern so the tern would not be adversely affected by implementation of non-bank site protection.

[9] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, such as north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.4.7, *Access Roads*, and Section 6.4.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

### 6C.4.10.4 Site Protection Instruments

Site protection instruments may be used to protect and enhance agricultural and other lands (e.g., grassland, vernal pool complex) that provide suitable habitat for species such as greater sandhill crane, Swainson's hawk, and tricolored blackbird (see Section 6C.3.9.3, *Site Protection Instruments*, for details on these species). As these habitat types do not overlap with California least tern, the implementation of site protection instruments would not affect the species.

### 6C.4.10.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP (Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. While not the target of enhancement actions, California least tern also has the potential to benefit from the increase in shallow, slow-moving marsh habitat that would promote prey populations along levees in the central Delta.

There are no operational actions associated with channel margin enhancements. Maintenance and management actions would be identified in a long-term management plan for each channel margin mitigation location and would include actions such as vegetation management, weed control, trash management, and road, levee, and channel maintenance. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data. The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Section 3B.6, *Maintenance and Management*, and Section 3B.7, *Performance Standards and Monitoring*.

Maintenance and monitoring activities at channel margin enhancement sites would generate small levels of noise, require some vehicle traffic, and ground disturbance, and require the periodic presence of staff and vehicle traffic. Monitoring activities may even include some in-water sampling and boat traffic. Maintenance-related contaminants, such as gas, oil, pesticides, and herbicides, could accidentally be discharged into foraging habitat from near-water maintenance activities.

Implementation of AMM-2: *Develop and Implement Hazardous Materials Management Plan* and AMM-3: *Develop and Implement Spill Prevention, Control, and Countermeasure Plans* (Appendix 3A) would minimize the potential for spills and contamination. Given these measures and the infrequency with which these activities would occur, the potential for adverse effects on foraging California least terns is not likely.

### 6C.4.10.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of the CMP (Appendix 3B). Tidal perennial and tidal freshwater emergent wetland habitats provide important foraging and refugia habitat for listed fish species. The restoration of tidal perennial and wetland habitat, particularly complex wetland systems containing dendritic channels and shallow subtidal areas, is intended to support improved survival and growth (including food production) of one or more life stages of each listed fish species addressed in the

biological assessment. Tidal restoration sites within the lower Yolo Bypass and Cache Slough Complex will be prioritized as these areas would provide greater benefits for target fish species.

**Operations**

Tidal restoration could affect water quality in the Delta, namely levels of methylmercury, selenium, and CHABs such as *Microcystis.* Tidal restoration would be sited in the Cache Slough or Lower Yolo Bypass region and restoration in this area is not expected to increase the bioavailability of selenium or result in conditions conducive to CHABs. See Appendix 6B for rationale. The creation of tidal wetland habitats in this region could create conditions conducive to methylation of mercury and promote uptake and bioaccumulation of methylmercury in California least tern foraging adjacent to new tidal habitats.

To minimize the effects of methylmercury on California least tern due to tidal habitat restoration, AMM-23*: Develop and Implement a Mercury Management and Monitoring Plan* (Appendix 3A) would require project-specific assessments of tidal wetland habitats, integration of design measures to minimize mercury methylation, site monitoring and reporting, and adaptive management. With these measures in place, California least tern is not likely to be adversely affected by tidal restoration.

**Maintenance**

Maintenance and monitoring activities would generate small levels of noise, require some vehicle traffic, and ground disturbance, and require the periodic presence of staff and vehicle traffic, which could disturb California least tern foraging behavior. Maintenance-related contaminants, such as gas, oil, pesticides, and herbicides, could accidentally be discharged into foraging habitat from near-water maintenance activities.

Foraging habit is not limited and readily available and therefore individual foraging birds are not expected to be affected by the temporary disturbance to a small foraging area during maintenance activities. Implementation of AMM-2: *Develop and Implement Hazardous Materials Management Plan* and AMM-3: *Develop and Implement Spill Prevention, Control, and Countermeasure Plans* (Appendix 3A) would minimize the potential for spills and contamination. Given these reasons, the potential for adverse effects on foraging California least terns is not likely.

### 6C.4.11 Effects on Critical Habitat

Critical habitat has not been designated for the California least tern.

### 6C.4.12 Cumulative Effects

Refer to Chapter 6, Section 6.4.13, *Cumulative Effects*, for more information.

## 6C.5 Effects on Least Bell's Vireo

Appendix 6A describes the methods and assumptions used to analyze the effects of the proposed action on terrestrial species. Chapter 4, Section 4.4.11.6, *Suitable Habitat Definition*, and Section 4.4.11.7, *Recolonization Habitat Suitability Model*, define suitable habitat and describe the habitat

model for least Bell's vireo. Refer to Chapter 6, Section 6.5, *Effects on Least Bell's Vireo,* for more information.

## 6C.5.1 Field Investigations

There would be no ongoing operations and maintenance associated with the field investigations, resulting in no effect on least Bell's vireo.

## 6C.5.2 North Delta Intakes

### 6C.5.2.1 Operation

Operations activities at the north Delta intakes would generate small levels of noise, have permanent light sources, and require the periodic presence of staff and vehicle traffic. However, noise from the operation of the water conveyance facilities would not be discernably higher than existing conditions, and the periodic presence of staff would not be expected to affect least Bell's vireo if present. Permanent facility lighting could extend into suitable least Bell's vireo habitat and could affect the behavior of individuals if present within the illuminated habitat. However, permanent lighting at project facilities would be motion activated, downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13), and therefore permanent facilities would remain dark the majority of the time at night, which would minimize the potential for this effect. The potential for effects from increased exposure to methylmercury, CHABs, and selenium due to operation of the north Delta intakes is discussed in Appendix 6B. This analysis found that while modeling may predict some increases in toxin concentrations over existing conditions, these increases are not large enough to result in a measurable adverse effect to least Bell's vireo individuals or the population. For the rationale and assumptions that support this finding, please see Appendix 6B.

### 6C.5.2.2 Maintenance

Maintenance activities would generate small levels of noise and require the periodic presence of staff and vehicle traffic, all of which could alter normal foraging or nesting behaviors. Vegetation control could result in injury or mortality to individuals and/or nests. Implementation of AMM-17: *Avoid and Minimize Impacts on Biological Resources from Maintenance Activities*, detailed in Appendix 3A, would require environmental review of the potential for maintenance to impact least Bell's vireo; a preconstruction survey and biological monitor depending on site-specific conditions and timing; establishment of non-disturbance buffers if the species is present; and use of appropriate work windows.

## 6C.5.3 Tunnels

Tunnels would be constructed using subsurface horizontal tunnel boring machines (TBMs) and would not result in any surface disturbance from operations and maintenance to least Bell's vireo modeled habitat; therefore, this activity would not have an adverse effect on the species.

## 6C.5.4 Tunnel Shafts

There are three types of tunnel shafts: launch shafts, maintenance shafts, and reception shafts. The purpose of the tunnel shafts is to launch, maintain, and remove TBMs at the intakes, along the tunnel

alignment, and at the Bethany Complex. Least Bell's vireo modeled habitat overlaps with tunnel shaft work area at Twin Cities Complex. Permanent facility lighting at the tunnel shaft may have the potential to affect least Bell's vireo through changes in nighttime behaviors or to make vireos more vulnerable to night predators (e.g., owls, cats, racoons). However, the project was designed to require permanent facility lighting to be downcast and shielded, with the minimum intensity required to provide adequate strength for security, safety, and personnel access ( Chapter 3, Section 3.2.13), to reduce light spilling over into adjacent habitats; therefore, permanent facility lighting is not expected to disrupt normal behaviors.

Noise and visual disturbance from equipment and periodic presence of personnel during the nesting season could alter typical foraging and nesting behaviors. Maintenance-related contaminants such as gas, oil, or steering fluid could accidentally be discharged into recolonization habitat and could result in the injury or mortality of individuals and lead to the degradation of habitat.

To minimize potential effects of noise, visual disturbance, and contaminants due to maintenance activities, AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* (Appendix 3A) would be implemented. This measure would include site-specific environmental review of the potential for maintenance to impact sensitive resources; preconstruction surveys in suitable habitat; establishment of non-disturbance buffers; and usage of appropriate work windows.

## 6C.5.5 Reusable Tunnel Material

RTM areas do not overlap with least Bell's vireo modeled habitat and therefore operations and maintenance activities at these facilities would not affect the species.

## 6C.5.6 Bethany Complex

Permanent facility lighting and operations and maintenance-related noise could alter typical foraging behaviors. Herbicide or pesticides used to control vegetation and rodents could result in the injury or mortality of individuals if exposed to the chemicals and/or indirect effects if least Bell's vireo ingest prey items exposed to the chemical.

To minimize the potential effects of operations and maintenance of the Bethany Complex on least Bell's vireo, permanent facility lighting would be designed to require lights to be downcast and shielded, with the minimum intensity required to provide adequate strength for security, safety, and personnel access, to reduce light spilling over into adjacent habitats as described in Chapter 3, Section 3.2.13. Implementation of AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would further reduce the potential for injury and mortality by including site-specific environmental review of the potential for maintenance to impact sensitive resources, preconstruction surveys, establishment of non-disturbance buffers, usage of appropriate work windows, and conducting Worker Awareness Training and monitoring. With these measures in effect, and maintenance activities occurring infrequently, potential maintenance effects on the species are expected to be negligible and are not expected to result in take of the species.

Refer to Chapter 6, Section 6.5.6*, Bethany Complex,* for more information.

## 6C.5.7 Access Roads

Operational and maintenance vehicle and equipment traffic on access roads would generate noise, light, and strike potential. Operations and maintenance activities could also expose least Bell's vireo to contaminants such as fuels, oils, herbicides, and pesticides, which could result in injury and mortality. Maintenance-related noise could also disrupt normal behaviors and result in increased energy expenditures.

Noise and light generated from occasional nighttime traffic would occur infrequently is not expected to decrease baseline conditions such that adverse effects would be expected. The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife* (Appendix 3A), which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads.

To minimize potential effects of noise, visual disturbance, and contaminants due to maintenance activities, AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* (Appendix 3A) would be implemented. This measure would include site-specific environmental review of the potential for maintenance to impact sensitive resources; preconstruction surveys in suitable habitat; establishment of non-disturbance buffers; and usage of appropriate work windows.

Refer to Chapter 6, Section 6.5.7*, Access Roads,* for more information.

## 6C.5.8 Electrical and SCADA Facilities

DWR is not responsible for the operations and maintenance of electrical facilities. Operation and maintenance of electrical facilities would be the responsibility of the electrical providers—SMUD, WAPA, and PG&E. These companies would own and maintain their respective electrical facilities.

DWR is responsible for any operation and maintenance activities associated with SCADA facilities; however, SCADA facilities do not have any associated operational activities. Maintenance activities on SCADA facilities would include emergency repair of underground or aboveground SCADA lines. Vegetation management along SCADA line sections would not be required because underground SCADA lines occur within roadway rights-of-way (that are not vegetated) and aboveground SCADA lines all occur on existing poles that are being managed from vegetation in the existing conditions.

There is potential for injury or mortality to least Bell's vireo where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife*, which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans (Appendix 3A). Refer to Chapter 6, Section 6.5.8, *Electrical and SCADA Facilities*, for more information.

## 6C.5.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections[10]: concrete batch plants and park-and-ride lots. None of these features overlap with least Bell's vireo modeled habitat, thus operations and maintenance activities associated with these facilities are not expected to affect the species.

## 6C.5.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facility construction area does not overlap with least Bell's vireo modeled habitat. Operations and maintenance activities in this area are not expected to adversely affect the species.

## 6C.5.11 Compensatory Mitigation Plan

The CMP would offset the permanent loss of sensitive natural communities and habitat for special-status species, including least Bell's vireo, by creating and enhancing habitat on Bouldin Island and the I-5 ponds, and tidal habitat restoration and managing these areas in perpetuity. The habitat creation and enhancement sites would overlap with modeled least Bell's vireo recolonization habitat.

Operation and maintenance of CMP habitat enhancement and creation sites would require general site maintenance (i.e., site visits, trash removal, maintenance of signs, fences, and gates), vegetation management (i.e., mowing, controlled burns, grazing, discing), levee and channel maintenance (i.e., levee inspection, dredging, road repairs, grading, rodent abatement), and monitoring. These activities would require the use of vehicles and/or boats, heavy equipment, and periodic presence of personnel. Specific long-term management plans would be developed for each site. Maintenance activities would take place during daylight hours.

### 6C.5.11.1 Initial Mitigation Sites: Bouldin Island and I-5 Ponds

Riparian creation and enhancement at Bouldin Island would offset the permanent loss of sensitive natural communities and habitat for special-status species, including least Bell's vireo. Site construction would include ground disturbance, grading, vegetation removal, the use of heavy equipment, and presence of personnel. Construction would take several years to construct and would not require night lighting.

Operation and maintenance of CMP habitat enhancement and creation sites would require general site maintenance (i.e., site visits, trash removal, maintenance of signs, fences, and gates), vegetation management (i.e., mowing, controlled burns, grazing, discing), levee and channel maintenance (i.e., levee inspection, dredging, road repairs, grading, rodent abatement), and monitoring. These activities would require the use of vehicles and/or boats, heavy equipment, and periodic presence of personnel. Specific long-term management plans would be developed for each site as described in Section 3B.6. Maintenance activities would take place during daylight hours.

[10] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations such as the north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.5.7, *Access Roads*, and Section 6.5.6, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

Operational and maintenance vehicles on access roads would generate noise, light, and strike potential. Operations and maintenance activities could also expose least Bell's vireo to contaminants such as fuels, oils, herbicides, and pesticides, which could result in injury and mortality. Maintenance-related noise could also disrupt normal behaviors and result in increased energy expenditures.

Noise and light generated from occasional nighttime traffic would occur infrequently and is not expected to decrease baseline conditions such that adverse effects would be expected. The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife* (Appendix 3A), which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads.

To minimize potential effects of noise, visual disturbance, and contaminants due to maintenance activities, AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* (Appendix 3A) would be implemented. This measure would include site-specific environmental review of the potential for maintenance to impact sensitive resources; preconstruction surveys in suitable habitat; establishment of non-disturbance buffers; and usage of appropriate work windows.

The creation and enhancement of wetlands have the potential to increase bioavailability of contaminants such as methylmercury, CHABs, and selenium by creating conditions favorable for the formation of these contaminants. These contaminants have been known to transfer from aquatic to adjacent terrestrial food webs and accumulate in other songbird species (Cristol et al. 2008:335; Moy et al. 2016: A, Ohlendorf and Heinz 2011: 689) (Appendix 6B).

Potential for increased methylmercury exposure, relative to existing conditions, is low at Bouldin Island and the I-5 ponds for the following reasons (see Appendix 6B, Section 6B.1, *Mercury,* for more information).

- Both areas contain existing wetlands with conditions that allow mercury in the soil to be transformed into methylmercury.
- Perennial wetlands and seasonal wetlands would not have the frequent wetting and drying cycles associated with the highest methylmercury production.
- The I-5 ponds are in areas that were not historically connected to Delta waters, therefore it is unlikely that little, if any, mercury was deposited in soils at these locations.
- Bouldin Island was historically tidal marsh and mercury deposition likely occurred at this site; however, much of Bouldin Island consists of agricultural crops that are managed to flood seasonally, which creates existing conditions that promote mercury methylation.

In addition, mercury monitoring and adaptive management would be implemented at the Bouldin Island and I-5 ponds as described in AMM-23: *Develop and Implement a Mercury Monitoring and Management Plan* (Appendix 3A).

As described in Appendix 6B, Section 6B.2, *Cyanobacterial Harmful Algal Blooms*, the likelihood of CHAB formation is low at the I-5 ponds because they are not tidally connected and would contain ambient water that would not contain *Microystis*. However, Bouldin Island wetland sites have the potential to result in increased CHAB formation. To reduce the potential for incidental take, CHAB monitoring and adaptive management would be implemented at the Bouldin Island site to meet

specific performance criteria as part of the site-specific maintenance and management plans described in Appendix 3B, Sections 3B.6 and 3B.7.

Creation and enhancement of wetlands on Bouldin Island and at the I-5 ponds is not expected to increase the risk of selenium exposure to least Bell's vireo using these habitats because existing selenium concentrations in the Sacramento River watershed are low (Central Valley Regional Water Quality Control Board 1988:14) and, therefore, existing selenium in sediments at Bouldin Island or the I-5 ponds are expected to be low (Appendix 6B, Section 6B.3, *Selenium*). Also, existing land use at the Bouldin Island and I-5 ponds includes seasonally flooded agricultural fields. Modeled selenium concentrations in water, fish tissue, and bird eggs in the existing condition near this location have selenium levels far below levels of concern (Appendix 6B, Section 6B.3.3). Therefore, wetland creation and enhancement on Bouldin Island and at the I-5 ponds would not be expected to increase the bioavailability of selenium, relative to existing conditions, and are not likely to adversely affect least Bell's vireo.

### 6C.5.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be used to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, and vernal pool tadpole shrimp. The vernal pool, pond, and grassland communities that would be protected for these species does not overlap with least Bell's vireo habitat and therefore the vireo would not be adversely affected by operations and maintenance activities associated with this action.

### 6C.5.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.5.11.2, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. Non-bank sites are evaluated programmatically and would be subject to future, "step down" consultation when site-specific information becomes available. A non-bank site would protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat. These habitat types do not overlap with least Bell's vireo habitat so the species would not be adversely affected by operations and maintenance activities associated with non-bank site protection.

### 6C.5.11.4 Site Protection Instruments

Site protection instruments may be used to protect and enhance agricultural and other lands that provide suitable habitat for species such as greater sandhill crane, Swainson's hawk, and tricolored blackbird. Site protection instruments, including real estate protection instruments, ensure the long-term protection of a mitigation site (see Section 6C.3.9.3, Site Protection Instruments, for details on these species; Wood and Martin 2016). Examples include conservation easements, deed restrictions, transfer of title, or other documents such as Conservation Land Use Agreements. Because actions associated with site protection instruments are expected to be beneficial, consultation under the ESA is not expected to be necessary. However, if consultation is required, it would occur in the future when site-specific information is available.

Site protection instruments for greater sandhill crane, Swainson's hawk, and tricolored blackbird would primarily consist of the protection and management of agricultural areas but may also include protection and management of natural communities in the action area (see Section 6C.3.9.3 for details on these species). Site protection instruments could include riparian edge habitat that

could be suitable least Bell's vireo habitat through protection and management. However, there is some potential for injury and mortality from management and maintenance activities including vehicle traffic, use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides.

The potential effects of injury or mortality due to vehicle collisions would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on unpaved access roads (Appendix 3A). Implementation of AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from land management activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). With these measures in place and the potential for protection of riparian edge habitat on these agricultural sites, site protection instruments are not likely to adversely affect the species.

### 6C.5.11.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP(Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids.

The location(s) for channel margin enhancement is not known, however, locations along the Sacramento River between Freeport and Georgiana Slough, especially near the north Delta intakes, have been identified as areas of low-quality habitat for listed fish species that would benefit from enhancement actions.

There are no operational activities associated with channel margin habitat. Maintenance activities would generate small levels of noise and require the periodic presence of staff and vehicle traffic, all of which could alter normal foraging or nesting behaviors. Vegetation control could result in injury or mortality to individuals and/or nests. Implementation of AMM-17: *Avoid and Minimize Impacts on Biological Resources from Maintenance Activities*, detailed in Appendix 3A, would require environmental review of the potential for maintenance to impact least Bell's vireo; a preconstruction survey and biological monitor depending on site-specific conditions and timing; establishment of non-disturbance buffers if the species is present; and use of appropriate work windows. With this measure in place, maintenance activities are not likely to adversely affect least Bell's vireo.

### 6C.5.11.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of the CMP (Appendix 3B). Tidal perennial and tidal freshwater emergent wetland habitats provide important foraging and refugia habitat for listed fish species. The restoration of tidal perennial and wetland habitat, particularly complex wetland systems containing dendritic channels and shallow subtidal areas, is intended to support improved survival and growth (including food production) of one or more life stages of each listed fish species addressed in the

biological assessment. Tidal restoration sites within the lower Yolo Bypass and Cache Slough Complex will be prioritized as these areas would provide greater benefits for target fish species.

There are no operational actions associated with tidal wetland restoration locations. Maintenance and management actions would be identified in a long-term management plan for each tidal restoration location and would include actions such as vegetation management, weed control, and trash management, and facilities maintenance and management. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data. The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

### Operations

Tidal restoration could affect water quality in the Delta, namely levels of methylmercury, selenium, and *CHABs such as Microcystis.* Tidal restoration would be sited in the Cache Slough or Lower Yolo Bypass region and this area is not expected to increase the bioavailability of selenium or result in conditions conducive to CHABs. See Appendix 6B for rationale. The creation of tidal wetland habitats in this region could create conditions conducive to methylation of mercury and promote uptake and bioaccumulation of methylmercury in least Bell's vireo by transfer to riparian foodwebs through consumption of aquatic invertebrates (Cristol et al. 2008:335).

To minimize the effects of methylmercury on least Bell's vireo due to tidal habitat restoration, AMM-23*: Develop and Implement a Mercury Management and Monitoring Plan* (Appendix 3A) would require project-specific assessments of tidal wetland habitats, integration of design measures to minimize mercury methylation, site monitoring and reporting, and adaptive management. With this measure in place, the least Bell's vireo is not likely to be adversely affected by tidal restoration.

### Maintenance

Maintenance and monitoring activities would generate small levels of noise and require the periodic presence of staff and vehicle traffic, all of which could alter normal foraging or nesting behaviors. Vegetation control could result in injury or mortality to individuals and/or nests. Implementation of AMM-17: *Avoid and Minimize Impacts on Biological Resources from Maintenance Activities*, detailed in Appendix 3A, would require environmental review of the potential for maintenance to impact least Bell's vireo; a preconstruction survey and biological monitor depending on site-specific conditions and timing; establishment of non-disturbance buffers if the species is present; and use of appropriate work windows. With this measure in place, the least Bell's vireo is not likely to be adversely affected by maintenance of the tidal restoration site.

## 6C.5.12 Effects on Critical Habitat

There is no designated critical habitat for least Bell's vireo in the action area.

## 6C.5.13 Cumulative Effects

Refer to Chapter 6, Section 6.5.13, *Cumulative Effects*, for more information.

# 6C.6 Effects on Western Yellow-Billed Cuckoo

Appendix 6A describes the methods and assumptions used to analyze the effects of the proposed action on terrestrial species. Chapter 4, Section 4.4.12.6, *Suitable Habitat Definition*, and Section 4.4.12.7, *Migratory Habitat Suitability Model*, define suitable habitat and describe the habitat model for western yellow-billed cuckoo. Refer to Chapter 6, Section 6.6, *Effects on Western Yellow-Billed Cuckoo,* for more information.

## 6C.6.1 Field Investigations

There would be no ongoing operations and maintenance associated with the field investigations; therefore, there would be no effect on western yellow-billed cuckoo.

## 6C.6.2 North Delta Intakes

The operational components of the north Delta intakes include intakes, fish screens, sedimentation basins and drying lagoons, and associated facilities. Permanent facility lighting would be motion activated, downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13), and therefore permanent facilities would remain dark the majority of the time at night. Operations activities would generate small levels of noise and require the periodic presence of staff and vehicle traffic. Operation of the intakes also has the potential to change water quality parameters around the Delta.

Maintenance activities at the north Delta intakes would include semiannual general and ground maintenance (e.g., mowing, vegetation trimming, herbicide application), fish screen maintenance, annual sediment and debris removal at intakes, and periodic maintenance of the intake gates and associated structures approximately every 1 to 5 years. Access roads within the intake facilities would be repaved every 15 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting. Refer to Chapter 6, Section 6.6.2 (*North Delta Intakes)* for more information.

### 6C.6.2.1 Operation

Operations activities would generate small levels of noise, have permanent light sources, and require the periodic presence of staff and vehicle traffic. However, noise from the operation of the water conveyance facilities would not be discernably higher than existing conditions, and the periodic presence of staff would not be expected to affect western yellow-billed cuckoo if present. Permanent facility lighting could extend into suitable western yellow-billed habitat and could affect the behavior of individuals if present within the illuminated habitat. Night lighting could alter normal nesting and foraging behavior. However, permanent lighting at project facilities would be motion activated, downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13), and therefore permanent facilities would remain dark the majority of the time at night, which would minimize the potential for this effect. The potential for effects from increased exposure to methylmercury, CHABs, and selenium due to operation of the north Delta intakes is discussed in Appendix 6C6B, *Water Quality*6B. This analysis found that while modeling may predict some negligible increases in toxin concentrations over existing conditions, these increases are not large enough to result in a measurable adverse effect to western yellow-billed cuckoo individuals or the population. For the rationale and assumptions that support this finding, please see Appendix 6B.

#### 6C.6.2.2 Maintenance

Maintenance activities at the north Delta intakes would include semiannual general and ground maintenance (e.g., mowing, vegetation trimming, herbicide application), annual sediment and debris removal at intakes, and periodic maintenance of the intake gates and associated structures approximately every 1 to 5 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

Maintenance activities would generate noise and require the periodic presence of staff and vehicle traffic, all of which could alter normal foraging or migratory behaviors. Vegetation control could result in injury or mortality of individuals. Implementation of AMM-17: *Avoid and Minimize Impacts on Biological Resources from Maintenance Activities*, detailed in Appendix 3A, would require environmental review of the potential for maintenance to impact western yellow-billed cuckoo; a preconstruction survey and biological monitor depending on site-specific conditions and timing; establishment of non-disturbance buffers if the species is present; and use of appropriate work windows.

### 6C.6.3 Tunnels

Tunnel operations and maintenance would be subsurface so there would be no surface-related operations and maintenance effects to western yellow-billed cuckoo modeled habitat; therefore, this activity would not have an adverse effect on the species.

### 6C.6.4 Tunnel Shafts

There are three types of tunnel shafts: launch shafts, maintenance shafts, and reception shafts. The purpose of the tunnel shafts is to launch, maintain, and remove TBMs at the intakes, along the tunnel alignment, and at the Bethany Complex. Western yellow-billed cuckoo modeled habitat overlaps with tunnel shaft work areas at Twin Cities Complex.

Tunnel shaft sites would have permanent facility lighting. Permanent facility lighting would be motion activated, downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13), and therefore permanent facilities would remain dark the majority of the time at night. Maintenance during project operations could include inspection and maintenance of tunnel shafts, maintenance of the constructed water conveyance tunnel, vegetation control around tunnel shafts, and require periodic presence of staff and vehicle traffic. Maintenance activities at launch and maintenance shafts would include semiannual general and ground maintenance (e.g., mowing, vegetation trimming, herbicide application), and daily inspections by vehicle. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

Permanent facility lighting may also have the potential to affect western yellow-billed cuckoo through changes in nighttime behaviors or to make cuckoos more vulnerable to night predators (e.g., owls, cats, racoons). However, the project was designed to require permanent facility lighting to be downcast and shielded, with the minimum intensity required to provide adequate strength for security, safety, and personnel access (Section 3.4.13), to reduce light spilling over into adjacent habitats; therefore, permanent facility lighting is not expected to disrupt normal behaviors.

Noise, vibration, and visual disturbance from equipment and periodic presence of personnel during the nesting season could alter typical migratory behaviors. Maintenance-related contaminants, such

as gas, oil, or steering fluid, could accidentally be discharged into migratory habitat and could result in the injury or mortality of individuals and lead to the degradation of habitat.

To minimize potential effects of noise, visual disturbance, and contaminants due to maintenance activities, AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* (Appendix 3A) would be implemented. This measure would include site-specific environmental review of the potential for maintenance to impact sensitive resources; preconstruction surveys in suitable habitat; establishment of non-disturbance buffers; and usage of appropriate work windows.

## 6C.6.5 Reusable Tunnel Material

There are no operations and maintenance activities associated with the RTM sites and therefore no effects to western yellow-billed cuckoo.

## 6C.6.6 Bethany Complex

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, Bethany Reservoir Aqueduct, and Bethany Reservoir Discharge Structure. All aboveground portions of these features would have permanent facility lighting. Permanent outdoor facility lighting would be motion-activated and therefore would only be lit for a short time when activated (which is expected to occur infrequently). To further minimize impacts from permanent lighting, the fixtures would also be downcast, cut-off types with non-glare finishes (Chapter 3, Section 3.2.13). Because permanent facilities would have motion-detected lights, they are not expected to contribute to ambient nighttime light.

The Bethany Reservoir Pumping Plant operations are not expected to generate noise that would substantially alter the existing environment. The pumping plant would be within an underground facility, and therefore operational light and noise would not be expected to affect species. The Bethany Reservoir Aqueduct has aboveground and below-ground sections; the Bethany Reservoir Aqueduct would contain moving water but this is not expected to be a substantial source of noise because the aboveground sections would be backfilled with approximately 6 feet of soil and the tunneled portions would be below the ground surface. The Bethany Reservoir Discharge Structure would contain large volumes of flowing water at times and would be a source of noise in the areas adjacent to the structure.

Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and the right-of-way would require vegetation removal. Access roads within the Bethany Complex would be repaved every 15 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

Permanent facility lighting and operations and maintenance-related noise could alter typical foraging behaviors. Herbicide or pesticides used to control vegetation and rodents could result in the injury or mortality of individuals, if exposed to the chemicals, and/or indirect effects, if cuckoos ingest prey items exposed to the chemical.

To minimize the potential effects of operations and maintenance of the Bethany Complex on western yellow-billed cuckoo in the event that the species uses habitat near these facilities during migration, permanent facility lighting would be designed to require lights to be downcast and shielded, with the minimum intensity required to provide adequate strength for security, safety, and personnel

access, to reduce light spilling over into adjacent habitats as described in Chapter 3, Section 3.2.13. Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would further reduce the potential for injury and mortality by including site-specific environmental review of the potential for maintenance to impact sensitive resources, preconstruction surveys, establishment of non-disturbance buffers, usage of appropriate work windows, and conducting Worker Awareness Training and monitoring. With these measures in effect, and maintenance activities occurring infrequently, potential maintenance effects on the species are expected to be negligible and are not expected to result in take of the species.

Refer to Chapter 6, Section 6.6.6*, Bethany Complex,* for more information.

## 6C.6.7 Access Roads

Operational activities on access roads include vehicles and equipment traveling to, from, and within the project facilities. Some access roads would have permanent night-lighting, which would be downcast (Chapter 3, Section 3.2.13). Maintenance of access roads would include grading, repaving, and vegetation removal. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting. Maintenance would not be conducted by DWR on public access roads, such as SR 160.

Operational and maintenance vehicle and equipment traffic on access roads would generate noise, light, and strike potential. Operations and maintenance activities could also expose western yellow-billed cuckoo to contaminants such as fuels, oils, herbicides, and pesticides, which could result in injury and mortality. Maintenance-related noise could also disrupt normal behaviors and result in increased energy expenditures.

Noise and light generated from occasional nighttime traffic would occur infrequently is not expected to decrease baseline conditions such that adverse effects would be expected. The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife* (Appendix 3A), which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads.

To minimize potential effects of noise, visual disturbance, and contaminants due to maintenance activities, AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* (Appendix 3A) would be implemented. This measure would include site-specific environmental review of the potential for maintenance to impact sensitive resources; preconstruction surveys in suitable habitat; establishment of non-disturbance buffers; and usage of appropriate work windows.

Refer to Chapter 6, Section 6.6.7*, Access Roads,* for more information.

## 6C.6.8 Electrical and SCADA Facilities

DWR is not responsible for the operations and maintenance of electrical facilities. Operation and maintenance of electrical facilities would be the responsibility of the electrical providers—SMUD, WAPA, and PG&E. These companies would own and maintain their respective electrical facilities.

DWR is responsible for any operation and maintenance activities associated with SCADA facilities; however, SCADA facilities do not have any associated operational activities. Maintenance activities on SCADA facilities would include emergency repair of underground or aboveground SCADA lines.

Vegetation management along SCADA line sections would not be required because underground SCADA lines occur within roadway rights-of-way (that are not vegetated) and the new aboveground SCADA line occurs on existing poles that are being managed from vegetation in the existing conditions.

There is potential for injury or mortality to western yellow-billed cuckoo where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans (Appendix 3A).

## 6C.6.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[11] concrete and CLSM batch plants and park-and-ride lots. None of these features overlap with western yellow-billed cuckoo modeled habitat, thus operations and maintenance activities associated with these facilities are not expected to affect the species.

## 6C.6.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facility construction area does not overlap with western yellow-billed cuckoo modeled habitat. Operations and maintenance activities in this area would not adversely affect the species.

## 6C.6.11 Compensatory Mitigation Plan

The CMP would offset the loss of sensitive natural communities and habitat for special-status species, including western yellow-billed cuckoo, by creating and enhancing habitat on Bouldin Island and the I-5 ponds, and tidal habitat restoration and managing these areas in perpetuity. The habitat creation and enhancement sites would overlap with modeled western yellow-billed cuckoo habitat.

Operation and maintenance of CMP habitat enhancement and creation sites would require general site maintenance (i.e., site visits, trash removal, maintenance of signs, fences, and gates), vegetation management (i.e., mowing, controlled burns, grazing, discing), levee and channel maintenance (i.e., levee inspection, dredging, road repairs, grading, rodent abatement), and monitoring. Specific long-term management plans would be developed for each site. These activities would require the use of vehicles or boats, heavy equipment, and periodic presence of personnel. Maintenance activities would take place during daylight hours.

[11] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, such as north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.6.7, *Access Roads*, and Section 6.6.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

### 6C.6.11.1 Initial Mitigation Sites: Bouldin Island and the I-5 Ponds

Riparian creation and enhancement at Bouldin Island would offset the permanent loss of sensitive natural communities and habitat for special-status species, including western yellow-billed cuckoo. Site construction would include ground disturbance, grading, vegetation removal, the use of heavy equipment, and presence of personnel. Construction would take several years to construct and would not require night lighting.

Operation and maintenance of CMP habitat enhancement and creation sites would require general site maintenance (i.e., site visits, trash removal, maintenance of signs, fences, and gates), vegetation management (i.e., mowing, controlled burns, grazing, discing), levee and channel maintenance (i.e., levee inspection, dredging, road repairs, grading, rodent abatement), and monitoring. These activities would require the use of vehicles and/or boats, heavy equipment, and periodic presence of personnel. Specific long-term management plans would be developed for each site as described in Section 3B.6. Maintenance activities would take place during daylight hours.

Operational and maintenance vehicle and equipment traffic on access roads would generate noise, light, and strike potential. Operations and maintenance activities could also expose western yellow-billed cuckoo to contaminants such as fuels, oils, herbicides, and pesticides, which could result in injury and mortality. Maintenance-related noise could also disrupt normal behaviors and result in increased energy expenditures.

Noise and light generated from occasional nighttime traffic would occur infrequently is not expected to decrease baseline conditions such that adverse effects would be expected. The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife* (Appendix 3A), which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads.

To minimize potential effects of noise, visual disturbance, and contaminants due to maintenance activities, AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* (Appendix 3A) would be implemented. This measure would include site-specific environmental review of the potential for maintenance to impact sensitive resources; preconstruction surveys in suitable habitat; establishment of non-disturbance buffers; and usage of appropriate work windows.

The creation and enhancement of wetlands have the potential to increase bioavailability of contaminants such as methylmercury, CHABs, and selenium by creating conditions favorable for the formation of these contaminants. These contaminants have been known to transfer from aquatic to adjacent terrestrial food webs and accumulate in other songbird species (Cristol et al. 2008:335, Moy et al. 2016:A, Ohlendorf and Heinz 2011:689) (Appendix 6B).

Potential for increased methylmercury exposure, relative to existing conditions, is likely low at Bouldin Island and the I-5 ponds for the following reasons.

- Both areas contain existing wetlands with conditions that allow mercury in the soil to be transformed into methylmercury.
- Perennial wetlands and seasonal wetlands would not have the frequent wetting and drying cycles associated with the highest methylmercury production.

- The I-5 ponds are in areas that were not historically connected to Delta waters, therefore it is unlikely that little, if any, mercury was deposited in soils at these locations.
- Bouldin Island was historically tidal marsh and mercury deposition likely occurred at this site; however, much of Bouldin Island consists of agricultural crops that are managed to flood seasonally, which creates existing conditions that promote mercury methylation.

In addition, mercury monitoring and adaptive management would be implemented at the Bouldin Island and I-5 ponds as described in AMM-23: *Develop and Implement a Mercury Monitoring and Management Plan* (Appendix 3A).

As described in Appendix 6B, Section 6B.2, the likelihood of CHAB formation is low at the I-5 ponds because they are not tidally connected and would contain ambient water that would not contain *Microystis*. However, Bouldin Island wetland sites have the potential to result in increased CHAB formation. To reduce the potential for incidental take, CHAB monitoring and adaptive management would be implemented at the Bouldin Island site to meet specific performance criteria as part of the site-specific maintenance and management plans described in Appendix 3B, Sections 3B.6 and 3B.7.

Creation and enhancement of wetlands on Bouldin Island and at the I-5 ponds is not expected to increase the risk of selenium exposure to western yellow-billed cuckoo using these habitats because existing selenium concentrations in the Sacramento River watershed are low (Central Valley Regional Water Quality Control Board 1988:14) and, therefore, existing selenium in sediments at Bouldin Island or the I-5 ponds are expected to be low (Appendix 6B, Section 6B.3). Also, existing land use at the Bouldin Island and I-5 ponds includes seasonally flooded agricultural fields. Modeled selenium concentrations in water, fish tissue, and bird eggs in the existing condition near this location have selenium levels far below levels of concern (Appendix 6B, Section 6B.3.3). Therefore, wetland creation and enhancement on Bouldin Island and at the I-5 ponds would not be expected to increase the bioavailability of selenium, relative to existing conditions, and are not likely to adversely affect western yellow-billed cuckoo.

### 6C.6.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be used to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, and vernal pool tadpole shrimp. The vernal pool, pond, and grassland communities that would be protected for these species do not overlap with western yellow-billed cuckoo habitat and therefore the cuckoo would not be adversely affected by operations and maintenance activities associated with this action.

### 6C.6.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.6.11.5, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. A non-bank site would protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat. These habitat types do not overlap with western yellow-billed cuckoo habitat so the species would not be adversely affected by operations and maintenance associated with implementation of non-bank site protection.

### 6C.6.11.4 Site Protection Instruments

Site protection instruments may be used to protect and enhance agricultural and other lands that provide suitable habitat for species such as greater sandhill crane, Swainson's hawk, and tricolored

blackbird. Site protection instruments, including real estate protection instruments, ensure the long-term protection of a mitigation site (see Section 6C.3.9.3 for details on these species; Wood and Martin 2016). Examples include conservation easements, deed restrictions, transfer of title, or other documents such as Conservation Land Use Agreements. Because actions associated with site protection instruments are expected to be beneficial, consultation under the ESA is not expected to be necessary. However, if consultation is required, it would occur in the future when site-specific information is available.

Site protection instruments for greater sandhill crane, Swainson's hawk, and tricolored blackbird would primarily consist of the protection and management of agricultural areas but may also include protection and management of natural communities in the action area (see Section 6C.3.9.3 for details on these species). Site protection instruments could include riparian edge habitat that could be suitable western yellow-billed cuckoo habitat through protection and management. However, there is some potential for injury and mortality from management and maintenance activities including vehicle traffic, use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides.

The potential effects of injury or mortality due to vehicle collisions would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on unpaved access roads (Appendix 3A). Implementation of AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from land management activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). With these measures in place and the potential for protection of riparian edge habitat on these agricultural sites, site protection instruments are not likely to adversely affect western yellow-billed cuckoo.

### 6C.6.11.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP(Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. While not the target of enhancement actions, western yellow-billed cuckoo also has the potential to benefit from the increase in riparian habitat along levees in the central Delta.

The location(s) for channel margin enhancement is not known, however, locations along the Sacramento River between Freeport and Georgiana Slough, especially near the north Delta intakes, have been identified as areas of low-quality habitat for listed fish species that would benefit from enhancement actions.

There are no operational activities associated with channel margin habitat. Maintenance activities would generate small levels of noise and require the periodic presence of staff and vehicle traffic, all of which could alter normal behaviors and result in increased energy expenditures. Implementation of AMM-17: *Avoid and Minimize Impacts on Biological Resources from Maintenance Activities*, detailed in Appendix 3A, would require environmental review of the potential for maintenance to impact western yellow-billed cuckoo; a preconstruction survey and biological monitor depending on site-

specific conditions and timing; establishment of non-disturbance buffers if the species is present; and use of appropriate work windows. With this measure in place, maintenance activities are not likely to adversely affect western yellow-billed cuckoo.

### 6C.6.11.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of CMP (Appendix 3B). Tidal perennial and tidal freshwater emergent wetland habitats provide important foraging and refugia habitat for listed fish species. The restoration of tidal perennial and wetland habitat, particularly complex wetland systems containing dendritic channels and shallow subtidal areas, is intended to support improved survival and growth (including food production) of one or more life stages of each listed fish species addressed in the biological assessment. Tidal restoration sites within the lower Yolo Bypass and Cache Slough Complex will be prioritized as these areas would provide greater benefits for target fish species.

There are no operational actions associated with tidal wetland restoration locations. Maintenance and management actions would be identified in a long-term management plan for each tidal restoration location and would include actions such as vegetation management, weed control, and trash management, and facilities maintenance and management. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data. The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

#### Operations

Tidal restoration could affect water quality in the Delta, namely levels of methylmercury, selenium, and *CHABs such as Microcystis.* Tidal restoration would be sited in the Cache Slough or Lower Yolo Bypass region and this area is not expected to increase the bioavailability of selenium or result in conditions conducive to CHABs. See Appendix 6B for rationale. The creation of tidal wetland habitats in this region could create conditions conducive to methylation of mercury and promote uptake and bioaccumulation of methylmercury in western yellow-billed cuckoo by transfer to riparian foodwebs through consumption of aquatic invertebrates (Cristol et al. 2008:335).

To minimize the effects of methylmercury on western yellow-billed cuckoo due to tidal habitat restoration, AMM-23*: Develop and Implement a Mercury Management and Monitoring Plan* (Appendix 3A) would require project-specific assessments of tidal wetland habitats, integration of design measures to minimize mercury methylation, site monitoring and reporting, and adaptive management. With this measure in place, the western yellow-billed cuckoo is not likely to be adversely affected by tidal restoration.

#### Maintenance

Maintenance activities would generate small levels of noise and require the periodic presence of staff and vehicle traffic, all of which could alter normal behaviors and result in increased energy expenditures. Implementation of AMM-17: *Avoid and Minimize Impacts on Biological Resources from Maintenance Activities*, detailed in Appendix 3A, would require environmental review of the potential for maintenance to impact western yellow-billed cuckoo; a preconstruction survey and

biological monitor depending on site-specific conditions and timing; establishment of non-disturbance buffers if the species is present; and use of appropriate work windows. With this measure in place, the western yellow-billed cuckoo is not likely to be adversely affected by maintenance activities at tidal restoration site(s).

### 6C.6.12 Effects on Critical Habitat

There is no designated critical habitat for western yellow-billed cuckoo in the action area.

### 6C.6.13 Cumulative Effects

Refer to Chapter 6, Section 6.6.13, *Cumulative Effects*, for more information.

## 6C.7 Effects on California Red-Legged Frog

Appendix 6A describes the methods and assumptions used to analyze the effects of the proposed action on terrestrial species. Chapter 4, Section 4.4.13.6, *Suitable Habitat Definition*, and Section 4.4.13.7, *Habitat Suitability Model*, define suitable habitat and describe the habitat model for California red-legged frog. Refer to Chapter 6, Section 6.7, *Effects on California Red-Legged Frog,* for more information.

### 6C.7.1 Field Investigations

There would be no ongoing operations and maintenance associated with the field investigation activities; therefore, there would be no effect on California red-legged frog.

### 6C.7.2 North Delta Intakes

The north Delta intake construction area does not overlap with California red-legged frog modeled habitat and this activity would not have an adverse effect on the species (Figure 6.6-2).

### 6C.7.3 Tunnels

The tunnel alignment from the north Delta intakes to the Bethany Complex is subsurface and there are no surface operations and maintenance activities that would overlap with California red-legged frog modeled aquatic or upland habitat.

### 6C.7.4 Tunnel Shafts

There are three types of tunnel shafts: launch shafts, maintenance shafts, and reception shafts. The purpose of the tunnel shafts is to launch, maintain, and remove TBMs at the intakes, along the tunnel alignment, and at the Bethany Complex. One reception shaft within the Bethany Reservoir surge basin overlaps with modeled California red-legged frog dispersal habitat. That impact is discussed along with other construction-related impacts under Section 6C.7.6.

## 6C.7.5 Reusable Tunnel Material

RTM areas would not overlap with California red-legged frog modeled habitat; thus, RTM area operations and maintenance would not affect California red-legged frog.

## 6C.7.6 Bethany Complex

The Bethany Complex would include a pumping plant, surge basin, reception shaft, discharge structure, and aqueduct. In addition, a construction water pipeline, electrical substation, switchyard, and access roads would be used in support of construction and operations within the Bethany Complex footprint. The construction actions associated with the Bethany Complex are described and evaluated at the project level. Operations and maintenance actions are described and evaluated programmatically and will be subject to future, "step down" consultations when site-specific detail is available.

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, Bethany Reservoir Aqueduct, and Bethany Reservoir Discharge Structure. All aboveground portions of these features would have permanent facility lighting. Permanent outdoor facility lighting would be motion-activated and therefore would only be lit for a short time when activated (which is expected to occur infrequently). To further minimize impacts from permanent lighting, the fixtures would also be downcast, cut-off types with non-glare finishes (Chapter 3, Section 3.2.13). Because permanent facilities would have motion-detected lights, they are not expected to contribute to ambient nighttime light.

The tunneled portion of the Bethany Reservoir Aqueduct would not include any surface maintenance activities, such as mowing or vegetation clearing, within the conservation easement; all maintenance activities for the aqueduct would be conducted from inside the tunnel, except in emergency situations, and the inside of the tunnel would be accessed from the surface portions of the tunnel, which are located outside of the conservation easement boundary.

The Bethany Reservoir Pumping Plant operations are not expected to generate noise that would substantially alter the existing environment. The pumping plant would be within an underground facility, and therefore operational light and noise would not be expected to affect species. The Bethany Reservoir Aqueduct has aboveground and below-ground sections; the Bethany Reservoir Aqueduct would contain moving water but this is not expected to be a substantial source of noise because the aboveground sections would be backfilled with approximately 6 feet of soil and the tunneled portions would be below the ground surface. The Bethany Reservoir Discharge Structure would contain large volumes of flowing water at times and would be a source of noise in the areas adjacent to the structure.

Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and the right-of-way would require vegetation removal. Access roads within the Bethany Complex would be repaved every 15 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting. Refer to Chapter 6, Section 6.7.6*, Bethany Complex,* for more information.

Vehicles and heavy equipment used for operations and maintenance activities, including inspections, mowing, and vegetation removal, could injure or kill California red-legged frog if individuals are present within the Bethany Complex right-of-way. Operations and maintenance-related contaminants such as gas, oil, steering fluid, herbicides, and pesticides could accidentally be

discharged into California red-legged frog habitat. Permanent facility lighting could spill over into adjacent habitats, potentially disrupting foraging and breeding activities.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife*, which requires speed limits of 15 miles per hour and traffic control structures on non-public, DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential effects of injury or mortality due to vehicles and equipment, contaminant spills, or disruption of behaviors from operations and maintenance activities by requiring spill prevention and control plans, conducting a preconstruction environmental review, requiring preconstruction surveys and a biological monitor when appropriate, and implementing appropriate non-disturbance buffers using construction fencing, where applicable. Permanent lighting at project facilities would be motion activated and therefore permanent facilities would remain dark the majority of the time at night. Permanent facility lighting would also be downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13) and thus, when lit, would minimize lighting habitat adjacent to the DWR facility. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

## 6C.7.7 Access Roads

The construction of new roads and improvements to existing roads are necessary to support project construction. New access roads would be either gravel or paved and would be built to connect existing roads to construction areas. Existing roads would be widened and improved to support the construction-related traffic, and existing roads in the vicinity of the intakes and shafts would be repaved every 15 years. The access roads that overlap with California red-legged frog modeled habitat are those that are in service to, but occur outside of, the Bethany Complex. Impacts from access road construction within the Bethany Complex are described above in Section 6.7.6.

Operational activities on access roads include vehicles and equipment traveling to, from, and within the project facilities. Some access roads would have permanent facility lighting, which would be downcast (Chapter 3, Section 3.2.13). Maintenance of access roads would include periodic grading, repaving, and vegetation removal. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting. Refer to Chapter 6, Section 6.7.7, for more information about maintenance of access roads.

All access roads created or improved to support construction have potential to be used in support of operational and maintenance activities. Most access roads would also be used by the public, as they were in the existing condition. Operational activities on access roads include vehicular and equipment traffic and maintenance activities include grading, repaving, and vegetation removal.

Vehicular traffic at nighttime during the rainy season (generally October – April) could injure or kill California red-legged frog moving across the road; however, operations traffic at night would be low and maintenance activities would occur primarily during daylight hours. Operations and maintenance-related contaminants such as gas, oil, steering fluid, herbicides, and pesticides could accidentally be discharged into California red-legged frog habitat. Maintenance activities could produce noise, which could disrupt normal behaviors and cause California red-legged frogs to be more vulnerable to predation or result in increased energy expenditures. Permanent lighting installed at intersections or along roads could disrupt normal behaviors of California red-legged frog if lighting spills over into adjacent habitats.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires posted speed limits of 15 miles per hour and traffic control structures on non-public DWR facility access roads and posted wildlife crossing signs on new or widened access roads that overlap with California red-legged frog aquatic or upland habitat. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential effects of injury or mortality due to vehicles and equipment, contaminant spills, or disruption of behaviors from operations and maintenance activities by requiring spill prevention and control plans; conducting a preconstruction environmental review; requiring preconstruction surveys, environmental resources work awareness training, and a biological monitor when appropriate; and implementing appropriate non-disturbance buffers, where applicable. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

## 6C.7.8 Electrical and SCADA Facilities

DWR is not responsible for the operations and maintenance of electrical facilities. Operation and maintenance of electrical facilities would be the responsibility of the electrical providers—SMUD, WAPA, and PG&E. These companies would own and maintain their respective electrical facilities.

DWR is responsible for any operation and maintenance activities associated with SCADA facilities; however, SCADA facilities do not have any associated operational activities. Maintenance activities on SCADA facilities would include emergency repair of underground or aboveground SCADA lines. Vegetation management along SCADA line sections would not be required because underground SCADA lines occur within roadway rights-of-way (that are not vegetated) and the new aboveground SCADA line occurs on existing poles that are being managed from vegetation in the existing conditions.

There is potential for injury or mortality to California red-legged frogs where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife*, which requires speed limits of 15 miles per hour and traffic control structures on non-public DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans (Appendix 3A).

## 6C.7.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[12] concrete and CLSM batch plants and park-and-ride lots. None of these features overlap with the California red-legged frog modeled habitat.

[12] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, e.g., North Delta Intakes, Bethany Complex, etc. For example, there are impacts from road work areas included in Section 6.7.7, *Access Roads*, and Section 6.7.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside those primary construction locations.

# 6C.7.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facility construction area does not overlap with California red-legged frog modeled habitat. Activities in this area would not have an adverse effect on the species.

# 6C.7.11 Compensatory Mitigation Plan

## 6C.7.11.1 Initial Mitigation Sites: Bouldin Island and I-5 Ponds

The Bouldin Island and I-5 pond creation and enhancement sites do not overlap with California red-legged frog modeled habitat; therefore, operations and maintenance activities would have no effect on the species.

## 6C.7.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be used to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, and vernal pool tadpole shrimp. Mitigation or conservation bank credits purchased for these species would be purchased at banks that have been approved by USFWS. Through the approval process, any potential impacts on California red-legged frog from restoration, creation, enhancement, management, maintenance, or monitoring would have been addressed by the USFWS through credit approval process. Because the approved bank would provide bank credits for California red-legged frog, the purchase is assumed to be beneficial for the species.

## 6C.7.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.7.11.2, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. Non-bank sites are evaluated programmatically and would be subject to future, "step down" consultation when site-specific information becomes available. A non-bank site would create or restore, protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat. If non-bank sites are used for vernal pool or alkaline wetland creation or enhancement (Appendix 3B, Section 3B.3.2.4, *Vernal Pools and Alkaline Wetlands*), these activities could occur in areas where California red-legged frogs have potential to occur.

Construction and management activities could include ground disturbance, require some vehicle traffic and use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides, which could result in the injury, mortality, and disruption of normal behaviors of California red-legged frog. The *California Reg-Legged Frog Avoidance and Minimization Measure* described in Chapter 3, Section 3.6.2.5, would minimize impacts by requiring preconstruction surveys, requiring the presence of a qualified biological monitor, minimizing ground disturbing activities, minimizing nighttime construction, and avoiding initial ground disturbance work during periods of rainfall, implementing a relocation plan, installing exclusion fencing 14 days prior to construction to reduce effects of construction where California red-legged frog habitat is within 300 feet of construction activities. To reduce the potential effects of contamination from spills, AMM-2: *Develop and Implement Hazardous Materials Management Plans,* and AMM-3: *Develop and Implement Spill Prevention, Control, and Countermeasure Plans* (Appendix 3A) would require spill prevention and control plans be created and implemented. With these measures in place, and the long-term benefits

associated with protection and long-term management of California red-legged frog habitat, implementation of non-bank sites is not expected to adversely affect the species.

### 6C.7.11.4 Site Protection Instruments

Site protection instruments may be used to protect and enhance agricultural and other lands that provide suitable habitat for species such as greater sandhill crane, Swainson's hawk, and tricolored blackbird. Site protection instruments, including real estate protection instruments, ensure the long-term protection of a mitigation site (see Section 6C.3.9.3 for details on these species; Wood and Martin 2016). Examples include conservation easements, deed restrictions, transfer of title, or other documents such as Conservation Land Use Agreements. The site protection instrument would describe site ownership, management, and enforcement of any use restrictions. As with mitigation bank, conservation bank, or non-bank sites, the quantity and quality of acres proposed to be included in a site protection instrument would be determined, in coordination with USFWS and CDFW, during the preconstruction phase as described in Appendix 3B. Because actions associated with site protection instruments are expected to be beneficial, consultation under the ESA is not expected to be necessary. However, if consultation is required, it would occur in the future when site-specific information is available.

Site protection instruments for greater sandhill crane, Swainson's hawk, and tricolored blackbird would primarily consist of the protection and management of agricultural areas but may also include protection and management of natural communities (e.g., grasslands or vernal pool complex) in the action area (see Section 6C.3.9.3 for details on these species). The need for a site protection instrument is not yet known. Nor is the location of the protection known. However, these activities could occur in areas with suitable habitat for California red-legged frog.

Land management activities associated with site protection instruments could include ground disturbance, some vehicle traffic and use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides, which could result in the injury, mortality, and disruption of normal behaviors of California red-legged frog. The potential effects of injury or mortality due to vehicle collisions would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on unpaved access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from land management activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). Overall, site protection instruments would benefit California red-legged frog by protecting and managing lands with suitable California red-legged frog habitat, limiting use of pesticides, and promoting habitat connectivity.

### 6C.7.11.5 Channel Margin Enhancements

Channel margin enhancements would take place in areas that do not provide habitat for California red-legged frog and would be outside of the species' current range. Therefore, this activity would have no effect on California red-legged frog.

#### 6C.7.11.6 Tidal Perennial/Emergent Wetland Restoration

Tidal wetland restoration would take place in areas outside of the current California red-legged frog range. Therefore, this activity would have no effect on California red-legged frog.

### 6C.7.12 Effects on Critical Habitat

The Bethany Reservoir Aqueduct, Bethany Reservoir Discharge Structure, access road to the Bethany Reservoir Discharge Structure, and underground SCADA fiber routes overlap with critical habitat unit CCS-2B for California red-legged frog (50 CFR Part 17, 12816 – 12959). While construction of these project features has potential to affect California red-legged frog critical habitat, all operations and maintenance activities for these features will occur within the disturbed footprint so there is no potential for additional effects to critical habitat. Potential effects to critical habitat from construction are discussed in Section 6.7.12, *Effects on Critical Habitat.*

### 6C.7.13 Cumulative Effects

Refer to Chapter 6, Section 6.7.13, *Cumulative Effects*, for more information.

## 6C.8 Effects on California Tiger Salamander

Appendix 6A, *Terrestrial Effects Analysis Methods*, describes the methods and assumptions used to analyze the effects of the proposed action on terrestrial species. Chapter 4, Section 4.4.14.6, *Suitable Habitat Definition*, and Section 4.4.14.7, *Habitat Suitability Model*, define suitable habitat and describe the habitat model for California tiger salamander. Refer to Chapter 6, Section 6.8, *Effects on California Tiger Salamander,* for more information.

### 6C.8.1 Field Investigations

There would be no ongoing operations and maintenance associated with field investigations; therefore, there would be no effect on California tiger salamander.

### 6C.8.2 North Delta Intakes

The north Delta intake construction area does not overlap with California tiger salamander modeled habitat. Activities in this area would not affect the species.

### 6C.8.3 Tunnels

The tunnel alignment from the north Delta intakes to the Bethany Complex does not overlap with California tiger salamander modeled habitat. Activities in this area would not affect the species.

### 6C.8.4 Tunnel Shafts

California tiger salamander modeled habitat does not overlap with any tunnel shaft locations.

## 6C.8.5 Reusable Tunnel Material

RTM areas do not overlap with California tiger salamander modeled habitat. Activities for these facilities would not affect the species.

## 6C.8.6 Bethany Complex

The Bethany Complex would include a pumping plant, surge basin, reception shaft, discharge structure, and aqueduct. In addition, a construction water pipeline, electrical substation, switchyard, and access roads would be used in support of construction and operations within the Bethany Complex footprint. The construction actions associated with the Bethany Complex are described and evaluated at the project level. Operations and maintenance actions are described and evaluated programmatically and will be subject to future, "step down" consultations when site-specific detail is available. The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, Bethany Reservoir Aqueduct, and Bethany Reservoir Discharge Structure. All aboveground portions of these features would have permanent facility lighting. Permanent outdoor facility lighting would be motion-activated and therefore would only be lit for a short time when activated (which is expected to occur infrequently). To further minimize impacts from permanent lighting, the fixtures would also be downcast, cut-off types with non-glare finishes (Chapter 3, Section 3.2.13). Because permanent facilities would have motion-detected lights, they are not expected to contribute to ambient nighttime light.

The Bethany Reservoir Pumping Plant operations are not expected to generate noise that would substantially alter the existing environment. The pumping plant would be within an underground facility, and therefore operational light and noise would not be expected to affect species. The Bethany Reservoir Aqueduct has aboveground and below-ground sections; the Bethany Reservoir Aqueduct would contain moving water but this is not expected to be a substantial source of noise because the aboveground sections would be backfilled with approximately 6 feet of soil and the tunneled portions would be below the ground surface. The Bethany Reservoir Discharge Structure would contain large volumes of flowing water at times and would be a source of noise in the areas adjacent to the structure.

Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and the right-of-way would require vegetation removal. Access roads within the Bethany Complex would be repaved every 15 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting. Refer to Chapter 6, Section 6.8.6*, Bethany Complex,* for more information.

Vehicles and heavy equipment used for operations and maintenance activities could injure or kill California tiger salamander. Operations- and maintenance-related runoff and contaminants such as gas, oil, steering fluid, herbicides, and pesticides could accidentally be discharged into California tiger salamander habitat and result in injury and mortality or habitat degradation. Permanent facility lighting could disrupt normal behaviors if lighting spills over into adjacent habitat.

The Bethany Reservoir Aqueduct would not include any surface maintenance activities, such as mowing or vegetation clearing, within the boundary of the Bethany Reservoir Conservation Easement. Therefore, there would be no effects on California tiger salamander habitat in the conservation easement from maintenance activities. Maintenance activities for the aqueduct would be conducted from inside the tunnel and the inside of the tunnel would be accessed from the entry portals, which would be outside of the conservation easement boundary (Chapter 3, Section 3.2.6.3).

To limit injury and mortality from vehicles, AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife* would require speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would further reduce the potential for injury or mortality due to vehicles and equipment, contaminant spills, or disruption of behaviors from operations and maintenance activities by requiring spill prevention and control plans, a preconstruction environmental review, preconstruction surveys, a biological monitor, and, when appropriate, and non-disturbance buffers using construction fencing, where applicable. Permanent lighting at project facilities would be motion activated and therefore permanent facilities would remain dark the majority of the time at night. Permanent facility lighting would also be downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13) and thus, when lit, would minimize lighting habitat adjacent to the DWR facility. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

## 6C.8.7 Access Roads

The construction of new access roads and improvements to existing roads are necessary to support project construction and project facilities. New access roads would be either gravel or paved and would be built to connect existing roads to construction and operations areas. Existing roads would be widened and improved to support the construction-related traffic, and existing access roads in the vicinity of intakes and shafts would be repaved every 15 years.

Operational activities on access roads include vehicles and equipment traveling to, from, and within the project facilities. Some access roads would have permanent facility lighting, which would be downcast (Chapter 3, Section 3.2.13). Maintenance of access roads includes periodic grading, repaving, and vegetation removal. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting. Refer to Chapter 6, Section 6.8.7*, Access Roads,* for more information.

Vehicles and heavy equipment used for operations and maintenance activities could injure or kill California tiger salamander. Vehicular traffic at nighttime during the rainy season (generally October through April) could injure or kill California tiger salamander moving across access roads; however, operations traffic at night would be low and maintenance activities would occur primarily during daylight hours. Operations- and maintenance-related runoff and contaminants such as gas, oil, steering fluid, herbicides, and pesticides could accidentally be discharged into California tiger salamander habitat and result in injury and mortality or habitat degradation.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife*, which would require speed limits of 15 miles per hour and traffic control structures on non-public unpaved DWR facility access roads and posted wildlife crossing signs on new or widened access roads that overlap with California tiger salamander aquatic or upland habitat (Appendix 3A). AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality due to vehicles and equipment, contaminant spills, or disruption of behaviors from operations and maintenance activities by requiring spill prevention and control plans, a preconstruction environmental review, preconstruction surveys, environmental resources work awareness training, and a biological monitor, when appropriate, and non-disturbance buffers, where applicable (Appendix 3A).

Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

## 6C.8.8 Electrical and SCADA Facilities

DWR is not responsible for the operations and maintenance of electrical facilities. Operation and maintenance of electrical facilities would be the responsibility of the electrical providers—SMUD, WAPA, and PG&E. These companies would own and maintain their respective electrical facilities.

DWR is responsible for any operation and maintenance activities associated with SCADA facilities; however, SCADA facilities do not have any associated operational activities. Maintenance activities on SCADA facilities would include emergency repair of underground or aboveground SCADA lines. Vegetation management along SCADA line sections would not be required because underground SCADA lines occur within roadway rights-of-way (that are not vegetated) and aboveground SCADA lines all occur on existing poles that are being managed from vegetation in the existing conditions.

There is potential for injury or mortality to California tiger salamander where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife*, which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans (Appendix 3A).

## 6C.8.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[13] concrete and CLSM batch plants and park-and-ride lots. None of these features overlap with the California tiger salamander modeled habitat; thus, activities associated with these facilities are not expected to affect the species.

## 6C.8.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facility construction area does not overlap with California tiger salamander modeled habitat. Activities in this area would not adversely affect the species.

## 6C.8.11 Compensatory Mitigation

The wetland creation and enhancement sites under the CMP do not overlap with California tiger salamander modeled habitat. Activities in this area would not affect the species.

[13] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, such as north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.8.7, *Access Roads*, and Section 6.8.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

### 6C.8.11.1 Initial Mitigation Sites: Bouldin Island and I-5 Ponds

The Bouldin Island and I-5 pond creation and enhancement sites do not overlap with California tiger salamander modeled habitat; therefore, these activities would have no effect on the species.

### 6C.8.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be used to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, and vernal pool tadpole shrimp. Mitigation or conservation bank credits purchased for these species would be purchased at banks that have been approved by USFWS. Through the approval process, any potential impacts on California tiger salamander from restoration, creation, enhancement, management, maintenance, or monitoring would have been addressed by the USFWS through credit approval process. Because the approved bank would provide bank credits for California tiger salamander, the purchase is assumed to be beneficial to the species.

### 6C.8.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.8.11.2, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. Non-bank sites are evaluated programmatically and would be subject to future, "step down" consultation when site-specific information becomes available. A non-bank site would create or restore, protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat. If non-bank sites are used for vernal pool or alkaline wetland creation or enhancement (Appendix 3B, Section 3B.3.2.4), these activities could occur in areas where California tiger salamander have potential to occur.

Construction and management activities could include ground disturbance, require some vehicle traffic and use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides, which could result in the injury, mortality, and disruption of normal behaviors of California tiger salamander. The *California Tiger Salamander Avoidance and Minimization Measure* described in Chapter 3, Section 3.6.2.6 would minimize impacts by requiring preconstruction surveys, requiring the presence of a qualified biological monitor, minimizing ground disturbing activities, minimizing nighttime construction, avoiding initial ground disturbance work during periods of rainfall, implementing a relocation plan, and installing exclusion fencing around the perimeter of construction sites where California tiger salamander habitat is within 300 feet of construction activities 14 days prior to construction to reduce effects of construction. To reduce the potential effects of contamination from spills, AMM-2: *Develop and Implement Hazardous Materials Management Plans,* and AMM-3: *Develop and Implement Spill Prevention, Control, and Countermeasure Plans* would require spill prevention and control plans be created and implemented (Appendix 3A). With these measures in place, and the long-term benefits associated with protection and long-term management of California tiger salamander habitat, implementation of non-bank sites is not expected to adversely affect the species.

### 6C.8.11.4 Site Protection Instruments

Site protection instruments may be used to protect and enhance agricultural and other lands that provide suitable habitat for species such as greater sandhill crane, Swainson's hawk, and tricolored blackbird. Site protection instruments, including real estate protection instruments, ensure the long-term protection of a mitigation site (see Section 6C.3.9.3 for details on these species; Wood and

Martin 2016). Examples include conservation easements, deed restrictions, transfer of title, or other documents such as Conservation Land Use Agreements. The site protection instrument would describe site ownership, management, and enforcement of any use restrictions. As with mitigation bank, conservation bank, or non-bank sites, the quantity and quality of acres proposed to be included in a site protection instrument would be determined, in coordination with USFWS and CDFW, during the preconstruction phase as described in Appendix 3B. Because actions associated with site protection instruments are expected to be beneficial, consultation under the ESA is not expected to be necessary. However, if consultation is required, it would occur in the future when site-specific information is available.

### 6C.8.11.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP (Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the waterside of levees along channels that provide rearing and outmigration habitat for juvenile salmonids.

The location(s) for channel margin enhancement is not known; however, locations in the Cache Slough complex are possible. Because California tiger salamanders are known to occur in the upland areas adjust to tidal sloughs where enhancements could occur, the species has potential to be affected. However, because all maintenance and operations activities would occur within the channel margin enhancement site, and the channel margin site would be subject to tidal action, California tiger salamanders are not expected to use the site and therefore would not be subject to potential effects from operations or maintenance activities.

### 6C.8.11.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of the CMP (Appendix 3B). Tidal perennial and tidal freshwater emergent wetland habitats provide important foraging and refugia habitat for listed fish species. The restoration of tidal perennial and wetland habitat, particularly complex wetland systems containing dendritic channels and shallow subtidal areas, is intended to support improved survival and growth (including food production) of one or more life stages of each listed fish species addressed in the biological assessment.

Tidal restoration will generally be achieved by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Restoration would primarily occur through breaching or setback of levees, thereby restoring tidal fluctuation to land parcels currently isolated behind those levees. Where practicable and appropriate, portions of restoration sites will be raised to elevations that will support tidal marsh vegetation following levee breaching.

Because tidal restoration sites within the lower Yolo Bypass and Cache Slough Complex will be prioritized for tidal restoration, and California tiger salamander occur in the upland areas adjacent to tidal sloughs where restoration would occur, there is some potential for California tiger salamander to be affected by tidal restoration. However, there are no operational activities associated with tidal restoration that could affect California tiger salamander. And, any maintenance and monitoring activities would occur in areas that no longer provide suitable habitat for California tiger salamander; therefore, these activities would have no effect on the species.

### 6C.8.12 Effects on Critical Habitat

The action area does not overlap with designated California tiger salamander critical habitat.

### 6C.8.13 Cumulative Effects

Refer to Chapter 6, Section 6.8.13, *Cumulative Effects*, for more information.

## 6C.9 Effects on Giant Garter Snake

Appendix 6A, *Terrestrial Effects Analysis Methods*, describes the methods and assumptions used to analyze the effects of the proposed action on terrestrial species. Chapter 4, Section 4.4.15.6, *Suitable Habitat Definition*, and Section 4.4.15.7, *Habitat Suitability Model*, define suitable habitat and describe the habitat model for giant garter snake. Refer to Chapter 6, Section 6.9, *Effects on Giant Garter Snake,* for more information.

### 6C.9.1 Field Investigations

There would be no ongoing operations or maintenance associated with field investigations; therefore, there would be no effect on giant garter snake.

### 6C.9.2 North Delta Intakes

The north Delta intakes would be constructed on the east bank of the Sacramento River upstream and downstream of Hood. Two intakes would divert water from the Sacramento River and include cylindrical fish screens, intake structures, sedimentation basins, sediment drying lagoons, flow control structures, intake outlet channel and shaft, embankments, and other appurtenant structures. Intakes would also include construction support facilities (e.g., emergency facilities, fuel station), electrical substations, switchyards, and access roads that fall within the north Delta intake facility footprints. The north Delta intakes would be surrounded by security fencing.

The operational components of the north Delta intakes include intakes, fish screens, sedimentation basins and drying lagoons, and associated facilities. Permanent facility lighting would be motion activated, downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13), and therefore permanent facilities would remain dark the majority of the time at night. Operations activities would generate small levels of noise and require the periodic presence of staff and vehicle traffic.

Maintenance activities at the north Delta intakes would include semiannual general and ground maintenance (e.g., mowing, vegetation trimming, herbicide application), fish screen maintenance, annual sediment and debris removal at intakes, and periodic maintenance of the intake gates and associated structures approximately every 1 to 5 years. Access roads within the intake facilities would be repaved every 15 years.

#### 6C.9.2.1 Operation

Operations activities would generate small levels of noise, have permanent light sources, and require the periodic presence of staff and vehicle traffic that could disturb normal giant garter snake

behavior. However, noise from the operations of the water conveyance facilities would not be discernably higher than existing conditions, and the periodic presence of staff would not be expected to affect giant garter snake, if present.

The potential for effects from increased exposure to methylmercury, CHABs, and selenium due to operation of the north Delta intakes is discussed in Appendix 6B. This analysis found that while modeling may predict some negligible increases in toxin concentrations over existing conditions, these increases are not large enough to result in a measurable adverse effect to giant garter snake individuals or the population. For the rationale and assumptions that support this finding, please see Appendix 6B, Section6B.1, *Mercury*.

#### 6C.9.2.2 Maintenance

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of giant garter snake. Vehicle traffic traveling on access roads within the facilities during the active season (May 1 to September 30) could result in injury or mortality. Maintenance activities could also expose giant garter snake to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

### 6C.9.3 Tunnels

Tunnel operations require periodic and sometimes continuous operation of water pumps and air handlers (used to circulate air) within the tunnels. While pumps and air handlers produce vibration, it would be at noticeable levels only within a localized area, generally less than 50 feet away from equipment.

Operations and maintenance activities within the tunnels would produce low levels of vibration. Operations would produce periodic and sometimes continuous vibration; however, because of the depth of the tunnels (greater than 103 feet below surface), the vibration is very unlikely to be perceptible at the surface. Also, maintenance activities within the tunnel will be infrequent, and the infrequent and temporary nature of any vibration reaching the surface would not exceed existing background noise and vibration levels at the surface. As a result, operations and maintenance of the tunnels would not result in a measurable adverse effect on giant garter snake individuals.

### 6C.9.4 Tunnel Shafts

Maintenance during project operations could include inspection and maintenance of tunnel shafts, maintenance of the constructed water conveyance tunnel, vegetation control around tunnel shafts,

and periodic presence of staff and vehicle traffic. Maintenance activities at launch and maintenance shafts would include semiannual general and ground maintenance (e.g., mowing, vegetation trimming, herbicide application), burrow filling (for the purpose of rodent control), and daily inspections by vehicle.

Maintenance during project operations could include inspection and maintenance of tunnel shafts, maintenance of the constructed water conveyance tunnel, vegetation control around tunnel shafts, and periodic presence of staff and vehicle traffic. Maintenance activities at launch and maintenance shafts would include semiannual general and ground maintenance (e.g., mowing, vegetation trimming, herbicide application), burrow filling (for the purpose of rodent control), and daily inspections by vehicle.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of giant garter snake. Vehicle traffic traveling on access roads within the facilities during the active season (May 1 to September 30) could result in injury or mortality. Maintenance activities could also expose giant garter snake to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from operations and maintenance activities during operations and maintenance activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

## 6C.9.5 Reusable Tunnel Material

There are no operations and maintenance activities associated with the RTM sites and therefore no effects on giant garter snake.

## 6C.9.6 Bethany Complex

The Bethany Complex would include a pumping plant, surge basin, reception shaft, discharge structure, and aqueduct. In addition, a construction water pipeline, electrical substation, switchyard, and access roads would be used in support of construction and operations within the Bethany Complex footprint.

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, Bethany Reservoir Aqueduct, and Bethany Reservoir Discharge Structure. All aboveground portions of these features would have permanent facility lighting. Permanent outdoor facility lighting would be motion-activated and therefore would only be lit for a short time when activated (which is expected to occur infrequently). To further minimize impacts from permanent lighting, the fixtures would also be downcast, cut-off types with non-glare finishes (Chapter 3, Section 3.2.13). Because permanent facilities would have motion-detected lights, they are not expected to contribute to ambient nighttime light.

The Bethany Reservoir Pumping Plant operations are not expected to generate noise that would substantially alter the existing environment. The pumping plant would be within an underground facility, and therefore operational light and noise would not be expected to affect species. The Bethany Reservoir Aqueduct has aboveground and below-ground sections; the Bethany Reservoir Aqueduct would contain moving water but this is not expected to be a substantial source of noise because the aboveground sections would be backfilled with approximately 6 feet of soil and the tunneled portions would be below the ground surface. The Bethany Reservoir Discharge Structure would contain large volumes of flowing water at times and would be a source of noise in the areas adjacent to the structure.

Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and the right-of-way would require vegetation removal. Access roads within the Bethany Complex would be repaved every 15 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, aqueduct, and Bethany Reservoir Discharge Structure. Pumping plant operations would occur within an underground facility, and the aqueduct and discharge structure would be operated aboveground within the Bethany Complex. Operation of the Bethany Complex would involve periodic presence of humans and vehicle travel on access roads during day and night. The Bethany Complex includes the surface lands above the tunnel portion of the aqueduct that runs from the pumping plant facility to Bethany Reservoir. Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and associated facilities would involve periodic vegetation removal and repaving access roads within the Bethany Complex facilities every 15 years.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of giant garter snake. Vehicle traffic traveling on access roads within the facilities during the active season (May 1 to September 30) could result in injury or mortality. Maintenance activities could also expose giant garter snake to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality.

While these effect mechanisms would exist at the Bethany Complex, the likelihood of effects is minimal because giant garter snake is unlikely to be present. As a result, impacts on giant garter snake from operations and maintenance activities are extremely unlikely to occur and therefore discountable.

## 6C.9.7 Access Roads

The construction of new access roads, a new access railroad spur on Lower Roberts Island, and improvements to existing roads are necessary to support project construction and project facilities. In addition to these road and railroad features, impacts from levee improvements on Lower Roberts Island are also evaluated in this section (as the levee improvements would be adjacent to the access road, have similar impacts on species, and occur at roughly the same time).

Operational activities on access roads include vehicles and equipment traveling to, from, and within the project facilities. Some access roads would have permanent night-lighting, which would be downcast (Chapter 3, Section 3.2.13). Maintenance of access roads would include grading, repaving, and vegetation removal. Existing access roads in the vicinity of the intakes and shafts would be repaved every 15 years. Maintenance would not be conducted by DWR on public access roads, such

as SR 160 and SR 12. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of giant garter snake. Vehicle traffic traveling on access roads during the active season (May 1 to September 30) could result in injury or mortality. Maintenance activities could also expose giant garter snake to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires posted speed limits of 15 miles per hour and traffic control structures on non-public, DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from operations and maintenance activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers where applicable (Appendix 3A).

Refer to Chapter 6, Section 6.9.7*, Access Roads,* for more information.

## 6C.9.8 Electrical and SCADA Facilities

The following discussion includes an analysis of electrical facility types (e.g., electrical powerlines, substation on Lower Roberts Island) where they occur outside one of the project feature footprints described in the above sections (e.g., north Delta intakes, Bethany Complex). Where the construction footprint of an electrical or SCADA facility type (e.g., switching station, substation) falls within a larger facility construction footprint, such as Bethany Complex, the effects associated with that facility type are discussed in the relative sections.

DWR is not responsible for the operations and maintenance of electrical facilities. Operation and maintenance of electrical facilities would be the responsibility of the electrical providers—SMUD, WAPA, and PG&E. These companies would own and maintain their respective electrical facilities.

DWR is responsible for any maintenance activities associated with SCADA facilities; SCADA facilities do not have any associated operational activities. Maintenance activities on SCADA facilities would include emergency repair of underground or aboveground SCADA lines. Vegetation management along SCADA line sections would not be required because underground SCADA lines occur within roadway rights-of-way (that are not vegetated) and the new aboveground SCADA line occurs on existing poles that are being managed from vegetation in the existing conditions.

There is potential for injury or mortality to giant garter snakes where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans (Appendix 3A).

## 6C.9.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[14] concrete and CLSM batch plants and park-and-ride lots. None of these features overlap with giant garter snake modeled habitat, thus activities associated with these facilities are not expected to affect the species.

## 6C.9.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facilities would be constructed to deliver water from the Union Island tunnel shaft to the existing CCWD Middle River Pipeline on Victoria Island. DWR would be responsible for operations and maintenance of the interconnection pump station and interconnection pipeline between the Union Island tunnel shaft and the existing CCWD pumping plant. CCWD would be responsible for operations and maintenance of the interconnection valve within the CCWD facility. Operations and maintenance of the interconnection pump station would be similar to those at the Union Island tunnel shaft and take place within the shaft's permanent footprint. Inspections of the interconnection pump station and pipeline would occur at regular intervals, and annual mowing of the pipeline right-of-way would occur as needed.

The operational components of the CCWD interconnection pump station and interconnection valve would take place within the permanent footprints of the Union Island tunnel shaft and CCWD pumping plant, which would no longer contain suitable giant garter snake habitat. There is potential for injury or mortality to giant garter snakes where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair the CCWD interconnection pipeline. Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of giant garter snake. Maintenance activities could also expose giant garter snake to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality.

The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires posted speed limits of 15 miles per hour and traffic control structures on non-public, unpaved project facility access roads (Appendix 3A). AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers where applicable (Appendix 3A). Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting. Refer to Chapter 6, Section 6.9.10*, Contra Costa Water District Interconnection Facilities,* for more information.

[14] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, e.g., such as north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.9.7, *Access Roads*, and Section 6.9.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

# 6C.9.11 Compensatory Mitigation

## 6C.9.11.1 Initial Mitigation Sites: Bouldin Island and the I-5 Ponds

The CMP (Appendix 3B) would offset the permanent loss of wetlands and habitat for special-status species, including giant garter snake, by creating and enhancing habitat on Bouldin Island and I-5 ponds and managing these areas in perpetuity. The habitat creation and enhancement sites would overlap with modeled giant garter snake habitat.

Operation and maintenance of CMP created and enhanced habitat would require general site maintenance (i.e., site visits, trash removal, maintenance of signs, fences, and gates), vegetation management (i.e., mowing, controlled burns, grazing, discing), levee and channel maintenance (i.e., levee inspection, dredging, road repairs, grading, rodent abatement), and monitoring. These activities would require the use of vehicles and/or boats, heavy equipment, and periodic presence of personnel. Specific long-term management plans would be developed for each site. Maintenance activities would take place during daylight hours.

### Operations

The creation and enhancement of wetlands have the potential to increase bioavailability of contaminants such as methylmercury, CHABs, and selenium by creating conditions favorable for the formation of these contaminants. These contaminants have been known to transfer from aquatic to adjacent terrestrial food webs (Cristol et al. 2008:335) (Appendix 6B) and elevated methylmercury concentrations have been documented in snakes suggesting these species could be at risk for adverse effects of mercury contamination (Haskins et al. 2019:144).

Potential for increased methylmercury exposure, relative to existing conditions, is likely low at Bouldin Island and the I-5 ponds for the following reasons (see Appendix 6B, Section 6B.1 for more information).

- Both areas contain existing wetlands with conditions that allow mercury in the soil to be transformed into methylmercury.
- Perennial wetlands and seasonal wetlands would not have the frequent wetting and drying cycles associated with the highest methylmercury production.
- The I-5 ponds are in areas that were not historically connected to Delta waters, therefore it is unlikely that little, if any, mercury was deposited in soils at these locations.
- Bouldin Island was historically tidal marsh and mercury deposition likely occurred at this site; however, much of Bouldin Island consists of agricultural crops that are managed to flood seasonally, which creates existing conditions that promote mercury methylation.

In addition, mercury monitoring and adaptive management would be implemented at the Bouldin Island and I-5 ponds as described in AMM-23: *Develop and Implement a Mercury Monitoring and Management Plan* (Appendix 3A).

As described in Appendix 6B, Section 6B.2, the likelihood of CHAB formation is low at the I-5 ponds because they are not tidally connected and would contain ambient water that would not contain *Microystis*. However, Bouldin Island wetland sites have the potential to result in increased CHAB formation. To reduce the potential for incidental take, CHAB monitoring and adaptive management

would be implemented at the Bouldin Island site to meet specific performance criteria as part of the site-specific maintenance and management plans described in Appendix 3B, Sections 3B.6 and 3B.7.

Creation and enhancement of wetlands on Bouldin Island and at the I-5 ponds is not expected to increase the risk of selenium exposure to giant garter snake using these habitats because existing selenium concentrations in the Sacramento River watershed are low (Central Valley Regional Water Quality Control Board 1988:14) and, therefore, existing selenium in sediments at Bouldin Island or the I-5 ponds are expected to be low (Appendix 6B, Section 6B.3). Also, modeled selenium concentrations in water, fish tissue, and bird eggs in the existing condition near this location have selenium levels far below levels of concern (Appendix 6B, Section 6B.3.3). Therefore, wetland creation and enhancement on Bouldin Island and at the I-5 ponds would not be expected to increase the bioavailability of selenium, relative to existing conditions, and are not likely to adversely affect giant garter snake.

### Maintenance

Maintenance and monitoring activities would generate small levels of noise, require some vehicle traffic, and require the periodic presence of staff and vehicle traffic that could disturb normal giant garter snake behavior. Monitoring activities may include some in-water sampling, including small boat or kayak-based sampling and monitoring.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of giant garter snake. Vehicle traffic traveling on access roads within the facilities during the active season (April 16 to September 30) could result in injury or mortality. Maintenance activities could also expose giant garter snake to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public DWR facility access roads (Appendix 3A). Implementation of AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from operations and maintenance activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

## 6C.9.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be purchased to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, vernal pool tadpole shrimp, alkali seasonal wetland, and vernal pool habitat. Mitigation or conservation bank credits for these species or wetlands would be purchased at banks that have been approved by USFWS, and would have measures to avoid, minimize, and offset any effects to listed species. In addition, mitigation bank credits would be purchased within recovery units for these species in areas that are not likely to provide suitable giant garter snake habitat. Therefore, the purchase of mitigation or conservation bank credits for special-status species would not result in additional adverse effects on giant garter snake.

### 6C.9.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.9.11.2, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. A non-bank site would protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat. Vernal pool and alkali seasonable wetland habitat is not suitable for giant garter snake and therefore this activity would have no effect on giant garter snake.

### 6C.9.11.4 Site Protection Instruments

Site protection instruments may be used to protect and enhance agricultural and other lands that provide suitable habitat for species such as greater sandhill crane, Swainson's hawk, and tricolored blackbird. Site protection instruments, including real estate protection instruments, ensure the long-term protection of a mitigation site (see Section 6C.3.9.3 for details on these species; Wood and Martin 2016). Examples include conservation easements, deed restrictions, transfer of title, or other documents such as Conservation Land Use Agreements. The site protection instrument would describe site ownership, management, and enforcement of any use restrictions. As with mitigation bank, conservation bank, or non-bank sites; the quantity and quality of acres proposed to be included in a site protection instrument would be determined, in coordination with the USFWS, during the preconstruction phase as described in Appendix 3B. Because actions associated with site protection instruments are expected to be beneficial, consultation under the ESA is not expected to be necessary. However, if consultation is required, it would occur in the future when site-specific information is available.

### 6C.9.11.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP (Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids.

The location(s) for channel margin enhancement is not known, however, locations along the Sacramento River between Freeport and Georgiana Slough, especially near the north Delta intakes, have been identified as areas of low-quality habitat for migrating salmonids that would benefit from enhancement actions.

There are no operational actions associated with channel margin enhancements. Maintenance and management actions would be identified in a long-term management plan for each channel margin mitigation location and would include actions such as vegetation management, weed control, trash management, and road, levee, and channel maintenance. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data. The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

There are no operational activities associated with channel margin habitat. Maintenance and monitoring activities would generate small levels of noise, require some vehicle traffic, and ground

disturbance, and require the periodic presence of staff and vehicle traffic that could disturb normal giant garter snake behavior. Monitoring activities may even include some in-water sampling, boat traffic, and trapping.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of giant garter snake. Vehicle traffic traveling on levee roads in the channel margin enhancement area during the active season (May 1 to October 1) could result in injury or mortality. Maintenance activities could also expose giant garter snake to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public DWR facility access roads (Appendix 3A). Implementation of AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from operations and maintenance activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). With these measures in place, channel margin enhancement maintenance actions are not likely to adversely affect giant garter snake.

### 6C.9.11.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of the CMP (Appendix 3B). Tidal perennial and emergent wetland habitats provide important foraging and refugia habitat for listed fish species. The restoration of tidal perennial and wetland habitat, particularly complex wetland systems containing dendritic channels and shallow subtidal areas, is intended to support improved survival and growth (including food production) of one or more life stages of each listed fish species addressed in the biological assessment. Tidal restoration sites within the lower Yolo Bypass and Cache Slough Complex, where giant garter snakes have potential to occur, will be prioritized. Because tidal restoration locations have potential to provide aquatic habitat for giant garter snake, there is potential for operations and maintenance activities to affect giant garter snake.

#### Operations

Tidal restoration could affect water quality in the Delta, namely levels of methylmercury, selenium, and *CHABs such as Microcystis.* Based on the proposed location of restoration sites in the lower Yolo Bypass and Cache Slough Complex, tidal restoration is not expected to increase the bioavailability of selenium or result in conditions conducive to CHABs that could result in adverse effects on giant garter snake, relative to existing conditions. For the rationale and assumptions that support this finding, see Appendix 6B. However, I creation of tidal wetland habitats could create conditions conducive to methylation of mercury and promote uptake and bioaccumulation of methylmercury in giant garter snakes within and adjacent to new tidal habitats.

To minimize the effects of methylmercury on giant garter snake due to tidal habitat restoration, AMM-23*: Develop and Implement a Mercury Management and Monitoring Plan for Wetland Creation and Enhancement Sites* would involve the development of a Mercury Management and Monitoring

Plan (MMMP) to guide tidal habitat design (Appendix 3A). The MMMP would require project-specific assessments of tidal wetland habitats, integration of design measures to minimize mercury methylation, site monitoring and reporting, and adaptive management.

### Maintenance

Maintenance and monitoring activities would generate small levels of noise, require some vehicle traffic, and ground disturbance, and require the periodic presence of staff and vehicle traffic that could disturb normal giant garter snake behavior. Water quality monitoring and habitat assessment activities may include in-water disturbance and boat traffic.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of giant garter snake. Vehicle traffic traveling on levee roads in and around the tidal restoration area during the active season (May 1 to October 1) could result in injury or mortality. Maintenance activities could also expose giant garter snake to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public DWR facility access roads (Appendix 3A). Implementation of AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from operations and maintenance activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

## 6C.9.12 Effects on Critical Habitat

Critical habitat has not been designated for giant garter snake.

## 6C.9.13 Cumulative Effects

Refer to Chapter 6, Section 6.9.13, *Cumulative Effects*, for more information.

# 6C.10 Delta Green Ground Beetle

Appendix 6A describes the definitions, methods, and assumptions used to analyze the effects of the proposed action on terrestrial species, including impact categories, effect mechanisms, and habitat model development. Chapter 4, Section 4.4*,* Section 4.4.16.6, *Species Habitat Suitability Model*, define suitable habitat and describe the habitat model for Delta green ground beetle. Refer to Chapter 6, Section 6.10, *Effects on Delta Green Ground Beetle,* for more information.

## 6C.10.1 Field Investigations

Field investigations would not overlap with modeled Delta green ground beetle habitat; therefore, this activity would not have an adverse effect on the species.

## 6C.10.2 North Delta Intakes

The north Delta intakes would not overlap with modeled Delta green ground beetle habitat; therefore, this activity would not have an adverse effect on the species.

## 6C.10.3 Tunnels

The tunnel alignment would not overlap with modeled Delta green ground beetle habitat; therefore, this activity would not have an adverse effect on the species.

## 6C.10.4 Tunnel Shafts

Tunnel shafts would not overlap with modeled Delta green ground beetle habitat; therefore, this activity would not have an adverse effect on the species.

## 6C.10.5 Reusable Tunnel Material

Reusable tunnel material areas would not overlap with modeled Delta green ground beetle habitat; therefore, this activity would not have an adverse effect on the species (Figure 6.10-1).

## 6C.10.6 Bethany Complex

The Bethany Complex would not overlap with modeled Delta green ground beetle habitat; therefore, this activity would not have an adverse effect on the species (Figure 6.10-1).

## 6C.10.7 Access Roads

Access roads would not overlap with modeled Delta green ground beetle habitat; therefore, this activity would not have an adverse effect on the species (Figure 6.10-1).

## 6C.10.8 Electrical and SCADA Facilities

Electrical and SCADA facilities would not overlap with modeled Delta green ground beetle habitat; therefore, this activity would not have an adverse effect on the species (Figure 6.10-1).

## 6C.10.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[15] concrete batch plants and park-and-ride lots. These features would not overlap with modeled Delta green ground beetle habitat; therefore, this activity would not have an adverse effect on the species (Figure 6.10-1).

[15] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, e.g., such as north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.10.7, *Access Roads*, and Section 6.10.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

# 6C.10.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facility construction area does not overlap with Delta green ground beetle modeled habitat. Activities in this area would not adversely affect the species.

# 6C.10.11 Compensatory Mitigation Plan

## 6C.10.11.1 Initial Mitigation Sites: Bouldin Island and I-5 Ponds

Habitat creation and enhancement at Bouldin Island and the I-5 ponds would not overlap with Delta green ground beetle habitat; therefore, these activities would have no effect on the species.

## 6C.10.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be used to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, and vernal pool tadpole shrimp. The most likely location for the purchase of bank credits would be in the foothills to the west and south of Byron nearest the location of the impact and where all four species have overlapping habitat. However, there is potential that bank credits purchased for the vernal pool branchiopods or for California tiger salamander could overlap with the Delta green ground beetle range. Mitigation or conservation bank credits for these species would be purchased at banks that have been approved by the USFWS and would have measures to avoid, minimize, and offset any effects to listed species. Therefore, the purchase of conservation bank credits for special-status species would not result in additional adverse effects on Delta green ground beetle.

## 6C.10.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.10.11.2, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. A non-bank site would protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat in a quantity and quality sufficient to offset the adverse effects consistent with the biological opinion.

Non-bank sites for vernal pool or alkaline wetland creation, protection, or enhancement (Appendix 3B, Section 3B.3.2.4) could take place within modeled Delta green ground beetle habitat. Management activities could include ground disturbance, require some vehicle traffic and use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides, which could result in the injury, mortality, and disruption of normal behaviors of Delta green ground beetle. However, non-bank mitigation would create or restore vernal pool habitat and would be expected to provide an overall benefit to Delta green ground beetle if non-bank mitigation occurs within the species' range.

Implementation of the *Vernal Pool Avoidance and Minimization Measure* described in Chapter 3, Section 3.6.2.9 would avoid and minimize construction-related effects on Delta green ground beetle by requiring vernal pool habitat to be avoided to the extent practicable and, when avoidance is not possible, implementing construction BMPs to avoid and minimize effects on the habitat. To minimize effects of spills, AMM-2: *Develop and Implement Hazardous Materials Management Plans,* and AMM-3: *Develop and Implement Spill Prevention, Control, and Countermeasure Plans* would require spill prevention and control plans be created and implemented (Appendix 3A). With these measures in place, and the long-term benefits associated with protection and long-term management of Delta

green ground beetle habitat, implementation of non-bank sites is not expected to adversely affect the species.

### 6C.10.11.4 Site Protection Instruments

Site protection instruments for greater sandhill crane, Swainson's hawk and tricolored blackbird would primarily consist of the protection and management of existing agricultural areas, but may also include protection and management of natural communities (see Section 6C.3.9.3 for details on these species). The need or locations of site protection instruments are not known; however, these protected lands have the potential to overlap with suitable Delta green ground beetle habitat. Because actions associated with site protection instruments are expected to be beneficial, consultation under the ESA is not expected to be necessary. However, if consultation is required, it would occur in the future when site-specific information is available.

Because these are protection instruments (and will not require substantial habitat restoration or creation), the potential for adverse effects on Delta green ground beetle is low. Land management activities on site protection instruments would be typical of agricultural lands and include ground disturbance, vehicle traffic, use of heavy equipment, and use of contaminants such as fuels, oils, and herbicide, which could result in the injury, mortality, and disruption of normal behaviors of Delta green ground beetle just as they do in the existing condition.

The potential effects of injury or mortality due to vehicle collisions would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on unpaved access roads (Appendix 3A). Implementation of AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from land management activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). Overall, site protection instruments are likely to benefit Delta green ground beetle by protecting and managing lands with suitable habitat, limiting use of pesticides, and promoting habitat connectivity.

### 6C.10.11.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP (Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids.

Enhancement would generally entail replacing armored or otherwise altered channel banks with more natural shoreline habitats that provide shallow, slow-velocity river margins, overhanging riparian vegetation, and future woody debris sources. To maintain the current extent of in-water habitat and level of flood protection, the existing levee would need to be reconstructed to be set back from the shoreline. Waterside and landside improvements would be implemented to create enhanced channel margin habitat and provide continued flood protection.

While locations along the Sacramento River between Freeport and Georgiana Slough have been identified, the location(s) for channel margin enhancement is not known. One potential location is

Cache Slough complex where Delta ground beetle have potential to occur on the upland of future project locations.

There are no operational activities associated with channel margin habitat. Maintenance and monitoring activities would take place in areas that no longer provide habitat for Delta green ground beetle; therefore, these activities would have no effect on the species.

### 6C.10.11.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of the CMP (Appendix 3B). Tidal perennial and emergent wetland habitats provide important foraging and refugia habitat for listed fish species. The restoration of tidal perennial and wetland habitat, particularly complex wetland systems containing dendritic channels and shallow subtidal areas, is intended to support improved survival and growth (including food production) of one or more life stages of each listed fish species addressed in the biological assessment. Tidal restoration sites within the lower Yolo Bypass and Cache Slough Complex, where Delta green ground beetle have potential to occur, will be prioritized. Because tidal restoration locations have potential to affect adjacent upland habitats, there is potential for operations and maintenance activities to affect giant garter snake.

There are no operational activities associated with tidal wetland habitat. Maintenance and monitoring activities would take place in areas that no longer provide habitat for Delta green ground beetle; therefore, these activities would have no effect on the species.

# 6C.11 Effects on Valley Elderberry Longhorn Beetle

Appendix 6A, Terrestrial Effects Analysis Methods, describes the methods and assumptions used to analyze the effects of the PA on terrestrial species. Chapter 4, Section 4.4.17.6, *Suitable Habitat Definition*, and Section 4.4.17.7, *Habitat Suitability Model*, define suitable habitat and describe the habitat model for valley elderberry longhorn beetle. Refer to Chapter 6, Section 6.11, *Effects on Valley Elderberry Longhorn Beetle*, for more information.

## 6C.11.1 Field Investigations

There would be no ongoing operations and maintenance associated with the field investigations, resulting in no effect on valley elderberry longhorn beetle.

## 6C.11.2 North Delta Intakes

The north Delta intakes would be constructed on the east bank of the Sacramento River near the town of Hood. Two intakes would divert water from the Sacramento River and include cylindrical fish screens, intake structures, sedimentation basins, sediment drying lagoons, flow control structures, intake outlet channel and shaft, embankments, and other appurtenant structures. Intakes would also include construction support facilities (e.g., emergency facilities, fuel station), electrical substations, switchyards, and access roads that fall within the north Delta intake facility footprints. The north Delta intakes would be surrounded by security fencing.

The operational components of the north Delta intakes include intakes, fish screens, sedimentation basins and drying lagoons, and associated facilities. Operations activities would generate small levels of noise and light and would require the periodic presence of staff and vehicle traffic. Permanent facility lighting would be motion activated, downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13), and therefore permanent facilities would remain dark the majority of the time at night.

Maintenance activities at the north Delta intakes would include semiannual general and ground maintenance (e.g., mowing, vegetation trimming, herbicide application), fish screen maintenance, annual sediment and debris removal at intakes, and periodic maintenance of the intake gates and associated structures approximately every 1 to 5 years. Access roads within the intake facilities would be repaved every 15 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

Vegetation maintenance could affect shrubs that establish within, or occur adjacent to, north Delta intakes through physical damage, trimming, removal or pesticide or herbicide drift. Likewise, maintenance equipment could crush or kill beetles or disrupt of normal behaviors (i.e., feeding, breeding, dispersal), especially during the adult flight period (March to July). Similarly, daily and weekly inspections by vehicle could strike flying beetles.

AMM-17: *Avoid and Minimize Impacts on Biological Resources from Maintenance Activities* (Appendix 3A) would require environmental review prior to maintenance activities; a preconstruction survey, biological monitor, and establishment of non-disturbance buffers where sensitive resources like elderberry bushes occur; and the use of appropriate work windows. Also, AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife* would require speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads.

## 6C.11.3 Tunnels

Tunnels would be constructed using subsurface horizontal TBMs and would not result in any surface disturbance to valley elderberry longhorn beetle modeled habitat; therefore, this activity would not have an adverse effect on the species.

## 6C.11.4 Tunnel Shafts

There are three types of tunnel shafts: launch shafts, maintenance shafts, and reception shafts. The purpose of the tunnel shafts is to launch, maintain, and remove TBMs at the intakes, along the tunnel alignment, and at the Bethany Complex. Valley elderberry longhorn beetle modeled habitat overlaps with the tunnel shaft work area at the Twin Cities Complex.

Tunnel shaft sites would have permanent facility lighting. Permanent facility lighting would be motion activated, downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13), and therefore permanent facilities would remain dark the majority of the time at night. Maintenance during project operations could include inspection and maintenance of tunnel shafts, maintenance of the constructed water conveyance tunnel, vegetation control around tunnel shafts, and periodic presence of staff and vehicle traffic. Maintenance activities at launch and maintenance shafts would include semiannual general ground maintenance (e.g., mowing, vegetation trimming, herbicide application), and daily inspections by vehicle. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and therefore the need for additional lighting would be infrequent.

Vegetation maintenance at the tunnel shaft pad footprint, including trimming or pesticide or herbicide drift, could affect shrubs. Likewise, vegetation maintenance could result in injury or mortality or disrupt normal behaviors (i.e., feeding, breeding, dispersal), especially during the adult flight period between March and July.

AMM-17: *Avoid and Minimize Impacts on Biological Resources from Maintenance Activities* (Appendix 3A) would require environmental review prior to maintenance activities; a preconstruction survey, biological monitor, and establishment of non-disturbance buffers where sensitive resources like elderberry bushes occur; and the use of appropriate work windows. Also, AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife* would require speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads.

## 6C.11.5 Reusable Tunnel Material

There are no operations and maintenance activities associated with the RTM sites and therefore no effects to valley elderberry longhorn beetle.

## 6C.11.6 Bethany Complex

The Bethany Complex would include a pumping plant, surge basin, reception shaft, discharge structure, and aqueduct. In addition, a construction water pipeline, electrical substation, switchyard, and access roads would be used in support of construction and operations within the Bethany Complex footprint. The construction actions associated with the Bethany Complex are described and evaluated at the project level.

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, Bethany Reservoir Aqueduct, and Bethany Reservoir Discharge Structure. All aboveground portions of these features would have permanent facility lighting. Permanent outdoor facility lighting would be motion-activated and therefore would only be lit for a short time when activated (which is expected to occur infrequently). To further minimize impacts from permanent lighting, the fixtures would also be downcast, cut-off types with non-glare finishes (Chapter 3, Section 3.2.13). Because permanent facilities would have motion-detected lights, they are not expected to contribute to ambient nighttime light.

The Bethany Reservoir Pumping Plant operations are not expected to generate noise that would substantially alter the existing environment. The pumping plant would be within an underground facility, and therefore operational light and noise would not be expected to affect species. The Bethany Reservoir Aqueduct has aboveground and below-ground sections; the Bethany Reservoir Aqueduct would contain moving water but this is not expected to be a substantial source of noise because the aboveground sections would be backfilled with approximately 6 feet of soil and the tunneled portions would be below the ground surface. The Bethany Reservoir Discharge Structure would contain large volumes of flowing water at times and would be a source of noise in the areas adjacent to the structure.

Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and the right-of-way would require vegetation removal. Access roads within the Bethany Complex would be repaved every 15 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

Periodic maintenance of vegetation on the grounds surrounding the Bethany Complex may be required. Maintenance activities (e.g., mowing, vegetation trimming, herbicide application) would require periodic presence of staff and vehicle traffic. Vegetation maintenance could affect shrubs that establish or occur adjacent to Bethany Complex either through physical damage, trimming or removal of shrubs, or indirectly through pesticide or herbicide drift. Likewise, vegetation maintenance could result in injury or mortality to individual beetles and disruption of normal behaviors (i.e., feeding, breeding, dispersal), especially if activities occur during the adult flight period (March to July).

To minimize the potential effects of maintenance activities at Bethany Complex on valley elderberry longhorn beetle, AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would require Worker Awareness Training, site-specific environmental review, a preconstruction survey, establishment of non-disturbance buffers if the species is present, usage of appropriate work windows, and monitoring (Appendix 3A.).

Refer to Chapter 6, Section 6.11.6*, Bethany Complex,* for more information.

## 6C.11.7 Access Roads

New access roads, a new access railroad spur on Lower Roberts Island, and improvements to existing public roads would be necessary to support project construction and project facilities. In addition to these road and railroad features, impacts from levee improvements on Lower Roberts Island are also evaluated in this section (as the levee improvements would be adjacent to the access road, have similar impacts on species, and occur at roughly the same time). New access roads would be either gravel or paved and would provide connections between existing roads and construction areas for project facilities. The new access railroad spur would transport materials and equipment to the tunnel launch shaft. Existing roads would be widened and improved to support the construction-related traffic and existing access roads in the vicinity of the intakes would be repaved every 15 years.

Operational activities on access roads include vehicles and equipment traveling to, from, and within the project facilities. Some access roads would have permanent night-lighting, which would be downcast (Chapter 3, Section 3.2.13). Maintenance of access roads would include grading, repaving, and vegetation removal. Maintenance on public access roads such as SR 160 and SR 12 would not be conducted by DWR.

Movement of vehicles and maintenance equipment on project access roads could result in injury or mortality to adult beetles during their flight period if occupied shrubs are located adjacent to access roads. However, the potential for vehicle strike is low as maintenance vehicles would be traveling at low speeds and vehicle movement would be short in duration and infrequent. Maintenance activities (e.g., vegetation trimming/removal along access roads) and herbicide drift could result in injury or mortality, as well as disruption of normal behaviors (i.e., feeding, breeding, dispersal). Vehicle traffic on unpaved roads could generate dust that could accumulate on shrubs. The accidental discharge of chemicals and fluids (e.g., oil, gas, steering fluids) during maintenance activities could affect the vigor of shrubs, resulting in a further loss of habitat for valley elderberry longhorn beetle habitat.

To minimize potential effects of maintenance activities, AMM-17: *Avoid and Minimize Impacts on Biological Resources from Maintenance Activities* would require environmental review of the potential for maintenance to impact sensitive resources, a preconstruction survey, a biological monitor (depending on site-specific conditions and timing), establishment of non-disturbance

buffers, and use of appropriate work windows (Appendix 3A). AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife* would reduce the risk of vehicle collisions by requiring speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads.

Refer to Chapter 6, Section 6.11.7, Access Roads, for more information.

## 6C.11.8 Electrical and SCADA Facilities

The following discussion includes an analysis of electrical facility types (e.g., electrical powerlines, substation on Lower Roberts Island) where they occur outside one of the project feature footprints described in the above sections (e.g., north Delta intakes, Bethany Complex). Where the construction footprint of an electrical facility type (e.g., switching station, substation) falls within a larger facility construction footprint, such as Bethany Complex, the effects associated with that facility type are discussed in the relative sections. Refer to Chapter 6, Section 6.11.8, *Electrical and SCADA Facilities*, for more information.

DWR is not responsible for the operations and maintenance of electrical facilities. Operation and maintenance of electrical facilities would be the responsibility of the electrical providers—SMUD, WAPA, and PG&E. These companies would own and maintain their respective electrical facilities.

DWR is responsible for any operation and maintenance activities associated with SCADA facilities; however, SCADA facilities do not have any associated operational activities. Maintenance activities on SCADA facilities would include emergency repair of underground or aboveground SCADA lines. Vegetation management along SCADA line sections would not be required because underground SCADA lines occur within roadway rights-of-way (that are not vegetated) and the new aboveground SCADA line occurs on existing poles that are being managed from vegetation in the existing conditions.

There is potential for injury or mortality to valley elderberry longhorn beetle where the temporary use and staging of vehicles and equipment are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife*, which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans (Appendix 3A).

## 6C.11.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[16] concrete and CLSM batch plants and park-and-ride lots. None of these features overlap with valley elderberry longhorn

As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, such as north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.11.7, *Access Roads*, and Section 6.11.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

beetle modeled habitat; thus, activities associated with these facilities are not expected to affect the species.

## 6C.11.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facilities would be constructed to deliver water from the Union Island tunnel shaft to the existing CCWD Middle River Pipeline on Victoria Island. The CCWD interconnection facilities would include an interconnection pump station, a new underground 1.6-mile conveyance pipeline, and an interconnection valve to connect to the existing CCWD Middle River Pipeline. The construction actions associated with the CCWD interconnection facilities are described and evaluated at the project level. Maintenance actions are described and evaluated programmatically and will be subject to future, "step down" consultations when site-specific detail is available.

DWR would be responsible for operations and maintenance of the interconnection pump station and interconnection pipeline between the Union Island tunnel shaft and the existing CCWD pumping plant. CCWD would be responsible for operations and maintenance of the interconnection valve within the CCWD facility. Operations and maintenance of the interconnection pump station would be similar to those at the Union Island tunnel shaft and take place within the shaft's permanent footprint. Inspections of the interconnection pump station and pipeline would occur at regular intervals, and annual mowing of the pipeline right-of-way would occur as needed.

The operational components of the CCWD interconnection pump station and interconnection valve would take place within the permanent footprints of the Union Island tunnel shaft and CCWD pumping plant, which would no longer contain suitable valley elderberry longhorn beetle habitat.

Maintenance activities (e.g., mowing, vegetation trimming, herbicide application) would require periodic presence of staff and vehicle traffic. Vegetation maintenance could affect shrubs that establish or occur adjacent to the CCWD interconnection facilities either through physical damage, trimming or removal of shrubs, or indirectly through pesticide or herbicide drift. Likewise, vegetation maintenance could result in injury or mortality to individual beetles and disruption of normal behaviors (i.e., feeding, breeding, dispersal), especially if activities occur during the adult flight period (March to July).

To minimize the potential effects of maintenance activities at CCWD Interconnection facilities on valley elderberry longhorn beetle, AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would require Worker Awareness Training, site-specific environmental review, a preconstruction survey, establishment of non-disturbance buffers if the species is present, usage of appropriate work windows, and monitoring (Appendix 3A).

Refer to Chapter 6, Section 6.11.10*, Contra Costa Water District Interconnection Facilities,* for more information.

## 6C.11.11 Compensatory Mitigation Plan

### 6C.11.11.1 Initial Mitigation Sites: Bouldin Island and I-5 Ponds

The Bouldin Island and I-5 pond mitigation sites would offset the loss of sensitive natural communities and habitat for special-status species, including valley elderberry longhorn beetle, by creating and enhancing habitat on Bouldin Island and the I-5 ponds, and tidal habitat restoration,

and managing these areas in perpetuity. The habitat creation and enhancement sites would overlap with modeled valley elderberry longhorn beetle riparian habitat.

Operation and maintenance of CMP habitat enhancement and creation sites would require general site maintenance (i.e., site visits, trash removal, maintenance of signs, fences, and gates), vegetation management (i.e., mowing, controlled burns, grazing, discing), levee and channel maintenance (i.e., levee inspection, dredging, road repairs, grading, rodent abatement), and monitoring. Specific long-term management plans would be developed for each site. These activities would require the use of vehicles and/or boats, heavy equipment, and periodic presence of personnel. Maintenance activities would take place during daylight hours.

Monitoring activities and non-native plant management are not expected to result in any adverse effects to valley elderberry longhorn beetle; however, implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* (Appendix 3A) would ensure avoidance and minimization measures for sensitive habitats is considered prior to any monitoring or management activities.

### 6C.11.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be used to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, vernal pool tadpole shrimp, alkali seasonal wetland, and vernal pool habitat. The vernal pool, pond, and grassland communities that would be protected for these species do not provide habitat for valley elderberry longhorn beetle and therefore would not be adversely affected by implementation of this action.

### 6C.11.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.11.11.5, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. A non-bank site would protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat. These habitat types do not provide habitat for valley elderberry longhorn beetle so the species would not be adversely affected by implementation of non-bank site protection.

### 6C.11.11.4 Site Protection Instruments

Site protection instruments may be used to protect and enhance agricultural and other lands that provide suitable habitat for species such as greater sandhill crane, Swainson's hawk, and tricolored blackbird. Site protection instruments, including real estate protection instruments, ensure the long-term protection of a mitigation site (see Section 6C.3.9.3 for details on these species; Wood and Martin 2016). Examples include conservation easements, deed restrictions, transfer of title, or other documents such as Conservation Land Use Agreements. The site protection instrument would describe site ownership, management, and enforcement of any use restrictions. As with mitigation bank, conservation bank, or non-bank sites, the quantity and quality of acres proposed to be included in a site protection instrument would be determined, in coordination with the USFWS and CDFW, during the preconstruction phase as described in Appendix 3B. Because actions associated with site protection instruments are expected to be beneficial, consultation under the ESA is not expected to be necessary. However, if consultation is required, it would occur in the future when site-specific information is available.

Site protection instruments for greater sandhill crane, Swainson's hawk and tricolored blackbird would primarily consist of the protection and management of existing agricultural areas and, potentially, natural communities (see Section 6C.3.9.3 for details on these species). Site protection instruments could include riparian edge habitat suitable for valley elderberry longhorn beetle. While habitat would be protected if present, land management activities for site protection instruments could include ground disturbance, vehicle traffic and use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides. Construction-related vehicles traveling on access roads adjacent to occupied habitat during the beetle flight season (March to July) could cause potential injury or mortality of valley elderberry longhorn beetle as well as disrupt feeding, breeding, and dispersal. Also, work within 165 feet of host elderberry shrubs could result in dust and the accidental discharge of construction-related fluids (e.g., oil, gas, steering fluids) in areas where shrubs occur, which could affect the vigor of shrubs, resulting in a further loss of habitat for valley elderberry longhorn beetle.

The potential effects of injury or mortality due to vehicle collisions would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on unpaved access roads (Appendix 3A). AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from land management activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). Overall, site protection instruments are likely to benefit valley elderberry longhorn beetle by protecting and managing lands with suitable valley elderberry longhorn beetle habitat, limiting use of pesticides, and promoting habitat connectivity.

### 6C.11.11.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP (Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. While not the target of enhancement actions, valley elderberry longhorn beetle also has the potential to benefit from the increase in riparian habitat in the central Delta.

There are no operational actions associated with channel margin enhancements. Maintenance and management actions would be identified in a long-term management plan for each channel margin mitigation location and would include actions such as vegetation management, weed control, trash management, and road, levee, and channel maintenance. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data. The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

Monitoring activities and non-native plant management are not expected to result in any adverse effects to valley elderberry longhorn beetle; however, implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities,* described in

Appendix 3A, would ensure avoidance and minimization measures for sensitive habitats is considered prior to any monitoring or management activities.

#### 6C.11.11.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of the CMP (Appendix 3B). Tidal perennial and tidal freshwater emergent wetland habitats provide important foraging and refugia habitat for listed fish species. The restoration of tidal perennial and wetland habitat, particularly complex wetland systems containing dendritic channels and shallow subtidal areas, is intended to support improved survival and growth (including food production) of one or more life stages of each listed fish species addressed in the biological assessment. Tidal restoration sites within the lower Yolo Bypass and Cache Slough Complex will be prioritized as these areas would provide greater benefits for target fish species.

There are no operational actions associated with tidal wetland restoration locations. Maintenance and management actions would be identified in a long-term management plan for each tidal restoration location and would include actions such as vegetation management, weed control, and trash management, and facilities maintenance and management. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data. The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

Monitoring activities and non-native plant management are not expected to result in any adverse effects to valley elderberry longhorn beetle; however, implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities,* described in Appendix 3A, would ensure avoidance and minimization measures for sensitive habitats is considered prior to any monitoring or management activities.

### 6C.11.12 Effects on Critical Habitat

There is no designated critical habitat for valley elderberry longhorn beetle in the action area.

### 6C.11.13 Cumulative Effects

Refer to Chapter 6, Section 6.11.13, *Cumulative Effects*, for more information.

## 6C.12 Effects on Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp

Appendix 6A describes the definitions, methods, and assumptions used to analyze the effects of the PA on terrestrial species, including impact categories, effect mechanisms, and habitat model development. Chapter 4, Section 4.4.18.6, *Suitable Habitat Definition*, and Sections 4.4.18.7, *Species Habitat Suitability Model*, define habitat and describe the habitat model for vernal pool fairy shrimp. Chapter 4, Section 4.4.19.6, *Species Habitat Suitability Model,* and Section 4.4.19.7, *Species Habitat Suitability Model,* describes the habitat suitability model for vernal pool tadpole shrimp. Refer to

Chapter 6, Section 6.12, *Effects on Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp,* for more information.

## 6C.12.1 Field Investigations

There would be no ongoing operations and maintenance associated with the field investigations, therefore, there would be no effect on vernal pool fairy shrimp or vernal pool tadpole shrimp.

## 6C.12.2 North Delta Intakes

The construction footprint for the north Delta intakes does not overlap with modeled habitat for vernal pool fairy shrimp or vernal pool tadpole shrimp. Additionally, there is no modeled habitat for vernal pool fairy shrimp or vernal pool tadpole shrimp within 250 feet of the north Delta intake construction footprint; therefore, construction of the north Delta intakes would not affect listed branchiopods.

## 6C.12.3 Tunnels

The tunnel alignment does not overlap with listed branchiopod modeled habitat except at one location directly south of the Delta-Mendota Canal. However, tunnels would be constructed using subsurface horizontal TBMs and would not result in any surface disturbance to listed branchiopod modeled habitat; therefore, this activity would not have an adverse effect on listed branchiopods.

## 6C.12.4 Tunnel Shafts

The construction footprints for tunnel shafts do not overlap with any modeled habitat for listed branchiopods and there is no modeled habitat within 250 feet of any tunnel shaft construction footprint. Therefore, construction of tunnel shafts would not affect listed branchiopods.

## 6C.12.5 Reusable Tunnel Material

The construction footprints for RTM placement and processing sites do not overlap with modeled vernal pool fairy shrimp or vernal pool tadpole shrimp habitat and there is no modeled habitat within 250 feet of any RTM sites. Therefore, RTM placement and processing would not affect listed branchiopods.

## 6C.12.6 Bethany Complex

The Bethany Complex would include a pumping plant, surge basin, reception shaft, discharge structure, and aqueduct. In addition, a construction water pipeline, electrical substation, switchyard, and access roads would be used in support of construction and operations within the Bethany Complex footprint. Refer to Chapter 6, Section 6.12.6*, Bethany Complex,* for more information.

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, Bethany Reservoir Aqueduct, and Bethany Reservoir Discharge Structure. All aboveground portions of these features would have permanent facility lighting. Permanent outdoor facility lighting would be motion-activated and therefore would only be lit for a short time when activated (which is expected to occur infrequently). To further minimize impacts from permanent lighting, the fixtures would also be downcast, cut-off types with non-glare finishes (Chapter 3, Section 3.2.13). Because

permanent facilities would have motion-detected lights, they are not expected to contribute to ambient nighttime light.

The Bethany Reservoir Pumping Plant operations are not expected to generate noise that would substantially alter the existing environment. The pumping plant would be within an underground facility, and therefore operational light and noise would not be expected to affect species. The Bethany Reservoir Aqueduct has aboveground and below-ground sections; the Bethany Reservoir Aqueduct would contain moving water but this is not expected to be a substantial source of noise because the aboveground sections would be backfilled with approximately 6 feet of soil and the tunneled portions would be below the ground surface. The Bethany Reservoir Discharge Structure would contain large volumes of flowing water at times and would be a source of noise in the areas adjacent to the structure.

Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and the right-of-way would require vegetation removal. Access roads within the Bethany Complex would be repaved every 15 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, aqueduct, and Bethany Reservoir Discharge Structure. Pumping plant operations would occur within an underground facility. The aqueduct and discharge structure would be operated aboveground, but any light or noise generated from operations would not affect branchiopods. Operations are not expected to affect vernal pool habitat.

Maintenance of the pumping plant, surge basin, surface lands above the aqueduct, discharge structure, and associated facilities would involve periodic vegetation removal and repaving access roads within the Bethany Complex facilities every 15 years. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would require an environmental review to identify sensitive habitat prior to maintenance activities. Also, no maintenance activities at the Bethany Complex are anticipated to result in impacts on vernal pool aquatic invertebrates because there are no aboveground facilities that occur within 250 feet of aquatic habitat. Although the Bethany Reservoir Aqueduct would affect a pool during construction and would be within 250 feet of the remaining portions of that pool, as well as another pool, this section of the aqueduct would be buried and maintenance would be limited to vegetation management around manways (i.e., access points to buried pipelines), which would be more than 500 feet from the nearest pool and would not likely result in direct or indirect effects on these pools.

## 6C.12.7 Access Roads

New access roads and improvements to existing public roads are necessary to support project construction. New access roads are either gravel or paved and would be created to provide connections between existing roads and construction and operations areas. Existing public roads would be widened and improved to support the construction-related traffic, and existing access roads in the vicinity of the intakes and shafts would be repaved every 15 years.

Operational activities on access roads include vehicles and equipment traveling to and from the project facilities. Some access roads would have permanent lighting, which would be downcast (Chapter 3, Section 3.2.13). Maintenance of access roads would include periodic grading, repaving, and vegetation removal.

Refer to Chapter 6, Section 6.12.7, *Access Roads,* for more information.

Impacts from operations and maintenance activities are evaluated only where they occur within DWR-owned or DWR-maintained facilities. Mountain House Road improvements and the new Mountain House/Grant Line Road connection will be maintained by the county following construction. As a result, the impacts from operations and maintenance on Mountain House Road are not evaluated in this biological assessment.

## 6C.12.8 Electrical and SCADA Facilities

Electrical and SCADA facilities would overlap with or would be within 250 feet of modeled vernal pool fairy shrimp and vernal pool tadpole shrimp habitat. However, these activities would all be located within the footprints for construction or improvement of access roads. As a result, no additional impacts are incurred from the construction, operation, or maintenance of electrical or SCADA facilities.

## 6C.12.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[17] concrete and CLSM batch plants and park-and-ride lots. Although the Hood-Franklin Park-and-Ride lot does not directly overlap with vernal pool fairy shrimp or vernal pool tadpole shrimp modeled habitat, construction of the facility would occur within 250 feet of vernal pool habitat. The park-and-ride lot would be removed following construction but because it would be in place for over 1 year the impact would be considered permanent.

The Hood-Franklin Park-and-Ride lot would be used during construction and then removed. Vehicles moving and parking at the park-and-ride lot could result in chemical contamination from vehicle leaks. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would require spill prevention and response measures be in place to avoid and minimize accidental discharges into wetlands, including vernal pools (Appendix 3A).

## 6C.12.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facility construction area does not overlap with listed vernal pool branchiopod modeled habitat. Activities in this area would not have the potential for incidental take of the species.

## 6C.12.11 Compensatory Mitigation Plan

### 6C.12.11.1 Initial Mitigation Sites: Bouldin Island and I-5 Ponds

Construction activities for habitat creation and enhancement at Bouldin Island and the I-5 ponds under the CMP would not overlap with modeled listed branchiopod habitat. No modeled habitat for

[17] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, such as north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.12.7, *Access Roads*, and Section 6.12.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

listed branchiopods occurs within 250 feet of the construction footprint for the CMP; therefore, implementation of the initial mitigation sites would not result in impacts on listed branchiopods.

### 6C.12.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be used to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, and vernal pool tadpole shrimp. Mitigation or conservation bank credits purchased for these species would be purchased at banks that have been approved by USFWS. Through the approval process, any potential impacts on vernal pool c from restoration, creation, enhancement, management, maintenance, or monitoring would have been addressed by the USFWS. Because the approved bank would provide bank credits for vernal pool fairy shrimp and vernal pool tadpole shrimp, the purchase is assumed to be beneficial to the species.

### 6C.12.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.12.11.2 are not available in part or in full, a non-bank site may be used. A non-bank site would create or restore, protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat. If non-bank sites are used for vernal pool or alkaline wetland creation or enhancement (Appendix 3B, Section 3B.3.2.4), these activities could occur in areas where vernal pool fairy shrimp and vernal pool tadpole shrimp have potential to occur.

Ground-disturbing activities (e.g., excavation and grading) that occur within 250 feet of an aquatic feature occupied or presumed occupied by listed branchiopods have potential to result in the loss or degradation of that habitat and the potential for injury or mortality to listed branchiopods. For example, construction-related fluids or sediments could be inadvertently discharged into aquatic habitat. To minimize effects from construction-related fluids and contaminants, the following general measures described in Appendix 3A would be implemented: AMM-1: *Conduct Environmental Resources Worker Awareness Training*; AMM-2: *Develop and Implement Hazardous Materials Management Plans*; AMM-3: *Develop and Implement Spill Prevention, Control, and Countermeasure Plans*; and AMM-14: *Construction Best Management Practices for Biological Resources*.

### 6C.12.11.4 Site Protection Instruments

Site protection instruments for greater sandhill crane, Swainson's hawk, and tricolored blackbird would primarily consist of the protection and management of agricultural areas but may also include protection and management of natural communities (e.g., grasslands or vernal pool complex) in the action area (see Section 6C.3.9.3 for details on these species). The need or locations for site protection instruments is not yet known. However, these activities could occur in areas with suitable habitat for vernal pool branchiopods. Because actions associated with site protection instruments are expected to be beneficial, consultation under the ESA is not expected to be necessary. However, if consultation is required, it would occur in the future when site-specific information is available.

Land management activities associated with site protection instruments could include ground disturbance, some vehicle traffic and use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides, which could result in the injury or mortality of vernal pool branchiopods. The potential effects of injury or mortality due to vehicle collisions would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 10

miles per hour and traffic control structures on unpaved access roads (Appendix 3A). Implementation of AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from land management activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). Overall, site protection instruments would benefit vernal pool branchiopods by protecting and managing lands with suitable habitat, limiting use of pesticides, and promoting habitat connectivity.

### 6C.12.11.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP (Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids.

The location(s) for channel margin enhancement is not known, however, locations along the Sacramento River between Freeport and Georgiana Slough, especially near the north Delta intakes, have been identified as areas of low-quality habitat for listed fish species that would benefit from enhancement actions. Another potential location for channel margin enhancement is Cache Slough, where vernal pool complex habitat occurs on the upland side of the channel margins. Landside improvements would include the construction of a new setback levee behind and connected to the existing levee. Because vernal pool brachiopod habitat can occur on the upland side of existing levees, especially in locations like Cache Slough, there is potential for effects to the species. However, there are no operational, maintenance, or monitoring activities associated with channel margin habitat that would take place in areas that habitat for vernal pool brachiopods (i.e., any affected vernal pool grass habitat would be lost during construction and therefore not subject to operations and maintenance activities); therefore, these activities would have no effect on the species

### 6C.12.11.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of the CMP (Appendix 3B). Tidal restoration will generally be achieved by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Restoration would primarily occur through breaching or setback of levees, thereby restoring tidal fluctuation to land parcels currently isolated behind those levees, including, potentially, those areas that include vernal pool brachiopods.

There are no operational actions associated with tidal wetland restoration locations. Maintenance and management actions would be identified in a long-term management plan for each tidal restoration location and would include actions such as vegetation management, weed control, and trash management, and facilities maintenance and management. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data.

The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

Maintenance and monitoring activities associated with restored tidal wetlands would involve some ground disturbance and periodic vehicle traffic; however, these activities would take place in areas that no longer contain suitable habitat for vernal pool branchiopods. Therefore, maintenance of restored tidal wetland habitat is not expected to adversely affect these species.

### 6C.12.12 Effects on Vernal Pool Fairy Shrimp Critical Habitat

The only activity that has potential to affect critical habitat are field investigations and there are no operations and maintenance activities associated with that activity. Refer to Chapter 6, Section 6.12.12, *Effects on Vernal Pool Fairy Shrimp Critical Habitat*, for more information.

### 6C.12.13 Cumulative Effects

Refer to Chapter 6, Section 6.12.13, *Cumulative Effects*, for more information.

## 6C.13 Effects on Vernal Pool Grasses

Because they occupy the same habitat type and location in the action area, Colusa grass and Solano grass are treated together in this analysis. Appendix 6A describes the definitions, methods, and assumptions used to analyze the effects of the PA on terrestrial species, including impact categories, effect mechanisms, and habitat model development. Chapter 4, Sections 4.4.20.6, *Suitable Habitat Definition,* and 4.4.21.6, *Suitable Habitat Definition*, and Sections 4.4.20.7, *Habitat Model Description*, and 4.4.21.7, *Habitat Model Description*, define suitable habitat and describe the habitat model for Colusa grass and Solano grass. Refer to Chapter 6, Section 6.13, *Effects on Vernal Pool Grasses,* for more information.

### 6C.13.1 Field Investigations

Field investigations would occur outside of the range of Colusa grass and Solano grass; therefore, this activity would not have an adverse effect on the species.

### 6C.13.2 North Delta Intakes

The north Delta intakes are outside of the range of Colusa grass and Solano grass; therefore, this activity would not have an adverse effect on the species.

### 6C.13.3 Tunnels

The tunnel alignment is outside of the range of Colusa grass and Solano grass; therefore, this activity would not have an adverse effect on the species.

### 6C.13.4 Tunnel Shafts

Tunnel shafts are outside of the range of Colusa grass and Solano grass; therefore, this activity would not have an adverse effect on the species.

## 6C.13.5 Reusable Tunnel Material

Reusable tunnel material areas are outside of the range of Colusa grass and Solano grass; therefore, this activity would not have an adverse effect on the species.

## 6C.13.6 Bethany Complex

The Bethany Complex is outside of the range of Colusa grass and Solano grass; therefore, this activity would not have an adverse effect on the species.

## 6C.13.7 Access Roads

Access roads are outside of the range of Colusa grass and Solano grass; therefore, this activity would not have an adverse effect on the species.

## 6C.13.8 Electrical and SCADA Facilities

Electrical and SCADA facilities are outside of the range of Colusa grass and Solano grass; therefore, this activity would not have an adverse effect on the species.

## 6C.13.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[18] concrete batch plants and park-and-ride lots. These features are outside of the range of Colusa grass and Solano grass; therefore, this activity would not have an adverse effect on the species.

## 6C.13.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facility construction area does not overlap with vernal pool grasses modeled habitat.

## 6C.13.11 Compensatory Mitigation

### 6C.13.11.1 Initial Mitigation Sites: Bouldin Island and I-5 Ponds

Habitat creation and enhancement at Bouldin Island and the I-5 ponds are outside of the range of Colusa grass and Solano grass; therefore, these activities would have no effect on the species.

### 6C.13.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be used to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, and vernal pool tadpole shrimp. The location of these banks has potential to overlap with vernal pool plant habitat.

[18] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, e.g., such as north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.13.7, *Access Roads*, and Section 6.13.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

Mitigation or conservation bank credits purchased for these species would be purchased at banks that have been approved by USFWS. Through the approval process, any potential impacts on vernal pool plants from restoration, creation, enhancement, management, maintenance, or monitoring would have been addressed by the USFWS through the credit approval process. Because the approved bank would provide bank credits for vernal pool branchiopods, the purchase is assumed to either have no effect or to be beneficial to vernal pool grasses.

### 6C.13.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.13.11.2, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. A non-bank site would protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat in a quantity and quality sufficient to offset the adverse effects consistent with the biological opinion.

In the event that non-bank sites are used for vernal pool or alkaline wetland creation or enhancement (Appendix 3B, Section 3B.3.2.4), these activities could occur in areas where Colusa grass or Solano grass occur.

Operation and maintenance of non-bank sites could require general site maintenance (i.e., site visits, trash removal, maintenance of signs, fences, and gates), vegetation management (i.e., mowing, controlled burns, grazing, discing), and monitoring. Specific long-term management plans would be developed for each site. These activities would require the use of vehicles, heavy equipment, and periodic presence of personnel. Maintenance activities would take place during daylight hours.

Infrequent site maintenance, monitoring, and vegetation management activities are not expected to result in any adverse effects to vernal pool plants; however, implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* (Appendix 3A) would ensure avoidance and minimization measures for sensitive habitats is considered prior to any monitoring or management activities. With these measures in place, non-bank mitigation construction is not likely to adversely affect vernal pool grasses.

### 6C.13.11.4 Site Protection Instruments

Site protection instruments for greater sandhill crane, Swainson's hawk, and tricolored blackbird would primarily consist of the protection and management of agricultural areas but may also include protection and management of natural communities (e.g., grasslands or vernal pool complex) in the action area (see Section 6C.3.9.3 for details on these species). The need or locations for site protection instruments is not yet known. However, these activities could occur in areas with suitable habitat for vernal pool branchiopods. Because actions associated with site protection instruments are expected to be beneficial, consultation under the ESA is not expected to be necessary. However, if consultation is required, it would occur in the future when site-specific information is available.

Land management activities associated with site protection instruments could include ground disturbance, some vehicle traffic and use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides, which could result in the injury or mortality of vernal pool branchiopods. The potential effects of injury or mortality due to vehicle collisions would be minimized through AMM-18*: Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 10 miles per hour and traffic control structures on unpaved access roads (Appendix 3A).

Implementation of AMM-17*: Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from land management activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). Overall, site protection instruments would benefit vernal pool branchiopods by protecting and managing lands with suitable habitat, limiting use of pesticides, and promoting habitat connectivity.

### 6C.13.11.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP (Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids.

The location(s) for channel margin enhancement is not known, however, locations along the Sacramento River between Freeport and Georgiana Slough, especially near the north Delta intakes, have been identified as areas of low-quality habitat for listed fish species that would benefit from enhancement actions. Another potential location for channel margin enhancement is Cache Slough, where vernal pool complex habitat occurs on the upland side of the channel margins. Landside improvements would include the construction of a new setback levee behind and connected to the existing levee. Because vernal pool grass habitat can occur on the upland side of existing levees, especially in locations like Cache Slough, there is potential for effects to the species. However, there are no operational, maintenance, or monitoring activities associated with channel margin habitat that would take place in areas that habitat for vernal pool grasses (i.e., any affected vernal pool grass habitat would be lost during construction and therefore not subject to operations and maintenance activities); therefore, these activities would have no effect on the species

### 6C.13.11.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of the CMP (Appendix 3B). Tidal restoration will generally be achieved by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Restoration would primarily occur through breaching or setback of levees, thereby restoring tidal fluctuation to land parcels currently isolated behind those levees, including, potentially, those areas that include vernal pool grasses.

There are no operational actions associated with tidal wetland restoration locations. Maintenance and management actions would be identified in a long-term management plan for each tidal restoration location and would include actions such as vegetation management, weed control, and trash management, and facilities maintenance and management. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data. The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

Maintenance and monitoring activities associated with restored tidal wetlands would involve some ground disturbance and periodic vehicle traffic; however, these activities would take place in areas that no longer contain suitable habitat for vernal pool grasses (i.e., (i.e., any affected vernal pool grass habitat would be lost during construction and therefore not subject to operations and maintenance activities). Therefore, maintenance of restored tidal wetland habitat is not expected to adversely affect these species.

### 6C.13.12 Effects on Vernal Pool Grass Critical Habitat

Solano and Colusa grass critical habitat occurs outside the action area.

### 6C.13.13 Cumulative Effects

Refer to Chapter 6, Section 6.13.13, *Cumulative Effects*, for more information.

## 6C.14 Northwestern Pond Turtle

Appendix 6A describes the definitions, methods and assumptions used to analyze the effects of the proposed action on terrestrial species, including impact categories, effect mechanisms, and habitat model development. Chapter 4, Section 4.4.22.6, *Suitable Habitat Definition*, and Section 4.4.22.7, *Habitat Suitability Model*, define suitable habitat and describe the habitat model for northwestern pond turtle. Refer to Chapter 6, Section 6.14, *Northwestern Pond Turtle,* for more information.

### 6C.14.1 Field Investigations

There would be no ongoing operations or maintenance associated with field investigations; therefore, there would be no effect on northwestern pond turtle.

### 6C.14.2 North Delta Intakes

The north Delta intakes would be constructed on the east bank of the Sacramento River upstream and downstream of Hood. Two intakes would divert water from the Sacramento River and include cylindrical fish screens, intake structures, sedimentation basins, sediment drying lagoons, flow control structures, intake outlet channel and shaft, embankments, and other appurtenant structures. Intakes would also include construction support facilities (e.g., emergency facilities, fuel station), electrical substations, switchyards, and access roads that fall within the north Delta intake facility footprints. The north Delta intakes would be surrounded by security fencing.

The operational components of the north Delta intakes include intakes, fish screens, sedimentation basins and drying lagoons, and associated facilities. Permanent facility lighting would be motion activated, downcast, cut-off type fixtures with non-glare finishes (Chapter 3, Section 3.2.13), and therefore permanent facilities would remain dark the majority of the time at night. Operations activities would generate small levels of noise and require the periodic presence of staff and vehicle traffic.

Maintenance activities at the north Delta intakes would include semiannual general and ground maintenance (e.g., mowing, vegetation trimming, herbicide application), fish screen maintenance, annual sediment and debris removal at intakes, and periodic maintenance of the intake gates and

associated structures approximately every 1 to 5 years. Access roads within the intake facilities would be repaved every 15 years.

#### 6C.14.2.1 Operation

Operations activities would generate small levels of noise, have permanent light sources, and require the periodic presence of staff and vehicle traffic that could disturb normal northwestern pond turtle behavior. However, noise from the operations of the water conveyance facilities would not be discernably higher than existing conditions, and the periodic presence of staff would not be expected to affect northwestern pond turtle, if present.

#### 6C.14.2.2 Maintenance

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of northwestern pond turtle adults, eggs, and hatchlings. Vehicle traffic traveling on access roads within the facilities could result in injury or mortality. Maintenance activities could also expose northwestern pond turtle to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality of adults, eggs, or hatchlings.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

### 6C.14.3 Tunnels

The tunnel occurs completely subsurface. Tunnel operations require periodic and sometimes continuous operation of water pumps and air handlers (used to circulate air) within the tunnels. While pumps and air handlers produce vibration, it would be at noticeable levels only within a localized area, generally less than 50 feet away from equipment.

Operations and maintenance activities within the tunnels would produce low levels of vibration. Operations would produce periodic and sometimes continuous vibration; however, because of the depth of the tunnels (greater than 103 feet below surface), the vibration is very unlikely to be perceptible at the surface. Also, maintenance activities within the tunnel will be infrequent, and the infrequent and temporary nature of any vibration reaching the surface would not exceed existing background noise and vibration levels at the surface. As a result, operations and maintenance of the tunnels would not result in a measurable adverse effect to on northwestern pond turtle individuals.

### 6C.14.4 Tunnel Shafts

There are three types of tunnel shafts: launch shafts, maintenance shafts, and reception shafts. The purpose of the tunnel shafts is to launch, maintain, and remove TBMs at the intakes, along the tunnel alignment, and at the Bethany Complex. Northwestern pond turtle modeled habitat overlaps with

tunnel shaft work areas at Twin Cities Complex, Canal Ranch Tract, Terminous Tract, King Island, Lower Roberts Island, Upper Jones Tract, and Union Island.

Maintenance during project operations could include inspection and maintenance of tunnel shafts, maintenance of the constructed water conveyance tunnel, vegetation control around tunnel shafts, and require periodic presence of staff and vehicle traffic. Maintenance activities at tunnel shafts would include semiannual general and ground maintenance (e.g., mowing and vegetation trimming) and daily inspections by vehicle.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of northwestern pond turtle adults, eggs, and hatchlings. Vehicle traffic traveling on access roads within the facilities could result in injury or mortality. Maintenance activities could also expose northwestern pond turtle to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality of adults, eggs, or hatchlings.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

Maintenance during project operations could include inspection and maintenance of tunnel shafts, maintenance of the constructed water conveyance tunnel, vegetation control around tunnel shafts, and periodic presence of staff and vehicle traffic. Maintenance activities at launch and maintenance shafts would include semiannual general and ground maintenance (e.g., mowing, vegetation trimming, herbicide application), burrow filling (for the purpose of rodent control), and daily inspections by vehicle.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of northwestern pond turtle adults, eggs, and hatchlings. Vehicle traffic traveling on access roads within the facilities could result in injury or mortality. Maintenance activities could also expose northwestern pond turtle to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality of adults, eggs, or hatchlings.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

## 6C.14.5 Reusable Tunnel Material

There are no operations and maintenance activities associated with the RTM sites and therefore no effects on northwestern pond turtle.

## 6C.14.6 Bethany Complex

The Bethany Complex would include a pumping plant, surge basin, reception shaft, discharge structure, and aqueduct. In addition, a construction water pipeline, electrical substation, switchyard, and access roads would be used in support of construction and operations within the Bethany Complex footprint.

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, Bethany Reservoir Aqueduct, and Bethany Reservoir Discharge Structure. All aboveground portions of these features would have permanent facility lighting. Permanent outdoor facility lighting would be motion-activated and therefore would only be lit for a short time when activated (which is expected to occur infrequently). To further minimize impacts from permanent lighting, the fixtures would also be downcast, cut-off types with non-glare finishes (Chapter 3, Section 3.2.13). Because permanent facilities would have motion-detected lights, they are not expected to contribute to ambient nighttime light.

The Bethany Reservoir Pumping Plant operations are not expected to generate noise that would substantially alter the existing environment. The pumping plant would be within an underground facility, and therefore operational light and noise would not be expected to affect species. The Bethany Reservoir Aqueduct has aboveground and below-ground sections; the Bethany Reservoir Aqueduct would contain moving water but this is not expected to be a substantial source of noise because the aboveground sections would be backfilled with approximately 6 feet of soil and the tunneled portions would be below the ground surface. The Bethany Reservoir Discharge Structure would contain large volumes of flowing water at times and would be a source of noise in the areas adjacent to the structure.

Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and the right-of-way would require vegetation removal. Access roads within the Bethany Complex would be repaved every 15 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, aqueduct, and Bethany Reservoir Discharge Structure. Pumping plant operations would occur within an underground facility, and the aqueduct and discharge structure would be operated aboveground within the Bethany Complex. Operation of the Bethany Complex would involve periodic presence of humans and vehicle travel on access roads during day and night. The Bethany Complex includes the surface lands above the tunnel portion of the aqueduct that runs from the pumping plant facility to Bethany Reservoir. Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and associated facilities would involve periodic vegetation removal and repaving access roads within the Bethany Complex facilities every 15 years.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of northwestern pond turtle adults, eggs, and hatchlings. Vehicle traffic traveling on access roads within the facilities could result in injury or

mortality. Maintenance activities could also expose northwestern pond turtle to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality of adults, eggs, or hatchlings.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

## 6C.14.7 Access Roads

The construction of new access roads, a new access railroad spur on Lower Roberts Island, and improvements to existing roads are necessary to support project construction and project facilities. In addition to these road and railroad features, impacts from levee improvements on Lower Roberts Island are also evaluated in this section (as the levee improvements would be adjacent to the access road, have similar impacts on species, and occur at roughly the same time).

Operational activities on access roads include vehicles and equipment traveling to, from, and within the project facilities. Some access roads would have permanent night-lighting, which would be downcast (Chapter 3, Section 3.2.13). Maintenance of access roads would include grading, repaving, and vegetation removal. Existing access roads in the vicinity of the intakes and shafts would be repaved every 15 years. Maintenance would not be conducted by DWR on public access roads, such as SR 160 and SR 12. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of northwestern pond turtle adults, eggs, and hatchlings. Vehicle traffic traveling on access roads could result in injury or mortality. Maintenance activities could also expose northwestern pond turtle to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality of adults, eggs, or hatchlings.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

## 6C.14.8 Electrical and SCADA Facilities

DWR is not responsible for the operations and maintenance of electrical facilities. Operation and maintenance of electrical facilities would be the responsibility of the electrical providers—SMUD, WAPA, and PG&E. These companies would own and maintain their respective electrical facilities.

DWR is responsible for any maintenance activities associated with SCADA facilities; SCADA facilities do not have any associated operational activities. Maintenance activities on SCADA facilities would include emergency repair of underground or aboveground SCADA lines. Vegetation management along SCADA line sections would not be required because underground SCADA lines occur within roadway rights-of-way (that are not vegetated) and the new aboveground SCADA line occurs on existing poles that are being managed from vegetation in the existing conditions.

There is potential for injury or mortality to northwestern pond turtle adults, eggs, or hatchlings where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (as described in Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans (Appendix 3A).

## 6C.14.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[19] concrete and CLSM batch plants and park-and-ride lots. The CLSM batch plants and Hood-Franklin Park-and-Ride lot would be used during construction and then removed. Vehicles moving and parking at these facilities and chemical contamination from vehicle leaks could result in injury or mortality of northwestern pond turtle adults, eggs, or hatchlings. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would require spill prevention and response measures be in place to avoid and minimize accidental discharges into wetlands, including northwestern pond turtle aquatic habitat.

## 6C.14.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facilities would be constructed to deliver water from the Union Island tunnel shaft to the existing CCWD Middle River Pipeline on Victoria Island. The CCWD interconnection facilities would include an interconnection pump station, a new underground 1.6-mile conveyance pipeline, and an interconnection valve to connect to the existing CCWD Middle River Pipeline.

DWR would be responsible for operations and maintenance of the interconnection pump station and interconnection pipeline between the Union Island tunnel shaft and the existing CCWD pumping plant. CCWD would be responsible for operations and maintenance of the interconnection valve within the CCWD facility. Operations and maintenance of the interconnection pump station would be similar to those at the Union Island tunnel shaft and take place within the shaft's permanent

[19] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, such as north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.14.7, *Access Roads*, and Section 6.14.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

footprint. Inspections of the interconnection pump station and pipeline would occur at regular intervals, and annual mowing of the pipeline right-of-way would occur as needed.

The operational components of the CCWD interconnection pump station and interconnection valve would take place within the permanent footprints of the Union Island tunnel shaft and CCWD pumping plant, which would no longer contain suitable northwestern pond turtle habitat. There is potential for injury or mortality to northwestern pond turtle where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair the CCWD interconnection pipeline. Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of northwestern pond turtle. Maintenance activities could also expose northwestern pond turtle and its habitat to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality of adults, eggs, and hatchlings.

The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires posted speed limits of 15 miles per hour and traffic control structures on non-public, unpaved project facility access roads (Appendix 3A). AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers where applicable (Appendix 3A). Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

# 6C.14.11 Compensatory Mitigation

## 6C.14.11.1 Initial Mitigation Sites: Bouldin Island and I-5 Ponds

The CMP (Appendix 3B) would offset the permanent loss of wetlands and habitat for special-status species, including northwestern pond turtle, by creating and enhancing habitat on Bouldin Island and I-5 ponds and managing these areas in perpetuity. The habitat creation and enhancement sites would overlap with modeled northwestern pond turtle habitat.

Operation and maintenance of CMP created and enhanced habitat would require general site maintenance (i.e., site visits, trash removal, maintenance of signs, fences, and gates), vegetation management (i.e., mowing, controlled burns, grazing, discing), levee and channel maintenance (i.e., levee inspection, dredging, road repairs, grading, rodent abatement), and monitoring. These activities would require the use of vehicles and/or boats, heavy equipment, and periodic presence of personnel. Specific long-term management plans would be developed for each site. Maintenance activities would take place during daylight hours.

### Operations

The creation and enhancement of wetlands have the potential to increase bioavailability of contaminants such as methylmercury, CHABs, and selenium by creating conditions favorable for the formation of these contaminants. These contaminants have been known to transfer from aquatic to adjacent terrestrial food webs (Cristol et al. 2008:335) (Appendix 6B) and elevated methylmercury concentrations have been documented in pond turtles and their prey suggesting these species could be at risk for adverse effects of mercury contamination (U.S. Fish and Wildlife Service 2023).

Potential for increased methylmercury exposure, relative to existing conditions, is likely low at Bouldin Island and the I-5 ponds for the below reasons (see Appendix 6B, Section 6B.1 for more information).

- Both areas contain existing wetlands with conditions that allow mercury in the soil to be transformed into methylmercury.
- Perennial wetlands and seasonal wetlands would not have the frequent wetting and drying cycles associated with the highest methylmercury production.
- The I-5 ponds are in areas that were not historically connected to Delta waters, therefore it is unlikely that little, if any, mercury was deposited in soils at these locations.
- Bouldin Island was historically tidal marsh and mercury deposition likely occurred at this site; however, much of Bouldin Island consists of agricultural crops that are managed to flood seasonally, which creates existing conditions that promote mercury methylation.

In addition, mercury monitoring and adaptive management would be implemented at the Bouldin Island and I-5 ponds as described in AMM-23: *Develop and Implement a Mercury Monitoring and Management Plan*.

As described in Appendix 6B, Section 6B.2, the likelihood of CHAB formation is low at the I-5 ponds because they are not tidally connected and would contain ambient water that would not contain *Microystis*. However, Bouldin Island wetland sites have the potential to result in increased CHAB formation. To reduce the potential for incidental take, CHAB monitoring and adaptive management would be implemented at the Bouldin Island site to meet specific performance criteria as part of the site-specific maintenance and management plans described in Appendix 3B, Sections 3B.6 and 3B.7.

Creation and enhancement of wetlands on Bouldin Island and at the I-5 ponds is not expected to increase the risk of selenium exposure to northwestern pond turtle using these habitats because existing selenium concentrations in the Sacramento River watershed are low (Central Valley Regional Water Quality Control Board 1988:14) and, therefore, existing selenium in sediments at Bouldin Island or the I-5 ponds are expected to be low (Appendix 6B, Section 6B.3). Also, modeled selenium concentrations in water, fish tissue, and bird eggs in the existing condition near this location have selenium levels far below levels of concern (Appendix 6B, Section 6B.3.3). Therefore, wetland creation and enhancement on Bouldin Island and at the I-5 ponds would not be expected to increase the bioavailability of selenium, relative to existing conditions, and is not likely to adversely affect northwestern pond turtle.

## Maintenance

Maintenance and monitoring activities would generate small levels of noise, require some vehicle traffic, and require the periodic presence of staff and vehicle traffic that could disturb normal northwestern pond turtle behavior. Monitoring activities may include some in-water sampling, including small boat or kayak-based sampling and monitoring.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of northwestern pond turtle adults, eggs, and hatchlings. Vehicle traffic traveling on access roads within the facilities could result in injury or mortality. Maintenance activities could also expose northwestern pond turtle to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality of adults, eggs, or hatchlings.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

### 6C.14.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be purchased to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, vernal pool tadpole shrimp, alkali seasonal wetland, and vernal pool habitat. Mitigation or conservation bank credits for these species or wetlands would be purchased at banks that have been approved by USFWS, and would have measures to avoid, minimize, and offset any effects to listed species. Therefore, the purchase of mitigation or conservation bank credits for special-status species would not result in additional adverse effects on northwestern pond turtle.

### 6C.14.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.9.11.2, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. A non-bank site would protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat. Vernal pool and alkali seasonable wetland habitat is not suitable for northwestern pond turtle and therefore this activity would have no effect on northwestern pond turtle.

### 6C.14.11.4 Site Protection Instruments

Site protection instruments may be used to protect and enhance agricultural and other lands that provide suitable habitat for species such as greater sandhill crane, Swainson's hawk, and tricolored blackbird. Site protection instruments, including real estate protection instruments, ensure the long-term protection of a mitigation site (Wood and Martin 2016). Examples include conservation easements, deed restrictions, transfer of title, or other documents such as Conservation Land Use Agreements. The site protection instrument would describe site ownership, management, and enforcement of any use restrictions. As with mitigation bank, conservation bank, or non-bank sites; the quantity and quality of acres proposed to be included in a site protection instrument would be determined, in coordination with the USFWS, during the preconstruction phase as described in Appendix 3B.

Site protection instruments for greater sandhill crane, Swainson's hawk, and tricolored blackbird would primarily consist of the protection and management of existing agricultural areas but may also include protection and management of natural communities ( see Section 6C.3.9.3 for details on these species). However, these protected lands are likely to be located in the central or northern parts of the legal Delta and would likely overlap with suitable northwestern pond turtle habitat.

Because these are protection instruments (and will not require substantial habitat restoration or creation), the potential for incidental take of northwestern pond turtle is low. Land management

activities associated with site protection instruments would be typical of agricultural lands and include ground disturbance, vehicle traffic, use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides. These activities would have potential to result in the injury, mortality, and disruption of normal behaviors of northwestern pond turtle just as they do in the existing condition. Changes in water management or crop types for Swainson's hawk would be unlikely to affect northwestern pond turtle suitable habitat as the protection instruments to benefit this species would target preservation of alfalfa, grain, hay, or field crop types (and these types do not provide suitable northwestern pond turtle habitat). Site protection instruments to benefit greater sandhill crane and tricolored blackbird would either maintain or increase the extent and duration of flooded habitat (whether that be flooded corn for the crane or freshwater emergent wetland for the blackbird) and thus would either maintain or increase potentially suitable habitat for the northwestern pond turtle.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). To offset any decrease in northwestern pond turtle habitat as a result of water management or crop type change, the CMP and site-specific permitting approvals would ensure that there is no significant loss in habitat or habitat value by adjusting the overall commitment (Appendix 3B, Section 3B.1, *Introduction,* Section 3B.2.4, *Mitigation Design Parameters,* and Attachment 3B.1, *Compensatory Mitigation Design Parameters*, Table 3B.1-2, CMP-0: *General Design Guidelines*).

### 6C.14.11.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP (Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids.

The location(s) for channel margin enhancement is not known, however, locations along the Sacramento River between Freeport and Georgiana Slough, especially near the north Delta intakes, have been identified as areas of low-quality habitat for migrating salmonids that would benefit from enhancement actions.

There are no operational actions associated with channel margin enhancements. Maintenance and management actions would be identified in a long-term management plan for each channel margin mitigation location and would include actions such as vegetation management, weed control, trash management, and road, levee, and channel maintenance. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data.

The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

Maintenance and monitoring activities would generate small levels of noise, require some vehicle traffic, and ground disturbance, and require the periodic presence of staff and vehicle traffic that could disturb normal northwestern pond turtle behavior. Monitoring activities may even include some in-water sampling, boat traffic, and trapping.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of northwestern pond turtle adults, eggs, and hatchlings. Vehicle traffic traveling on levee roads in the channel margin enhancement area during the active season (May 1 to October 1) could result in injury or mortality. Maintenance activities could also expose northwestern pond turtle to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). With these measures in place, channel margin enhancement maintenance actions are not likely to adversely affect northwestern pond turtle.

### 6C.14.11.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of the CMP (Appendix 3B). Tidal perennial and emergent wetland habitats provide important foraging and refugia habitat for listed fish species. The restoration of tidal perennial and wetland habitat, particularly complex wetland systems containing dendritic channels and shallow subtidal areas, is intended to support improved survival and growth (including food production) of one or more life stages of each listed fish species addressed in the biological assessment. Tidal restoration sites within the lower Yolo Bypass and Cache Slough Complex will be prioritized as these areas would provide greater benefits for target fish species.

Tidal restoration will generally be achieved by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Restoration would primarily occur through breaching or setback of levees, thereby restoring tidal fluctuation to land parcels currently isolated behind those levees. Where practicable and appropriate, portions of restoration sites will be raised to elevations that will support tidal marsh vegetation following levee breaching.

There are no operational actions associated with tidal wetland restoration locations. Maintenance and management actions would be identified in a long-term management plan for each tidal restoration location and would include actions such as vegetation management, weed control, and trash management, and facilities maintenance and management. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could

include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data. The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

## Operations

Tidal restoration could affect water quality in the Delta, namely levels of methylmercury, selenium, and *CHABs such as Microcystis.* Based on the proposed location of restoration sites in the lower Yolo Bypass and Cache Slough Complex, tidal restoration is not expected to increase the bioavailability of selenium or result in conditions conducive to CHABs that could result in adverse effects on northwestern pond turtle, relative to existing conditions. For the rationale and assumptions that support this finding, see Appendix 6B. However, the creation of tidal wetland habitats could create conditions conducive to methylation of mercury and promote uptake and bioaccumulation of methylmercury in northwestern pond turtle or affect prey availability within and adjacent to new tidal habitats.

To minimize the effects of methylmercury on northwestern pond turtle due to tidal habitat restoration, AMM-23*: Develop and Implement a Mercury Management and Monitoring Plan for Wetland Creation and Enhancement Sites* would involve the development of an MMMP to guide tidal habitat design. The MMMP would require project-specific assessments of tidal wetland habitats, integration of design measures to minimize mercury methylation, site monitoring and reporting, and adaptive management.

## Maintenance

Maintenance and monitoring activities would generate small levels of noise, require some vehicle traffic, and ground disturbance, and require the periodic presence of staff and vehicle traffic that could disturb normal giant garter snake behavior. Water quality monitoring and habitat assessment activities may include in-water disturbance and boat traffic.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of northwestern pond turtle adults, eggs, and hatchlings. Vehicle traffic traveling on levee roads in the channel margin enhancement area during the active season (May 1 to October 1) could result in injury or mortality. Maintenance activities could also expose northwestern pond turtle to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). With these measures in place, tidal wetland restoration maintenance actions are not likely to adversely affect northwestern pond turtle.

### 6C.14.12 Effects on Critical Habitat

Critical habitat has not been designated for western pond turtle.

### 6C.14.13 Cumulative Effects

Refer to Chapter 6), Section 6.14.13, *Cumulative Effects*, for more information.

## 6C.15 Western Spadefoot

Appendix 6A describes the definitions, methods and assumptions used to analyze the effects of the proposed action on terrestrial species, including impact categories, effect mechanisms, and habitat model development. Chapter 4, Section 4.4.23.6, *Suitable Habitat Definition*, and Section 4.4.23.7, *Habitat Suitability Model*, define suitable habitat and describe the habitat model for western spadefoot. Refer to Chapter 6, Section 6.15, *Western Spadefoot,* for more information.

### 6C.15.1 Field Investigations

There would be no ongoing operations and maintenance associated with field investigations; therefore, there would be no effect on western spadefoot.

### 6C.15.2 North Delta Intakes

The north Delta intake construction area does not overlap with western spadefoot modeled habitat. Activities in this area would not affect the species.

### 6C.15.3 Tunnels

The tunnel alignment from the north Delta intakes to the Bethany Complex does not overlap with western spadefoot modeled habitat. Activities in this area would not affect the species.

### 6C.15.4 Tunnel Shafts

There are three types of tunnel shafts: launch shafts, maintenance shafts, and reception shafts. The purpose of the tunnel shafts is to launch, maintain, and remove tunnel boring machines at the intakes, along the tunnel alignment, and at the Bethany Complex. Western spadefoot modeled habitat does not overlap with any tunnel shaft locations.

### 6C.15.5 Reusable Tunnel Material

RTM areas do not overlap with Western spadefoot modeled habitat. Activities for these facilities would not affect the species.

### 6C.15.6 Bethany Complex

The Bethany Complex would include a pumping plant, surge basin, reception shaft, discharge structure, and aqueduct. In addition, a construction water pipeline, electrical substation, switchyard, and access roads would be used in support of construction and operations within the Bethany

Complex footprint. The Bethany Reservoir Aqueduct that connects the Bethany Reservoir Pumping Plant to the Bethany Reservoir Discharge Structure would be aboveground, except for two tunneled sections that would pass under the Jones Pumping Plant discharge pipelines and Bethany Conservation Easement. The tunneled portion of the Bethany Aqueduct under the conservation easement would be constructed at a depth of 45 to 180 feet below ground surface, and entry and exit portals to the aqueduct would be outside of the conservation easement (Chapter 3, Section 3.2.6.3). All geotechnical, construction, and maintenance activities would avoid surface disturbance to the conservation easement. No surface facilities (e.g., roads, utilities, or other structures) would be located on top of the conservation easement and no surface maintenance (e.g., mowing) would be conducted on the conservation easement. Maintenance activities of the aqueduct would be conducted from inside the tunnel and access to inside of the tunnel would occur outside of the conservation easement boundary.

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, Bethany Reservoir Aqueduct, and Bethany Reservoir Discharge Structure. All aboveground portions of these features would have permanent facility lighting. Permanent outdoor facility lighting would be motion-activated and therefore would only be lit for a short time when activated (which is expected to occur infrequently). To further minimize impacts from permanent lighting, the fixtures would also be downcast, cut-off types with non-glare finishes (Chapter 3, Section 3.2.13). Because permanent facilities would have motion-detected lights, they are not expected to contribute to ambient nighttime light.

The Bethany Reservoir Pumping Plant operations are not expected to generate noise that would substantially alter the existing environment. The pumping plant would be within an underground facility, and therefore operational light and noise would not be expected to affect species. The Bethany Reservoir Aqueduct has aboveground and below-ground sections; the Bethany Reservoir Aqueduct would contain moving water but this is not expected to be a substantial source of noise because the aboveground sections would be backfilled with approximately 6 feet of soil and the tunneled portions would be 50 to 180 feet below the ground surface; due to the depth of the tunneled portion it is anticipated that any noise or vibration from flowing water through the tunnel would attenuate before reaching the ground surface. The Bethany Reservoir Discharge Structure would contain large volumes of flowing water at times and would be a source of noise in the areas adjacent to the structure.

Maintenance of the pumping plant, surge basin, aqueduct, discharge structure, and the right-of-way would require vegetation removal. Access roads within the Bethany Complex would be repaved every 15 years. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

The operational components of the Bethany Complex include the Bethany Reservoir Pumping Plant, aqueduct, and Bethany Reservoir Discharge Structure. Pumping plant operations would occur within an underground facility. The aqueduct and discharge structure would be operated aboveground, but any light or noise generated from operations would not be expected to affect Western spadefoot habitat.

Vehicles and heavy equipment used for maintenance activities could injure or kill western spadefoot. Maintenance-related runoff and contaminants such as gas, oil, steering fluid, herbicides, and pesticides could accidentally be discharged into western spadefoot upland habitat and result in injury and mortality or habitat degradation.

Maintenance of the pumping plant, surge basin, surface lands above the aqueduct, discharge structure, and associated facilities would not affect Western spadefoot aquatic habitat because there are no aboveground facilities that occur within 250 feet of aquatic habitat. Although the Bethany Reservoir Aqueduct would affect a potentially suitable aquatic pool during construction and would be within 250 feet of the remaining portions of that pool, as well as another pool, this section of the aqueduct would be buried and maintenance would be limited to vegetation management around manways (i.e., access points to buried pipelines), which would be more than 500 feet from the nearest aquatic habitat and would not likely result in direct or indirect effects on the aquatic habitat.

To limit injury and mortality from vehicles, AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife* would require speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would further reduce the potential for injury or mortality due to vehicles and equipment, contaminant spills, or disruption of behaviors from operations and maintenance activities by requiring spill prevention and control plans, a preconstruction environmental review, preconstruction surveys, a biological monitor, and, when appropriate, and non-disturbance buffers using construction fencing, where applicable.

## 6C.15.7 Access Roads

The construction of new roads and improvements to existing roads are necessary to support project construction. New access roads would be either gravel or paved and would be built to connect existing roads to construction areas. Existing roads would be widened and improved to support the construction-related traffic, and existing roads in the vicinity of the intakes and shafts would be repaved every 15 years. The access roads that overlap with western spadefoot modeled habitat are those that are in service to, but occur outside of, the Bethany Complex; improvements to Hood-Franklin Road, and an intake haul road to north Delta intakes.

There are three regions where new access roads would be constructed and existing access roads would be improved in service of the Bethany Complex: to the northeast of the Bethany Complex, connecting Mountain House Road to Byron Highway; between Mountain House Road and the Bethany discharge structure; and to the south of the Bethany Complex, connecting Mountain House Road to Grant Line Road (Chapter 6, Figure 6.15-1). A haul road would be constructed and used to access the northern intake facility. Additionally, an existing road would be improved along Hood-Franklin Road in service to a Park-and-Ride on Hood-Franklin Road. For more information about access roads see Chapter 3, Section 3.2.7, *Access Roads*.

Operational activities on access roads include vehicles and equipment traveling to, from, and within the project facilities. Some access roads would have permanent facility lighting, which would be downcast (Chapter 3, Section 3.2.13). Maintenance of access roads would include periodic grading, repaving, and vegetation removal. Maintenance activities would generally be conducted during the day, except for emergency maintenance, and would therefore not require additional lighting.

Impacts from operations and maintenance activities are evaluated only where they occur within DWR-owned or DWR-maintained facilities. Vehicles and heavy equipment used for operations and maintenance activities could injure or kill Western spadefoot. Operations- and maintenance-related runoff and contaminants such as gas, oil, steering fluid, herbicides, and pesticides could accidentally be discharged into California tiger salamander habitat and result in injury and mortality or habitat degradation.

AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality due to vehicles and equipment, contaminant spills, or disruption of behaviors from operations and maintenance activities by requiring spill prevention and control plans, a preconstruction environmental review, preconstruction surveys, environmental resources work awareness training, and a biological monitor, when appropriate, and non-disturbance buffers, where applicable (Appendix 3A).

## 6C.15.8 Electrical and SCADA Facilities

DWR is not responsible for the operations and maintenance of electrical facilities. Operation and maintenance of electrical facilities would be the responsibility of the electrical providers—SMUD, WAPA, and PG&E. These companies would own and maintain their respective electrical facilities.

DWR is responsible for any operation and maintenance activities associated with SCADA facilities; however, SCADA facilities do not have any associated operational activities. Maintenance activities on SCADA facilities would include emergency repair of underground or aboveground SCADA lines. Vegetation management along SCADA line sections would not be required because underground SCADA lines occur within roadway rights-of-way (that are not vegetated) and the new aboveground SCADA line occurs on existing poles that are being managed from vegetation in the existing conditions. Electrical and SCADA facilities operations and maintenance actions are evaluated programmatically and would be subject to future, "step down" consultation when site-specific information becomes available.

There is potential for injury or mortality to western spadefoot where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife*, which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans (Appendix 3A).

There is potential for injury or mortality to western spadefoot where the temporary use and staging of vehicles and equipment and ground disturbance (including trenching) are necessary to maintain or repair a SCADA line. The potential effects of injury or mortality due to collisions with operations- and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife*, which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads (Appendix 3A). Implementation of AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans (Appendix 3A).

# 6C.15.9 Other Construction Support Facilities

Other construction support facilities include the following project feature types where they occur outside one of the project feature footprints described in the above sections:[20] concrete and CLSM batch plants and park-and-ride lots. None of these features overlap with the western spadefoot modeled habitat; thus, activities associated with these facilities are not expected to affect the species.

# 6C.15.10 Contra Costa Water District Interconnection Facilities

The CCWD interconnection facility construction area does not overlap with western spadefoot modeled habitat. Activities in this area would not adversely affect the species.

# 6C.15.11 Compensatory Mitigation Plan

## 6C.15.11.1 Initial Mitigation Sites: Bouldin Island and I-5 Ponds

The Bouldin Island and I-5 Pond 6 creation and enhancement sites do not overlap with western spadefoot modeled habitat; therefore, construction activities at those sites would have no effect on the species. However, western spadefoot modeled habitat overlaps with initial mitigation sites at the Ponds 7 and 8.

Operation and maintenance of CMP created and enhanced habitat would require general site maintenance (i.e., site visits, trash removal, maintenance of signs, fences, and gates), vegetation management (i.e., mowing, controlled burns, grazing, discing), levee and channel maintenance (i.e., levee inspection, dredging, road repairs, grading, rodent abatement), and monitoring. These activities would require the use of vehicles and/or boats, heavy equipment, and periodic presence of personnel. Specific long-term management plans would be developed for each site. Maintenance activities would take place during daylight hours.

**Operation**

The creation and enhancement of wetlands have the potential to increase bioavailability of contaminants such as methylmercury, CHABs, and selenium by creating conditions favorable for the formation of these contaminants. These contaminants have been known to transfer from aquatic to adjacent terrestrial food webs (Cristol et al. 2008:335) (Appendix 6B) and elevated methylmercury concentrations have been documented in amphibans, such as western toad (*Anaxyrus boreas*) and Sierra Nevada yellow-legged frog (*Rana sierrae*), suggesting western spadefoot could be at risk for adverse effects of mercury contamination (Tornabene et al. 2023:17514).

Potential for increased methylmercury exposure, relative to existing conditions, is likely low at Bouldin Island and the I-5 ponds for the below reasons (see Appendix 6B, Section 6B.1 for more information).

- Both areas contain existing wetlands with conditions that allow mercury in the soil to be transformed into methylmercury.

[20] As described in Appendix 6A, the project features evaluated in this section occur outside the primary construction locations, such as north Delta intakes and Bethany Complex. For example, there are impacts from road work areas included in Section 6.15.7, *Access Roads*, and Section 6.15.6, *Bethany Complex*, but the road work area described in this section occurs in a discreet location, outside a large project footprint.

- Perennial wetlands and seasonal wetlands would not have the frequent wetting and drying cycles associated with the highest methylmercury production.
- The I-5 ponds are in areas that were not historically connected to Delta waters, therefore it is unlikely that little, if any, mercury was deposited in soils at these locations.
- Bouldin Island was historically tidal marsh and mercury deposition likely occurred at this site; however, much of Bouldin Island consists of agricultural crops that are managed to flood seasonally, which creates existing conditions that promote mercury methylation.

In addition, mercury monitoring and adaptive management would be implemented at the Bouldin Island and I-5 ponds as described in AMM-23: *Develop and Implement a Mercury Monitoring and Management Plan* (Appendix 3A).

As described in Appendix 6B, Section 6B.2, the likelihood of CHAB formation is low at the I-5 ponds because they are not tidally connected and would contain ambient water that would not contain *Microystis*. However, Bouldin Island wetland sites have the potential to result in increased CHAB formation. To reduce the potential for incidental take, CHAB monitoring and adaptive management would be implemented at the Bouldin Island site to meet specific performance criteria as part of the site-specific maintenance and management plans described in Appendix 3B, Sections 3B.6 and 3B.7.

Creation and enhancement of wetlands on Bouldin Island and at the I-5 ponds is not expected to increase the risk of selenium exposure to western spadefoot using these habitats because existing selenium concentrations in the Sacramento River watershed are low (Central Valley Regional Water Quality Control Board 1988:14) and, therefore, existing selenium in sediments at Bouldin Island or the I-5 ponds are expected to be low (Appendix 6B, Section 6B.3). Also, modeled selenium concentrations in water, fish tissue, and bird eggs in the existing condition near this location have selenium levels far below levels of concern (Appendix 6B, Section 6B.3.3). Therefore, wetland creation and enhancement on Bouldin Island and at the I-5 ponds would not be expected to increase the bioavailability of selenium, relative to existing conditions, and is not likely to adversely affect western spadefoot.

**Maintenance**

Maintenance and monitoring activities would generate small levels of noise, require some vehicle traffic, and require the periodic presence of staff and vehicle traffic that could disturb normal western spadefoot behavior. Monitoring activities may include some in-water sampling, including small boat or kayak-based sampling and monitoring.

Use of vehicles and heavy equipment for operations and maintenance activities could result in the injury, mortality, and disruption of normal behaviors of western spadefoot adults, eggs, and hatchlings. If western spadefoot were moving across access roads they could be injured or killed by maintenance vehicles. Maintenance activities could also expose western spadefoot to contaminants such as fuels, oils, and herbicides, which could result in injury and mortality of adults, eggs, or hatchlings.

The potential effects of injury or mortality due to collisions with operations and maintenance-related vehicles would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on non-public, unpaved DWR facility access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would

also minimize impacts from maintenance-related activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A).

### 6C.15.11.2 Mitigation/Conservation Bank Credits

Mitigation or conservation bank credits may be purchased to meet compensatory mitigation requirements for California red-legged frog, California tiger salamander, western spadefoot, vernal pool fairy shrimp, vernal pool tadpole shrimp, alkali seasonal wetland, and vernal pool habitat. Mitigation or conservation bank credits for these species or wetlands would be purchased at banks that have been approved by USFWS, and would have measures to avoid, minimize, and offset any effects to listed species. Therefore, the purchase of mitigation or conservation bank credits for special-status species would not result in additional adverse effects on western spadefoot.

### 6C.15.11.3 Non-Bank Site

In the instance that mitigation or conservation bank credits for vernal pools and alkali seasonal wetlands described in Section 6.15.11.2, *Mitigation/Conservation Bank Credits*, are not available in part or in full, a non-bank site may be used. Non-bank sites are evaluated programmatically and would be subject to future, "step down' consultation when site-specific information becomes available. A non-bank site would protect, enhance, and manage suitable vernal pool or alkali seasonal wetland habitat. If non-bank sites are used for vernal pool or alkaline wetland creation or enhancement (Appendix 3B, Section 3B.3.2.4), these activities could occur in areas where western spadefoot have potential to occur.

Management activities could include ground disturbance, require some vehicle traffic and use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides, which could result in the injury, mortality, and disruption of normal behaviors of western spadefoot. The *Western Spadefoot Avoidance and Minimization Measure* described in Chapter 3, Section 3.6.2.11 would minimize impacts by requiring preconstruction surveys, requiring the presence of a qualified biological monitor, minimizing ground disturbing activities, minimizing nighttime construction, avoiding initial ground disturbance work during periods of rainfall, implementing a relocation plan, and installing exclusion fencing around the perimeter of construction sites where western spadefoot habitat is within 300 feet of construction activities 14 days prior to construction to reduce effects of construction. To reduce the potential effects of contamination from spills, AMM-2: *Develop and Implement Hazardous Materials Management Plans,* and AMM-3: *Develop and Implement Spill Prevention, Control, and Countermeasure Plans* would require spill prevention and control plans be created and implemented (Appendix 3A). With these measures in place, and the long-term benefits associated with protection and long-term management of Western spadefoot habitat, implementation of non-bank sites is not expected to adversely affect the species.

### 6C.15.11.4 Site Protection Instruments

Site protection instruments may be used to protect and enhance agricultural and other lands that provide suitable habitat for species such as greater sandhill crane, Swainson's hawk, and tricolored blackbird. Site protection instruments, including real estate protection instruments, ensure the long-term protection of a mitigation site (see Section 6C.3.9.3 for details on these species; Wood and Martin 2016). Examples include conservation easements, deed restrictions, transfer of title, or other documents such as Conservation Land Use Agreements. The site protection instrument would

describe site ownership, management, and enforcement of any use restrictions. As with mitigation bank, conservation bank, or non-bank sites, the quantity and quality of acres proposed to be included in a site protection instrument would be determined, in coordination with the USFWS and CDFW, during the preconstruction phase as described in Appendix 3B. Because actions associated with site protection instruments are expected to be beneficial, consultation under the ESA is not expected to be necessary. However, if consultation is required, it would occur in the future when site-specific information is available.

Site protection instruments for greater sandhill crane, Swainson's hawk, and tricolored blackbird would primarily consist of the protection and management of agricultural areas but may also include protection and management of natural communities (e.g., grasslands or vernal pool complex) in the action area (see Section 6C.3.9.3 for details on these species). The need for a site protection instrument is not yet known. Nor is the location of the protection known. However, these activities could occur in areas with suitable habitat for western spadefoot.

Land management activities associated with site protection instruments could include ground disturbance, require some vehicle traffic and use of heavy equipment, and use of contaminants such as fuels, oils, and herbicides, which could result in the injury, mortality, and disruption of normal behaviors of western spadefoot. The potential effects of injury or mortality due to vehicle collisions would be minimized through AMM-18: *Avoid and Minimize Operational Traffic Impacts on Wildlife,* which requires speed limits of 15 miles per hour and traffic control structures on unpaved access roads. AMM-17: *Avoid and Minimize Impacts on Terrestrial Biological Resources from Maintenance Activities* would reduce the potential for injury or mortality from contaminant spills by requiring spill prevention and control plans. AMM-17 would also minimize impacts from land management activities by requiring a preconstruction environmental review, preconstruction surveys, a biological monitor when appropriate, and non-disturbance buffers using construction fencing where applicable (Appendix 3A). Overall, site protection instruments would benefit western spadefoot r by protecting and managing lands with suitable western spadefoot habitat, limiting use of pesticides, and promoting habitat connectivity.

### 6C.15.11.5 Channel Margin Enhancements

To offset the adverse effects of project construction on juvenile salmonids, a total of 3,619 linear feet of channel margin habitat would be constructed and maintained as part of the CMP (Appendix 3B). Channel margin enhancement would improve channel geometry and restore riparian, marsh, and mudflat habitats on the waterside of levees along channels that provide rearing and outmigration habitat for juvenile salmonids.

The location(s) for channel margin enhancement is not known; however, locations along the Sacramento River between Freeport and Georgiana Slough, especially near the north Delta intakes, have been identified as areas of low-quality habitat for migrating salmonids that would benefit from enhancement actions.

There are no operations activities associated with channel margin enhancements. Maintenance and management activities would be identified in a long-term management plan for each channel margin mitigation location and would include activities such as vegetation management; weed control; trash management; and road, levee, and channel maintenance. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data.

The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

There are no operational activities associated with channel margin habitat. Maintenance and monitoring activities would take place in areas that no longer provide habitat for western spadefoot; therefore, these activities would have no effect on the species.

### 6C.15.11.6 Tidal Perennial/Emergent Wetland Restoration

To offset the adverse effects of project construction and operations on listed fish species (e.g., Chinook salmon, delta smelt), a total of 3,500 acres of tidal habitat would be constructed and maintained as part of the CMP (Appendix 3B). Tidal perennial and tidal freshwater emergent wetland habitats provide important foraging and refugia habitat for listed fish species. The restoration of tidal perennial and wetland habitat, particularly complex wetland systems containing dendritic channels and shallow subtidal areas, is intended to support improved survival and growth (including food production) of one or more life stages of each listed fish species addressed in the biological assessment. Tidal restoration sites within the lower Yolo Bypass and Cache Slough Complex will be prioritized as these areas would provide greater benefits for target fish species.

Tidal restoration will generally be achieved by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Restoration would primarily occur through breaching or setback of levees, thereby restoring tidal fluctuation to land parcels currently isolated behind those levees. Where practicable and appropriate, portions of restoration sites will be raised to elevations that will support tidal marsh vegetation following levee breaching.

There are no operational actions associated with tidal wetland restoration locations. Maintenance and management actions would be identified in a long-term management plan for each tidal restoration location and would include actions such as vegetation management, weed control, and trash management, and facilities maintenance and management. In addition, an adaptive management and monitoring plan would be prepared for each channel margin location and could include effectiveness monitoring and focused research projects, both of which could require on-site collection of water quality, vegetation cover, species occurrence, or other types of biological data. The long-term management and adaptive management and monitoring plans are described in Appendix 3B, Sections 3B.6 and 3B.7.

There are no operational activities associated with tidal restoration that could affect western spadefoot. Maintenance and monitoring activities would occur in areas that no longer provide suitable habitat for spadefoot; therefore, these activities would have no effect on the species.

## 6C.15.12 Effects on Critical Habitat

Critical habitat has not been designated for western spadefoot.

## 6C.15.13 Cumulative Effects

Refer to Chapter 6, Section 6.15.13, *Cumulative Effects*, for more information.

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Appendix 7A

# Framework Programmatic Assessment for the Delta Conveyance Project and Sites Reservoir Project

## 7A.1 Introduction

This Proposed Action (PA) Biological Assessment (BA) includes a programmatic framework consultation (See Section 3.15 of the Long-Term Operations (LTO) BA for a description of the programmatic approach) for the operations of the Sites Reservoir Project (Sites) and the operations of the Delta Conveyance Project (DCP). The use of a mixed programmatic framework consultation for these two projects provides information, to the extent possible given the information available today, to assess how these projects would operate in the context of the LTO PA along with broadly assessing the impacts of the operations of each of these projects. This appendix will discuss these two distinct projects for which independent and separate programmatic coverage is sought, and it will discuss them collectively so the potential future combined effects of these projects as well as the ongoing operations of the CVP and SWP can be considered.

For the Sites Project, the Sites Authority would own and operate all newly constructed project facilities that are not already owned by another entity. There are currently 22 Storage Partners representing local and regional water delivery agencies that serve over 24.5 million people and over 500,000 acres of farmland that are paying for the Sites Project and that would receive the resulting water supply benefits. In addition, the State of California, through the California Water Commission, and the Bureau of Reclamation are also envisioned to be Storage Partners and receive water supply benefits. The Bureau of Reclamation is seeking coverage for its participation in Sites in the context of LTO, as well as Sites more generally as a project. Sites will not be a CVP facility.

The DCP, proposed to be added as part of the State Water Project (SWP), includes the construction and operation of new water intake facilities on the Sacramento River in the north Delta and a single main tunnel to divert and move water entering the northern Delta from the Sacramento Valley watershed to existing SWP facilities in the southern Delta, which would result in a dual conveyance system for the SWP in the Delta. As described further in the draft DCP BA, for example, the DCP would operate primarily to capture excess flows when certain conditions are met and DWR is not seeking to increase its existing water rights, nor proposing any operations changes upstream of the Delta. The DCP would be part of the SWP's integrated water delivery system and, therefore, would be considered within the SWP and CVP LTO. If the DCP becomes operational, it would be a part of the SWP Delta operations and subject to Reclamation and DWR Coordinated Operations Agreement (COA). The Bureau of Reclamation is seeking coverage for the DCP in the context of LTO. The DCP is not proposed as a CVP facility.

This BA considers only the operation of Sites and of DCP (additional detailed information is provided in the project specific descriptions and analyses presented individually for projects in the Sites administrative draft biological assessment and the DCP draft biological assessment). All effects associated with intake operations, including near- and far-field effects within the river as well as potential associated effects to aquatic biological resources, are assessed through this Programmatic LTO analysis. In the sections below, potential effects to stressors are summarized in the same

manner as done in the species-specific effects analyses presented in Chapters 5-11, according to the assessment scheme used by National Marine Fisheries Service (2019:29). Project level assessment of operations will be included in subsequent consultations.

The project level consultation for construction of these two projects are covered by separate BAs. For purposes of the USACE DCP BA, project-specific effects associated with construction and placement of DCP facilities, including in-water work, as well as both temporary and permanent impacts will be covered under the USACE's section 7 consultation. Subsequent project-level consultation for Sites will be associated with the operations of the reservoir and the resulting effects to listed pelagic and anadromous species as implemented by the National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service. Reclamation will be the federal lead agency for that consultation.

# 7A.2 Guiding Principles and Project Refinements

Guiding principles inform the upfront development of operational criteria and measures to avoid or minimize effects to listed species and critical habitat, including possible adjustment through adaptive management, that would be analyzed in subsequent project-level consultations. Current proposed operational criteria will be included and considered through quantitative assessments, as applicable. Potential operational refinements will be informed by the programmatic analysis, which will guide subsequent project-level consultations. Adaptive Management is intended to further address outstanding uncertainties up to, and throughout, the operations phase. Project specific compliance efforts and monitoring would continue to be the responsibility of the individual projects, but there would be a commitment to ongoing coordination and information sharing to support the broader monitoring and adaptive management processes. In relation to the LTO process, it is anticipated that DCP and Sites adaptive management activities would be considered Bin 3 actions in the LTO AMP, i.e., adaptive management actions for which agencies evaluate data over longer periods of implementation (on the order of 10-15 years), potentially requiring a full structured decision-making process as described in further detail in Appendix B of the LTO Adaptive Management Program. Both programs would be coordinated and aligned with the LTO Adaptive Management Steering Committee, as needed.

Guiding principles include principles applicable to Sites, principles that are applicable to DCP, principles that are the responsibility of both projects, as well as joint commitments related to coordination and cooperation that are the joint responsibility of both projects. Note that DCP would not create changes to baseline SWP or CVP upstream reservoir operational criteria. The DCP would be operated in a manner that does not impact either DWR or Reclamation's ability to operate upstream reservoirs to meet existing and future criteria and regulations. The guiding principles for regions upstream from the Delta are therefore specific only to Sites and the Bureau of Reclamation's participation in Sites. Guiding principles relevant to each species are discussed below in the qualitative effects analyses for DCP and Sites. Among these guiding principles is that the projects would operate consistent with existing and/or future regulatory requirements in the Delta as applied specifically to the projects; this includes not proposing to change any applicable Delta regulatory requirements that currently exist or that are proposed under the Proposed Action.

Ongoing planning includes assessment of existing independent effects analyses for DCP, Sites, and LTO (as summarized in this document) as well as the following key efforts: 1) Development of a

combined LTO, Sites, and DCP Calsim 3 model to support the quantitative assessment of the projects; 2) Use of key biological tools (e.g. existing life-cycle-models for winter-run Chinook salmon, delta smelt and those in development for spring-run Chinook salmon, and longfin smelt once available) to evaluate combined/integrated effects of DCP, Sites, and LTO on listed species as well as critical habitat; 3) Use of aforementioned tools to revisit and refine operational criteria, as necessary; 4) Implementation of studies and monitoring efforts in support of adaptive management; 5) Identification and planning for compensatory mitigation associated with operational effects.

# 7A.3 DCP Combined with Proposed Action Qualitative Effects Analysis

## 7A.3.1 Sacramento River Winter-Run Chinook Salmon

Chapter 5 discusses the status of Sacramento River winter-run Chinook Salmon, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. Summaries of the effects analysis for effects on the species and its critical habitat are provided in Tables WR1 and WR2. A qualitative analysis was conducted to provide a programmatic summary of the effects of the DCP for the species life stages, critical habitat physical and biological features, and stressors discussed for the Proposed Action (Tables WR1 and WR2)[1]. The analysis of the DCP was based on information in the draft DCP BA and Final Environmental Impact Report (FEIR), which includes consideration of various quantitative and qualitative analyses.

As illustrated in Tables WR1 and WR2, the principal potential effects of the DCP in addition to the Proposed Action would be from operations effects of the north Delta intakes on juvenile rearing and outmigration and the associated critical habitat PBFs of river flows for downstream transport of juveniles and access downstream for juveniles. Life cycle modeling undertaken for DCP indicated overall potential negative effects on winter-run Chinook Salmon adult abundance based on two of the models (IOS and OBAN), whereas the Winter-Run Chinook Salmon Life Cycle Model suggested overall potential positive effects of DCP. Life cycle modeling described in Chapter 5 for the Proposed Action with the CVPIA winter-run Chinook salmon life cycle model suggested generally similar adult spawner abundance population change for Proposed Action phases compared to the No Action Alternative.

The DCP intakes include cylindrical fish screens meeting fish agency standards for factors such as screen opening size and approach velocity to minimize risk from entrainment and impingement. The DCP intakes operational criteria include factors such as pulse protection criteria and bypass flows—wherein diversions are restricted based on large-scale downstream movement of juvenile salmonids—in order to avoid or minimize the potential for negative effects. Compensatory mitigation would be undertaken for north Delta hydrodynamic effects including the potential for reduced riverine flow leading to a greater tidal influence and more flow and therefore juvenile fish entering the relatively low-survival interior Delta at Georgiana Slough, in addition to less inundation of riparian and wetland bench rearing habitat.

As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects

[1] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

of the proposed operations of the DCP would be avoided, minimized, and offset. Guiding principles relevant to winter-run Chinook salmon include:

- Operate projects consistent with existing and/or future regulatory requirements in the Delta.
- Implement pulse flow criteria to provide migrating anadromous fish with an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.
- Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
- Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.
- Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations.
- Implement project operations and maintenance consistent with the proposed project description, as an integrated component of the SWP.
    - Future consultation on Delta Conveyance Project Operations and Maintenance is envisioned to update and align elements of project description with conditions (e.g. regulatory, climate, status of species) in advance of operations of the north Delta diversions.

As described in Chapter 3, DCP has an adaptive management program which would integrate with the adaptive management program for the Proposed Action and includes a number of general principles such as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

**Table 7A-1. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Sacramento River Winter-Run Chinook Salmon**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Adult Migration | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Stranding Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Toxicity from Contaminants | Increase (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other AMMs minimize effects); DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Water Temperature | Increase (discountable/insignificant) | — | Construction: increase (discountable/insignificant). Operations and maintenance: not anticipated to change. | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Pathogens and Disease | Increase (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL), noted as key driver of pathogens/disease (Chapter 5). |
| | Other construction-related stressors (acoustic effects; direct physical injury; prey availability; predation; habitat extent) | — | — | Increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance and adults unlikely to be at risk from predation; CMP-23 and CMP-24 mitigate for reduced habitat extent. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | |
| Adult Holding and Spawning | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Stranding Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Competition, Introgression, and Broodstock Removal | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Spawning Habitat | Increase (lethal; proportion: likely small/medium; frequency: low) | Minimize/compensate: Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; Drought Actions<br>Exacerbate: SRSC Diversion Spring Delays and Shifting; Shasta Operations Team (SHOT) Water Transfer Timing Approvals | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Water Temperature | Decrease (beneficial; proportion: likely large; frequency: high); increase (sublethal; proportion: small; frequency: low) | Minimize/compensate: Adult Migration and Holding Water Temperature Objectives<br>Exacerbate: Drought Tool Kit Warmwater Bypass; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Pathogens and Disease | Decrease (beneficial; proportion: likely large; frequency: high); increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: Adult Migration and Holding Water Temperature Objectives | Not anticipated to change | — | DCP would not affect upstream operations. |
| Egg Incubation and Fry Emergence | In-River Fishery or Trampling | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Predation Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity from Contaminants | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Pathogens and Disease | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Sedimentation and Gravel Quantity | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Redd Stranding and Dewatering | Increase (lethal; proportion: likely small; frequency: high) | Minimize/compensate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance<br>Exacerbate: SHOT Water Transfer Timing Approvals | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Redd Quality | Decrease (beneficial; proportion: likely large; frequency: likely high) | Minimize/compensate: SHOT Water Transfer Timing Approvals<br>Exacerbate: Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; SRSC Diversion Spring Delays and Shifting; Minimum Refuge Summer Deliveries North of Delta; Drought Actions | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Water Temperature | Decrease (beneficial; proportion: likely large; frequency: medium); increase (lethal; proportion: likely small; frequency: medium) | Minimize/compensate: Shasta Reservoir Water Temperature and Storage Management; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; SRSC Diversion Spring Delays and Shifting; Drought Actions<br>Exacerbate: Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Adult Migration and Holding Water Temperature Objectives; SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool); SHOT Water Transfer Timing Approvals (Denials that precludes water transfers) | Not anticipated to change | — | DCP would not affect upstream operations. |
| Juvenile Rearing and Outmigration | Pathogens and Disease | Increase or decrease (discountable/insignificant) | — | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal; proportion: small; frequency: high). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL), noted as key driver of pathogens/disease (Chapter 5); small potential for injury leading to disease from contacting north Delta intake screens, minimized by screen design (smooth screen face; cleaning system) and operating criteria (e.g., approach velocity) |
| | Toxicity from Contaminants | Increase (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | increase (discountable/insignificant). | Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-27: Develop and Implement a Barge Operations Plan | because of AMM-14 work window; other AMMs minimize effects); DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Predation and Competition | Increase (discountable/insignificant) | — | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: increase (lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction has the potential to disturb juveniles and make them more susceptible to predation (however, there would be limited temporal overlap with construction because of AMM-14 work window; other AMMs minimize effects); presence of cofferdams during construction period provides potential predator habitat but is small in extent relative to the area of habitat in the Delta. Predation associated with DCP operations could occur at the north Delta intakes if predators aggregate there but existing literature suggests such effects would be minimal; uncertainty to be addressed with fisheries studies and adaptive management. |
| | Stranding Risk | Increase (lethal; proportion: small; frequency: high) | Minimize/compensate: Minimum Instream Flows; Ramping Rates | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: not anticipated to change. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan | DCP construction has the potential to strand juveniles within cofferdams but there would be limited temporal overlap with construction because of AMM-14 work window; AMM-25 would provide fish rescue. DCP would not affect upstream operations and therefore would not affect areas of concern noted in Chapter 5. Within the Delta, stranding on inundated riparian or wetland benches would not be anticipated given bench design (slope). |
| | Outmigration Cues | Increase (lethal; proportion: large; frequency: low) | Minimize/compensate: Minimum Instream Flows; SRSC Diversion Spring Delays and Shifting<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Shasta Reservoir Water Temperature and Storage Management; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North | Construction: not anticipated to change. Operations and maintenance: not anticipated to change (Sacramento River); increase (Delta; lethal; proportion: high; frequency: high). | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | DCP would not affect upstream operations and therefore would not affect Sacramento River outmigration cues. DCP north Delta intake operations would reduce Sacramento River flow into the Delta, potentially reducing through-Delta survival based on flow-survival relationships. This is limited by operating criteria, with modeling indicating relative differences in through-Delta survival of 4% or less during main outmigration period. CMP-25 would offset potential increases in reverse flows at the Sacramento River- |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | of Delta; Drought Actions; SHOT Water Transfer Timing Approvals | | | Georgiana Slough junction as a result of north Delta intakes operations (which could otherwise lead to more fish entering the relatively high-predation interior Delta migration pathway); CMP-25 would also reduce interior Delta entry when the north Delta intakes are not operating. |
| | Entrainment Risk | Increase (lethal; proportion: small/medium; frequency: high) | Minimize/compensate: SRSC Transfer Delays; Delta Cross Channel Gate Closure; Winter-Run Chinook Salmon Early Season Salvage Threshold; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Winter-Run 50% Annual Loss Threshold; Winter-Run 75% Annual Loss Threshold; Winter-Run Weekly Loss Thresholds; Winter and Spring Delta Outflows; Salvage Facilities<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; SHOT Water Transfer Timing Approvals; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: not anticipated to change. Operations and maintenance: increase (lethal; proportion: high; frequency: high). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | North Delta intakes' 1.75-mm cylindrical screens would exclude juveniles from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. Operating criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment; see discussion of Outmigration Cues for CMP-25, which would offset potential for greater entrainment at the south Delta export facilities caused by greater interior Delta entry via Georgiana Slough. |
| | Refuge Habitat | Not anticipated to change (more seaward end of Delta); increase (Sacramento River and more landward end of Delta; sub-lethal; proportion: large; frequency: medium) | Minimize/compensate: Minimum Instream Flows; SRSC Transfer Delays<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Reduced Wilkins Slough Minimum Flows; SHOT Water Transfer Timing Approvals; Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (sub-lethal; proportion: small; frequency: high) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, mitigated by CMP-26. |
| | Food Availability and Quality | Not anticipated to change (more seaward end of Delta); increase (Sacramento River and more landward end of Delta; sub-lethal; proportion: large; frequency: low) | Minimize/compensate: Minimum Instream Flows; SRSC Transfer Delays<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Reduced Wilkins Slough Minimum Flows; SHOT Water Transfer Timing Approvals; Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Resources); North Delta intakes operating criteria | |
| | Water Temperature and Dissolved Oxygen | Not anticipated to change (Delta); decrease or increase (Sacramento River; beneficial or sub-lethal/lethal; proportion: medium to large; frequency: high) | Minimize/compensate: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management (preserve cold water)<br>Exacerbate: SHOT Water Transfer Timing Approvals (denial of water transfers); SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool) | Construction: increase (discountable/insignificant); operations and maintenance: not anticipated to change | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Other construction-related stressors (acoustic effects; direct physical injury) | — | — | Increase (sub-lethal to lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation.

**Table 7A-2. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Sacramento River Winter-Run Chinook Salmon Critical Habitat**

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Access from the Pacific Ocean to Appropriate Spawning Areas | In-River Fishery and Poaching | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Stranding Risk | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Toxicity from Contaminants | No adverse effects anticipated | — | Construction: adverse. Operations and maintenance: no adverse effects anticipated. | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other AMMs minimize effects); DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Water Temperature | No adverse effects anticipated | — | Construction: no adverse effects anticipated. Operations and maintenance: no adverse effects anticipated. | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Other construction- | — | — | Adverse | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; | DCP construction effects would be limited in temporal overlap because of AMM-14 work |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | related stressors | | | | AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | window; other AMMs minimize effects; CMP-23 and CMP-24 mitigate for reduced habitat extent. |
| Clean Gravel for Spawning Substrate | Spawning Habitat | Adverse | Minimize/compensate: Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; Drought Actions<br>Exacerbate: SRSC Diversion Spring Delays and Shifting; Shasta Operations Team (SHOT) Water Transfer Timing Approvals | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| River Flows for Spawning, Incubation, Fry Development and Emergence, and Downstream Transport of Juveniles | Spawning Habitat | Adverse | Minimize/compensate: Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; Drought Actions<br>Exacerbate: SRSC Diversion Spring Delays and Shifting; Shasta Operations Team (SHOT) Water Transfer Timing Approvals | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Redd Quality | No adverse effects anticipated | Minimize/compensate: SHOT Water Transfer Timing Approvals<br>Exacerbate: Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; SRSC Diversion Spring Delays and Shifting; Minimum Refuge Summer Deliveries North of Delta; Drought Actions | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Redd Stranding and Dewatering | Adverse | Minimize/compensate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance<br>Exacerbate: SHOT Water Transfer Timing Approvals | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Stranding Risk | Adverse | Minimize/compensate: Minimum Instream Flows; Ramping Rates | No adverse effects anticipated | — | DCP would not affect upstream operations and therefore would not affect areas of concern noted in Chapter 5. Within the Delta, stranding |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | on inundated riparian or wetland benches would not be anticipated given bench design (slope). |
| | Outmigration Cues | Adverse | Minimize/compensate: Minimum Instream Flows; SRSC Diversion Spring Delays and Shifting<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Shasta Reservoir Water Temperature and Storage Management; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; Drought Actions; SHOT Water Transfer Timing Approvals | Construction: no adverse effects anticipated. Operations and maintenance: no adverse effects anticipated (Sacramento River); adverse (Delta). | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | DCP would not affect upstream operations and therefore would not affect Sacramento River outmigration cues. DCP north Delta intake operations would reduce Sacramento River flow into the Delta, potentially reducing through-Delta survival based on flow-survival relationships. This is limited by operating criteria, with modeling indicating relative differences in through-Delta survival of 4% or less during main outmigration period. CMP-25 would offset potential increases in reverse flows at the Sacramento River-Georgiana Slough junction as a result of north Delta intakes operations (which could otherwise lead to more fish entering the relatively high-predation interior Delta migration pathway); CMP-25 would also reduce interior Delta entry when the north Delta intakes are not operating. |
| | Entrainment Risk | Adverse | Minimize/compensate: SRSC Transfer Delays; Delta Cross Channel Gate Closure; Winter-Run Chinook Salmon Early Season Salvage Threshold; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Winter-Run 50% Annual Loss Threshold; Winter-Run 75% Annual Loss Threshold; Winter-Run Weekly Loss Thresholds; Winter and Spring Delta Outflows; Salvage Facilities<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; SHOT Water Transfer Timing Approvals; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: no adverse effects anticipated. Operations and maintenance: adverse. | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | North Delta intakes' 1.75-mm cylindrical screens would exclude juveniles from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. Operating criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment; see discussion of Outmigration Cues for CMP-25, which would offset potential for greater entrainment at the south Delta export facilities caused by greater interior Delta entry via Georgiana Slough. |
| Water Temperatures between 42.5 and 57.5°F for Spawning, Incubation, and Fry Development | Water Temperature | Primarily no adverse effects anticipated | Minimize/compensate: Shasta Reservoir Water Temperature and Storage Management; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; SRSC Diversion Spring Delays and Shifting; Drought Actions<br>Exacerbate: Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Adult Migration and Holding Water Temperature Objectives; SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool); SHOT Water Transfer Timing Approvals (Denials that precludes water transfers) | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| Habitat and Adequate | Toxicity from | No adverse effects | — | Construction: adverse. | Minimize/compensate: AMM-2: Develop and | DCP construction effects from sediment |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Prey that are not Contaminated | Contaminants | anticipated | | Operations and maintenance: no adverse effects anticipated. | Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-27: Develop and Implement a Barge Operations Plan | disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other AMMs minimize effects); DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| Riparian Habitat for Juvenile Development and Survival | Refuge Habitat | No adverse effects anticipated (more seaward end of Delta); adverse (Sacramento River and more landward end of Delta) | Minimize/compensate: Minimum Instream Flows; SRSC Transfer Delays<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Reduced Wilkins Slough Minimum Flows; SHOT Water Transfer Timing Approvals; Drought Actions | Construction: adverse. Operations and maintenance: adverse. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles) | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, mitigated by CMP-26. |
| | Food Availability and Quality | No adverse effects anticipated (more seaward end of Delta); adverse (Sacramento River and more landward end of Delta) | Minimize/compensate: Minimum Instream Flows; SRSC Transfer Delays<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Reduced Wilkins Slough Minimum Flows; SHOT Water Transfer Timing Approvals; Drought Actions | Construction: adverse. Operations and maintenance: adverse | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. |
| Access Downstream for Juvenile Migration to San Francisco Bay and the Pacific Ocean | Entrainment Risk | Adverse | Minimize/compensate: SRSC Transfer Delays; Delta Cross Channel Gate Closure; Winter-Run Chinook Salmon Early Season Salvage Threshold; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Winter-Run 50% Annual Loss Threshold; Winter-Run 75% Annual Loss Threshold; Winter-Run Weekly Loss Thresholds; Winter and Spring Delta Outflows; Salvage Facilities<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; SHOT Water Transfer Timing Approvals; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: no adverse effects anticipated. Operations and maintenance: no adverse. | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | North Delta intakes' 1.75-mm cylindrical screens would exclude juveniles from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. Operating criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment; see discussion of Outmigration Cues for CMP-25, which would offset potential for greater entrainment at the south Delta export facilities caused by greater interior Delta entry via Georgiana Slough. |
| | Other construction-related stressors | — | — | Adverse | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation.

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## 7A.3.2 Central Valley Spring-Run Chinook Salmon

Chapter 6 discusses the status of Central Valley spring-run Chinook Salmon, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. Summaries of the effects analysis for effects on the species and its critical habitat are provided in Tables SR1 and SR2. A qualitative analysis was conducted to provide a programmatic summary of the effects of the DCP for the species life stages, critical habitat physical and biological features, and stressors discussed for the Proposed Action (Tables SR1 and SR2)[2]. The analysis of the DCP was based on information in the draft DCP BA and FEIR, which includes consideration of various quantitative and qualitative analyses.

As illustrated in Tables SR1 and SR2, the principal potential effects of the DCP in addition to the Proposed Action would be from operations effects of the north Delta intakes on juvenile/yearling rearing and outmigration and the associated critical habitat PBFs of river flows for downstream transport and access downstream for juveniles/yearlings. Life cycle modeling described in Chapter 6 for the Proposed Action with the CVPIA spring-run Chinook salmon life cycle model suggested generally similar adult spawner abundance population change for Proposed Action phases compared to the No Action Alternative. Spring-run Chinook salmon life cycle modeling has not been undertaken for the DCP, although the relatively limited nature of effects (Table 7A-1) and available life cycle modeling for winter-run Chinook salmon (see Section 7A.3.1) suggests that there would be little effect of DCP evident from such modeling.

The DCP intakes include cylindrical fish screens meeting fish agency standards for factors such as screen opening size and approach velocity to minimize risk from entrainment and impingement. The DCP intakes operational criteria include factors such as pulse protection criteria and bypass flows—wherein diversions are restricted based on large-scale downstream movement of juvenile salmonids—in order to minimize the potential for negative effects. Compensatory mitigation would be undertaken for north Delta hydrodynamic effects including the potential for reduced riverine flow leading to a greater tidal influence and more flow and therefore juvenile/yearling spring-run Chinook salmon entering the relatively low-survival interior Delta at Georgiana Slough, in addition to less inundation of riparian and wetland bench rearing habitat.

As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of the DCP would be avoided, minimized, and offset. Guiding principles relevant to spring-run Chinook salmon include:

- Operate projects consistent with existing and/or future regulatory requirements in the Delta.
- Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.
- Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
- Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.
- Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow

[2] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

related effects of DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations.

- Implement project operations and maintenance consistent with the proposed project description, as an integrated component of the SWP.
    - Future consultation on Delta Conveyance Project Operations and Maintenance is envisioned to update and align elements of project description with conditions (e.g. regulatory, climate, status of species) in advance of operations of the north Delta diversions.

As described in Chapter 3, DCP has an adaptive management program which would integrate with the adaptive management program for the Proposed Action and includes a number of general principles such as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

**Table 7A-3. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Central Valley Spring-Run Chinook Salmon**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Adult Migration | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Stranding Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other AMMs minimize effects); DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Water Temperature | Decrease (discountable/insignificant) | — | Construction: increase (discountable/insignificant). Operations and maintenance: not anticipated to change. | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Pathogens and Disease | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL), noted as key driver of pathogens/disease (Chapter 5). |
| | Other construction-related stressors (acoustic effects; direct physical injury; prey availability; predation; habitat extent) | — | — | Increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance and adults unlikely to be at risk from predation; CMP-23 and CMP-24 mitigate for reduced habitat extent. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | |
| Adult Holding and Spawning | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Competition, Introgression, and Broodstock Removal | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity from Contaminants | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Spawning Habitat | Increase (lethal; proportion: low) | Minimize/compensate: Sacramento River: Minimum Instream Flow; Fall and Winter Base Flows for Redd Maintenance; SRSC Rice Decomposition Smoothing. Clear Creek: Minimum Instream Flows, Segregation Weir. Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill. | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Water Temperature | Decrease (beneficial; proportion: likely large; frequency: high); increase (sublethal; proportion: small; frequency: low) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives; Shasta Reservoir Water Temperature and Storage Management. Clear Creek: Water Temperature Management.<br>Exacerbate: Drought Tool Kit Warmwater Bypass; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; SHOT Determination on Temperature Shoulders (requiring too cold releases too early and exhausting the coldwater pool). | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Pathogens and Disease | Decrease (beneficial; proportion: large; frequency: high); increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: Adult Migration and Holding Water Temperature Objectives | Not anticipated to change | — | DCP would not affect upstream operations. |
| Egg Incubation and Fry Emergence | In-River Fishery or Trampling | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Predation Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity from Contaminants | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Pathogens and | Increase or Decrease | — | Not anticipated to change | — | DCP would not affect upstream |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Disease | (discountable/insignificant) | | | | operations. |
| | Sedimentation and Gravel Quantity | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Redd Stranding and Dewatering | Increase (lethal; proportion: likely small; frequency: high) | Minimize/compensate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Minimum Instream Flows. Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill; SRSC Transfer Delays | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Redd Quality | Decrease (beneficial; proportion: medium; frequency: large) | Minimize/compensate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; SRSC Transfer Delayed Timing. Clear Creek: Minimum Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill; SHOT Water Transfer Timing Approvals | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Water Temperature | Decrease (beneficial; proportion: medium; frequency: medium to high); increase (lethal; proportion: medium; frequency: low) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Water Temperature Management<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool); Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows | Not anticipated to change | — | DCP would not affect upstream operations. |
| Juvenile Rearing and Outmigration | Pathogens and Disease | Increase (discountable/insignificant) | — | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal; proportion: small; frequency: high). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL), noted as key driver of pathogens/disease (Chapter 5); small potential for injury leading to disease from contacting north Delta intake screens, minimized by screen design (smooth screen face; cleaning system) and operating criteria (e.g., approach velocity) |
| | Toxicity from Contaminants | Increase (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other AMMs minimize effects); DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Predation and Competition | Increase (discountable/insignificant) | — | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: increase (lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction has the potential to disturb juveniles and make them more susceptible to predation (however, there would be limited temporal overlap with construction because of AMM-14 work window; other AMMs minimize effects); presence of cofferdams during construction period provides potential predator habitat but is small in extent relative to the area of habitat in the Delta. Predation associated with DCP operations could occur at the north Delta intakes if predators aggregate there but existing literature suggests such effects would be minimal; uncertainty to be addressed with fisheries studies and adaptive management. |
| | Stranding Risk | Increase (lethal; proportion: medium [Sacramento River], low [Clear Creek]; frequency: high [Sacramento River], low [Clear Creek]) | Minimize/compensate: Minimum Instream Flows; Ramping Rates | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: not anticipated to change. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan | DCP construction has the potential to strand juveniles within cofferdams but there would be limited temporal overlap with construction because of AMM-14 work window; AMM-25 would provide fish rescue. DCP would not affect upstream operations and therefore would not affect areas of concern noted in Chapter 6. Within the Delta, stranding on inundated riparian or wetland benches would not be anticipated given bench design (slope). |
| | Outmigration Cues | Increase (lethal; proportion: large [Sacramento River], medium [Clear Creek]; frequency: low [Sacramento River and Clear Creek]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Ramping Rates; Clear Creek: Minimum Instream Flows; Spring Pulse Flows; Ramping Rates<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: not anticipated to change. Operations and maintenance: not anticipated to change (Sacramento River); increase (Delta; lethal; proportion: high; frequency: high). | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | DCP would not affect upstream operations and therefore would not affect Sacramento River outmigration cues. DCP north Delta intake operations would reduce Sacramento River flow into the Delta, potentially reducing through-Delta survival based on flow-survival relationships. This is limited by operating criteria, with modeling indicating relative differences in through-Delta survival of 4% or less during main outmigration period. CMP-25 would offset potential increases in reverse flows at the Sacramento River-Georgiana Slough junction as a result of north Delta intakes operations (which could otherwise lead to more fish entering the relatively high-predation interior Delta migration pathway); CMP-25 would also reduce interior Delta entry when the north Delta intakes are not operating. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Entrainment Risk | Not anticipated to change (Clear Creek); increase (Delta; lethal; proportion: small; frequency: high) | Minimize/compensate: Delta Cross Channel Gate Closure; Winter-Run Chinook Salmon Early Season Salvage Threshold; January 1 and Start of OMR Management; Spring-run Chinook Salamon and Surrogate Thresholds; Winter-Run Weekly Loss Thresholds; Winter and Spring Delta Outflows; Salvage Facilities | Construction: not anticipated to change. Operations and maintenance: increase (lethal; proportion: high; frequency: high). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | North Delta intakes' 1.75-mm cylindrical screens would exclude juveniles from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. Operating criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment; see discussion of Outmigration Cues for CMP-25, which would offset potential for greater entrainment at the south Delta export facilities caused by greater interior Delta entry via Georgiana Slough. |
| | Refuge Habitat | Not anticipated to change (more seaward end of Delta); increase (Sacramento River, Clear Creek, and more landward end of Delta; sub-lethal; proportion: large; frequency: low [Sacramento River and more landward end of Delta], medium [Clear Creek]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (sub-lethal; proportion: small; frequency: high) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, mitigated by CMP-26. |
| | Food Availability and Quality | Not anticipated to change (more seaward end of Delta); increase (Sacramento River, Clear Creek, and more landward end of Delta; sub-lethal; proportion: large; frequency: low [Sacramento River and more landward end of Delta], medium [Clear Creek]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources); North Delta intakes operating criteria | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. |
| | Water Temperature and Dissolved Oxygen | Not anticipated to change (Delta); decrease or increase (Sacramento River and Clear Creek; beneficial or sub-lethal/lethal; proportion: medium to large; frequency: high) | Minimize/compensate: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management (preserve cold water)<br>Exacerbate: SHOT Water Transfer Timing | Construction: increase (discountable/insignificant); operations and maintenance: not anticipated to change | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Approvals (denial of water transfers); SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool) | | | upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Other construction-related stressors (acoustic effects; direct physical injury) | — | — | Increase (sub-lethal to lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance. |
| Yearling Rearing | Pathogens and Disease | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Predation and Competition | Increase (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Stranding Risk | Decrease (beneficial; proportion: small; frequency: low) | Minimize/compensate: Sacramento River and Clear Creek: Minimum Instream Flows; Ramping Rates | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Refuge Habitat | Increase (sub-lethal; proportion: small; frequency: medium) or decrease (beneficial) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; SRSC Diversion Spring Delays and Shifting; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Food Availability and Quality | Increase (sub-lethal; proportion: small; frequency: medium) or decrease (beneficial) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; SRSC Diversion Spring Delays and Shifting; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge | Not anticipated to change | — | DCP would not affect upstream operations. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Summer Deliveries North of Delta | | | |
| | Water Temperature and Dissolved Oxygen | Decrease (beneficial; proportion: low; frequency: high) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winer Base Flows for Shasta Reservoir Redd Maintenance; Shasta Reservoir Water Temperature and Storage Management; Clear Creek: Minimum Instream Flow; Water Temperature Management<br>Exacerbate: Sacramento River: Shasta Reservoir Water Temperature Storage Management | Not anticipated to change | — | DCP would not affect upstream operations. |
| Yearling Outmigration | Pathogens and Disease | Increase or decrease (discountable/insignificant) | — | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal; proportion: small; frequency: high). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL), noted as key driver of pathogens/disease (Chapter 5); small potential for injury leading to disease from contacting north Delta intake screens, minimized by screen design (smooth screen face; cleaning system) and operating criteria (e.g., approach velocity) |
| | Toxicity from Contaminants | Increase (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other AMMs minimize effects); DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Predation and Competition | Increase (discountable/insignificant) | — | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: increase (lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction has the potential to disturb yearlings and make them more susceptible to predation (however, there would be limited temporal overlap with construction because of AMM-14 work window; other AMMs minimize effects); presence of cofferdams during construction period provides potential predator habitat but is small in extent relative to the area of habitat in the Delta. Predation associated with DCP operations could occur at the north Delta intakes if predators aggregate there but existing literature suggests such effects would be minimal; uncertainty to be addressed with fisheries studies and adaptive management. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Stranding Risk | Not anticipated to change (Delta); increase (Sacramento River; lethal; proportion: small; frequency: high) | Minimize/compensate: Sacramento River and Clear Creek: Minimum Instream Flows; Ramping Rates | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: not anticipated to change. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan | DCP construction has the potential to strand yearlings within cofferdams but there would be limited temporal overlap with construction because of AMM-14 work window; AMM-25 would provide fish rescue. DCP would not affect upstream operations and therefore would not affect areas of concern noted in Chapter 5. Within the Delta, stranding on inundated riparian or wetland benches would not be anticipated given bench design (slope). |
| | Outmigration Cues | Increase (lethal; proportion: large; frequency: low) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: not anticipated to change. Operations and maintenance: not anticipated to change (Sacramento River); increase (Delta; lethal; proportion: high; frequency: high). | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | DCP would not affect upstream operations and therefore would not affect Sacramento River outmigration cues. DCP north Delta intake operations would reduce Sacramento River flow into the Delta, potentially reducing through-Delta survival based on flow-survival relationships. This is limited by operating criteria, with modeling indicating relative differences in through-Delta survival of 3% or less during main outmigration period. CMP-25 would offset potential increases in reverse flows at the Sacramento River-Georgiana Slough junction as a result of north Delta intakes operations (which could otherwise lead to more fish entering the relatively high-predation interior Delta migration pathway); CMP-25 would also reduce interior Delta entry when the north Delta intakes are not operating. |
| | Entrainment Risk | Increase (lethal; proportion: small; frequency: high) | Minimize/compensate: Delta Cross Channel Gate Closure; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Spring-run Chinook Salamon and Surrogate Thresholds; Winter and Spring Delta Outflows; Salvage Facilities<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Drought Actions | Construction: not anticipated to change. Operations and maintenance: increase (lethal; proportion: high; frequency: high). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | North Delta intakes' 1.75-mm cylindrical screens would exclude yearlings from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. Operating criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment; see discussion of Outmigration Cues for CMP-25, which would offset potential for greater entrainment at the south Delta export facilities caused by greater interior Delta entry via Georgiana Slough. |
| | Refuge Habitat | Increase (Sacramento River; sub-lethal; proportion: large; frequency: low); not | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter | Construction: increase (sub-lethal; proportion: small; frequency: low). | Minimize/compensate: AMM-14: Construction Best Management Practices | DCP construction effects would be limited in temporal overlap because of |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | anticipated to change (Delta) | Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Operations and maintenance: increase (sub-lethal; proportion: small; frequency: high) | for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, mitigated by CMP-26. |
| | Food Availability and Quality | Increase (Sacramento River and more landward end of the Delta; sub-lethal; proportion: large; frequency: low [Sacramento River], high [Delta]); not anticipated to change (more seaward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources); North Delta intakes operating criteria | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. |
| | Water Temperature and Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Construction: increase (discountable/insignificant); operations and maintenance: not anticipated to change | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Other construction-related stressors (acoustic effects; direct physical injury) | — | — | Increase (sub-lethal to lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance. |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation.

**Table 7A-4. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Central Valley Spring-Run Chinook Salmon Critical Habitat**

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Freshwater Spawning Sites | Spawning Habitat | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flow; Fall and Winter Base Flows for Redd Maintenance; SRSC Rice Decomposition Smoothing. Clear Creek: Minimum Instream Flows, Segregation Weir. Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill. | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Redd Quality (clean spawning gravel) | Decrease (beneficial; proportion: medium; frequency: large) | Minimize/compensate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; SRSC Transfer Delayed Timing. Clear Creek: Minimum Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill; SHOT Water Transfer Timing Approvals | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Redd Stranding and Dewatering | Increase (lethal; proportion: likely small; frequency: high) | Minimize/compensate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Minimum Instream Flows. Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill; SRSC Transfer Delays | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Water Temperature | No adverse effects anticipated | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Water Temperature Management<br>Exacerbate: Sacramento River:<br>SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool); Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows | Not anticipated to change | — | DCP would not affect upstream operations. |
| Freshwater Rearing Sites | Refuge habitat (juvenile) | No adverse effects anticipated (more seaward end of the Delta); adverse (Sacramento River, Clear Creek, and more landward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Adverse | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, mitigated by CMP-26. |
| | Refuge habitat (yearling) | Adverse or no adverse effects anticipated | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter | Not anticipated to change | — | DCP would not affect upstream operations. |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Base Flows for Shasta Reservoir Refill; SRSC Diversion Spring Delays and Shifting; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta | | | |
| | Food Availability and Quality (juvenile) | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources); North Delta intakes operating criteria | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. |
| | Food Availability and Quality (yearling) | Adverse or no adverse effects anticipated | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; SRSC Diversion Spring Delays and Shifting; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Stranding Risk (juvenile) | No adverse effects anticipated | — | Construction: adverse. Operations and maintenance: not anticipated to change. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan | DCP construction has the potential to strand juveniles within cofferdams but there would be limited temporal overlap with construction because of AMM-14 work window; AMM-25 would provide fish rescue. DCP would not affect upstream operations and therefore would not affect areas of concern noted in Chapter 6. Within the Delta, stranding on inundated riparian or wetland benches would not be anticipated given bench design (slope). |
| | Stranding Risk (yearling) | No adverse effects anticipated | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Water Temperature and Dissolved Oxygen (juvenile) | Adverse or no adverse effects anticipated | Minimize/compensate: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management (preserve cold water)<br>Exacerbate: SHOT Water Transfer Timing Approvals (denial of water transfers); SHOT | Not anticipated to change | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool) | | | effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Water Temperature and Dissolved Oxygen (yearling) | No adverse effects anticipated | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winer Base Flows for Shasta Reservoir Redd Maintenance; Shasta Reservoir Water Temperature and Storage Management; Clear Creek: Minimum Instream Flow; Water Temperature Management<br>Exacerbate: Sacramento River: Shasta Reservoir Water Temperature Storage Management | Not anticipated to change | — | DCP would not affect upstream operations. |
| Freshwater Migration Corridors | Outmigration Cues (juvenile) | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: no adverse effects anticipated. Operations and maintenance: no adverse effects anticipated (Sacramento River); adverse (Delta). | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | DCP would not affect upstream operations and therefore would not affect Sacramento River outmigration cues. DCP north Delta intake operations would reduce Sacramento River flow into the Delta, potentially reducing through-Delta survival based on flow-survival relationships. This is limited by operating criteria, with modeling indicating relative differences in through-Delta survival of 4% or less during main outmigration period. CMP-25 would offset potential increases in reverse flows at the Sacramento River-Georgiana Slough junction as a result of north Delta intakes operations (which could otherwise lead to more fish entering the relatively high-predation interior Delta migration pathway); CMP-25 would also reduce interior Delta entry when the north Delta intakes are not operating. |
| | Outmigration Cues (yearling) | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: no adverse effects anticipated. Operations and maintenance: no adverse effects anticipated (Sacramento River); adverse (Delta). | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | DCP would not affect upstream operations and therefore would not affect Sacramento River outmigration cues. DCP north Delta intake operations would reduce Sacramento River flow into the Delta, potentially reducing through-Delta survival based on flow-survival relationships. This is limited by operating criteria, with modeling indicating relative differences in through-Delta survival of 3% or less during main outmigration period. CMP-25 would offset potential increases in reverse flows at the Sacramento River-Georgiana Slough junction as a result of north Delta intakes operations (which could otherwise lead to more fish entering the relatively high-predation interior Delta migration pathway); CMP-25 would also reduce interior Delta entry when the north Delta intakes are not operating. |
| | Refuge Habitat | Adverse (Sacramento | Minimize/compensate: Sacramento River: | Adverse | Minimize/compensate: AMM-14: Construction Best | DCP construction effects would be limited in |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | (juvenile) | River and more landward end of the Delta); no adverse effects anticipated (more seaward end of the Delta) | Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | | Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, mitigated by CMP-26. |
| | Refuge Habitat (yearling) | Adverse (Sacramento River); no adverse effects anticipated (Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Adverse | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, mitigated by CMP-26. |
| | Food Availability and Quality (juvenile) | Adverse (Sacramento River and more landward end of the Delta); no adverse effects anticipated (more seaward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: adverse. Operations and maintenance: no adverse effects anticipated. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources); North Delta intakes operating criteria | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. |
| | Food Availability and Quality (yearling) | Adverse (Sacramento River and more landward end of the Delta); no adverse effects anticipated (more seaward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: adverse. Operations and maintenance: no adverse effects anticipated. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Construction Impacts on Habitat for Fish and Aquatic Resources); North Delta intakes operating criteria | |
| | Entrainment Risk (juvenile) | Adverse | Minimize/compensate: Delta Cross Channel Gate Closure; Winter-Run Chinook Salmon Early Season Salvage Threshold; January 1 and Start of OMR Management; Spring-run Chinook Salamon and Surrogate Thresholds; Winter-Run Weekly Loss Thresholds; Winter and Spring Delta Outflows; Salvage Facilities | Construction: no adverse effects anticipated. Operations and maintenance: adverse. | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | North Delta intakes' 1.75-mm cylindrical screens would exclude juveniles from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. Operating criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment; see discussion of Outmigration Cues for CMP-25, which would offset potential for greater entrainment at the south Delta export facilities caused by greater interior Delta entry via Georgiana Slough. |
| | Entrainment Risk (yearling) | Adverse | Minimize/compensate: Delta Cross Channel Gate Closure; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Spring-run Chinook Salamon and Surrogate Thresholds; Winter and Spring Delta Outflows; Salvage Facilities<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Drought Actions | Construction: no adverse effects anticipated. Operations and maintenance: adverse. | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | North Delta intakes' 1.75-mm cylindrical screens would exclude yearlings from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. Operating criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment; see discussion of Outmigration Cues for CMP-25, which would offset potential for greater entrainment at the south Delta export facilities caused by greater interior Delta entry via Georgiana Slough. |
| Estuarine Areas | Outmigration Cues (juvenile) | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: no adverse effects anticipated. Operations and maintenance: adverse. | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | DCP north Delta intake operations would reduce Sacramento River flow into the Delta, potentially reducing through-Delta survival based on flow-survival relationships. This is limited by operating criteria, with modeling indicating relative differences in through-Delta survival of 4% or less during main outmigration period. CMP-25 would offset potential increases in reverse flows at the Sacramento River-Georgiana Slough junction as a result of north Delta intakes operations (which could otherwise lead to more fish entering the relatively high-predation interior Delta migration pathway); CMP-25 would also reduce interior Delta entry when the north Delta intakes are not operating. |
| | Outmigration Cues (yearling) | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter | Construction: no adverse effects anticipated. Operations and maintenance: adverse. | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | DCP north Delta intake operations would reduce Sacramento River flow into the Delta, potentially reducing through-Delta survival based on flow-survival relationships. This is limited by operating criteria, with modeling |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | | | indicating relative differences in through-Delta survival of 3% or less during main outmigration period. CMP-25 would offset potential increases in reverse flows at the Sacramento River-Georgiana Slough junction as a result of north Delta intakes operations (which could otherwise lead to more fish entering the relatively high-predation interior Delta migration pathway); CMP-25 would also reduce interior Delta entry when the north Delta intakes are not operating. |
| | Refuge Habitat (juvenile) | No adverse effects anticipated (more seaward end of Delta); adverse (more landward end of Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Adverse | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, mitigated by CMP-26. |
| | Refuge Habitat (yearling) | No adverse effects anticipated (Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Adverse | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, mitigated by CMP-26. |
| | Food Availability and Quality (juvenile) | Adverse (more landward end of the Delta); no adverse effects anticipated (more seaward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: adverse. Operations and maintenance: no adverse effects anticipated. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Construction Impacts on Habitat for Fish and Aquatic Resources); North Delta intakes operating criteria | |
| | Food Availability and Quality (yearling) | Adverse (more landward end of the Delta); no adverse effects anticipated (more seaward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: adverse. Operations and maintenance: no adverse effects anticipated. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources); North Delta intakes operating criteria | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. |
| Nearshore Marine Areas | — | No adverse effects anticipated | — | No adverse effects anticipated | — | There would be no DCP effect on nearshore marine areas because this is outside the action area. |
| Offshore Marine Areas | — | No adverse effects anticipated | — | No adverse effects anticipated | — | There would be no DCP effect on offshore marine areas because this is outside the action area. |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation. **The entrainment risk stressor for DCP more clearly applies to estuarine areas but was not listed for estuarine areas in Chapter 6, thus has been kept in the freshwater migration corridors section for consistency with the PA analysis.

### 7A.3.3 California Central Valley Steelhead

Chapter 7 discusses the status of California Central Valley steelhead, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. Summaries of the effects analysis for effects on the species and its critical habitat are provided in Tables SH1 and SH2. A qualitative analysis was conducted to provide a programmatic summary of the effects of the DCP for the species life stages, critical habitat physical and biological features, and stressors discussed for the Proposed Action (Tables SH1 and SH2)[3]. The analysis of the DCP was based on information in the draft DCP BA and FEIR, which includes consideration of various quantitative and qualitative analyses.

As illustrated in Tables SH1 and SH2, the principal potential effects of the DCP in addition to the Proposed Action would be from operations effects of the north Delta intakes on juvenile rearing and outmigration and the associated critical habitat PBFs of freshwater migration corridors and estuarine areas. The DCP north Delta intakes include cylindrical fish screens meeting fish agency standards for factors such as screen opening size and approach velocity to minimize risk from entrainment and impingement. The north Delta intakes operational criteria include factors such as pulse protection criteria and bypass flows—wherein diversions are restricted based on large-scale downstream movement of juvenile salmonids—in order to minimize the potential for negative effects. Compensatory mitigation would be undertaken for north Delta hydrodynamic effects including the potential for reduced riverine flow leading to a greater tidal influence and more flow and therefore juvenile steelhead entering the relatively low-survival interior Delta at Georgiana Slough, in addition to less inundation of riparian and wetland bench rearing habitat.

As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of the DCP would be avoided, minimized, and offset. Guiding principles relevant to steelhead include:

- Operate projects consistent with existing and/or future regulatory requirements in the Delta.
- Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.
- Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
- Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.
- Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations.
- Implement project operations and maintenance consistent with the proposed project description, as an integrated component of the SWP.

[3] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

- Future consultation on Delta Conveyance Project Operations and Maintenance is envisioned to update and align elements of project description with conditions (e.g. regulatory, climate, status of species) in advance of operations of the north Delta diversions.

As described in Chapter 3, DCP has an adaptive management program which would integrate with the adaptive management program for the Proposed Action and includes a number of general principles such as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

**Table 7A-5. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Central Valley Steelhead**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Adult Migration and Holding | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Stranding Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Competition, Introgression, and Broodstock Removal | Not anticipated to change | | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (AMMs minimize effects); DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Water Temperature | Decrease (insignificant [Sacramento River, Clear Creek, San Joaquin River, Delta], beneficial; proportion: small [American River, Stanislaus River], frequency: medium [American River], low [Stanislaus River] | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All streams: Drought Action | Construction: increase (discountable/insignificant). Operations and maintenance: not anticipated to change. | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Pathogens and Disease | Decrease (beneficial; proportion: large [Sacramento River], small [Clear Creek, Stanislaus River], medium [American River]; frequency: medium [Sacramento River, Clear Creek], high [American River, Stanislaus | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature | Not anticipated to change | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL), noted as key driver of pathogens/disease (Chapter 7). |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | River] | Management. Stanislaus River: Stepped Release Plan. | | | |
| | Other construction-related stressors (acoustic effects; direct physical injury; prey availability; predation; habitat extent) | — | — | Increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction effects would be limited by AMMs; fish likely to move away from disturbance and adults unlikely to be at risk from predation; CMP-23 and CMP-24 mitigate for reduced habitat extent. |
| Adult Spawning | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Stranding Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Competition, Introgression, and Broodstock Removal | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity from Contaminants | Increase (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Increase (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Food Availability and Quality | Increase (discountable/insignificant) | | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Water Temperature | Increase (sublethal; proportion: small [Sacramento River, Clear Creek, American River], medium [Stanislaus River]; frequency: high [Sacramento River, American River, Stanislaus River], low [Clear Creek]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Water Temperature Management.<br>Exacerbate: Sacramento River: Drought Tool Kit Warmwater Bypass | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Pathogens and Disease | Increase (sublethal; proportion: small [Sacramento River]; frequency: medium [Sacramento River]; insignificant [Clear Creek, American River, Stanislaus River]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature | Not anticipated to change | — | DCP would not affect upstream operations. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Management. Stanislaus River: Stepped Release Plan | | | |
| | Spawning Habitat | Decrease (discountable [Sacramento River]; beneficial; proportion: high [Clear Creek, American River, Stanislaus]; frequency: medium [Clear Creek, American River], high [Stanislaus River]) | Minimize/compensate: Sacramento River: Minimum Instream Flow. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan. | Not anticipated to change | — | DCP would not affect upstream operations. |
| Kelt Emigration | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Stranding Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Competition, Introgression, and Broodstock Removal | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (AMMs minimize effects); DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Food Availability and Quality | Increase or decrease (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources); North Delta intakes operating criteria | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain smaller foodweb organisms but this is limited in extent, particularly relative to in situ production; larger foodweb items (e.g., fish) would not be entrained. |
| | Water Temperature | Increase or decrease (insignificant [Sacramento River, Clear Creek, San Joquin River, Delta]; spring; sublethal; proportion: | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives; Water | Construction: increase (discountable/insignificant). Operations and maintenance: not | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | small [American River]; frequency: low [American River]; summer; beneficial; proportion: small [Stanislaus River]; frequency: medium [American River], small [Stanislaus River] | Temperature Management. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: Drought Tool Kit Warmwater Bypass | anticipated to change. | Impacts on Habitat for Fish and Aquatic Resources) | would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Pathogens and Disease | Increase (insignificant [Clear Creek, San Joaquin River, Delta]; sublethal; proportion: medium [Sacramento River, American River], low [Clear Creek, Stanislaus River]; frequency: high [American River], medium [Sacramento River, Stanislaus River], low [Clear Creek] | | Not anticipated to change | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL), noted as key driver of pathogens/disease (Chapter 7). |
| | Other construction-related stressors (acoustic effects; direct physical injury; predation; habitat extent) | — | — | Increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction effects would be limited by AMMs, in particular AMM-14 minimizing temporal overlap with kelt emigration period; fish likely to move away from disturbance and adults unlikely to be at risk from predation; CMP-23 and CMP-24 mitigate for reduced habitat extent. |
| Egg Incubation and Fry Emergence | Predation Risk | Not anticipated to change | | Not anticipated to change | — | DCP would not affect upstream operations. |
| | In-River Fishery and Trampling | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Sedimentation and Gravel Quantity | Increase (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Redd Quality | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Food Availability and Quality | Increase or decrease (discountable/insignificant | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Water Temperature | Increase (sublethal; proportion: small [Clear Creek]; frequency: high [Clear Creek]; lethal; proportion: small [Sacramento River], | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: | Not anticipated to change | — | DCP would not affect upstream operations. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | medium [American River, Stanislaus River]; frequency: high [Sacramento River, American River], medium [Stanislaus River]) | Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan. | | | |
| | Pathogens and Disease | Increase (insignificant; [Clear Creek]; sublethal; proportion: small [Sacramento River, Stanislaus River], medium [American River]; frequency: medium [Sacramento River, American River], low [Stanislaus River]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan. | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Redd Stranding and Dewatering | Increase or decrease (beneficial; proportion: small to medium [Clear Creek]; frequency: high [Clear Creek]); (lethal; proportion: small [Sacramento River] small to medium [American River, Stanislaus River]; frequency: high [Sacramento River, American River, Stanislaus River]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management; Redd Dewatering Adjustment. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill and Redd Maintenance. | Not anticipated to change | — | DCP would not affect upstream operations. |
| Juvenile Rearing and Outmigration | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other AMMs minimize effects); DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Predation and Competition | Increase (discountable/insignificant) | — | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: increase (lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction has the potential to disturb juveniles and make them more susceptible to predation (however, there would be limited temporal overlap with construction because of AMM-14 work window; other AMMs minimize effects); presence of cofferdams during construction period provides potential predator habitat but is small in extent relative to the area of habitat in the Delta. Predation associated with DCP operations could occur at the north Delta intakes if predators aggregate there but existing literature suggests such effects would be minimal; uncertainty to be addressed with fisheries studies and adaptive |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | management. |
| | Dissolved Oxygen | Increase or decrease (insignificant; [Sacramento River, American River, Clear Creek, Delta]; sublethal; proportion: high [rearing: Stanislaus River], medium [outmigration: San Joaquin River, Stanislaus River], low [San Joaquin – rearing]; frequency: high [rearing: Stanislaus River], medium [rearing: San Joaquin River, outmigration: Stanislaus River], low [outmigration: San Joaquin River] | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management. Clear Creek; Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All Basins: Drought Action. | Construction: increase (discountable/insignificant); operations and maintenance: not anticipated to change | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects on temperature (channel margin habitat restoration would be undertaken to replace lost habitat) and therefore possibly dissolved oxygen; DCP would not affect upstream operations; no DCP operations effect on dissolved oxygen (DCP FEIR chapter 9). |
| | Water Temperature | Increase or decrease (summer; beneficial; proportion: large [American River]; frequency: medium [American River]; sublethal; proportion: large [Stanislaus River]; frequency: low [Stanislaus River] | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management. Clear Creek; Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All Basins: Drought Action. | Construction: increase (discountable/insignificant); operations and maintenance: not anticipated to change | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Pathogens and Disease | Increase or decrease (spring; sublethal; proportion: large [rearing: American River, Stanislaus River], medium [rearing: Sacramento River, Clear Creek], low [outmigration: Sacramento River, Clear Creek, American River, Stanislaus River], frequency: high [rearing: American River, Stanislaus], medium [rearing: Sacramento River, Clear | Minimize/compensate: Sacramento Adult Migration and Holding Water Objectives. Clear Creek; Water Temperature Management. American Water Temperature Management. Stanislaus River: Stepped Release Plan. | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal; proportion: small; frequency: high). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL), noted as key driver of pathogens/disease (Chapter 5); small potential for injury leading to disease from contacting north Delta intake screens, minimized by screen design |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | Creek, outmigration: Sacramento River, American River], low [outmigration: Clear Creek, Stanislaus River] | | | | (smooth screen face; cleaning system) and operating criteria (e.g., approach velocity) |
| | Outmigration Cues | Increase (insignificant [San Joaquin River, Delta]; sublethal; proportion; large [Sacramento River, American River, Stanislaus River], small [Clear Creek]; frequency: low to high [Sacramento River], high [Clear Creek, American River, Stanislaus River] | Minimize/compensate: Sacramento River: Minimum Instream Flows; Spring Pulse Flows. Clear Creek: Minimum Instream Flows; Spring Pulse Flows; American River: Minimum Instream Flows; Spring Pulse Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance. American River: Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage. All Basins: Drought Action. | Construction: not anticipated to change. Operations and maintenance: not anticipated to change (upstream); increase (Delta; lethal; proportion: high; frequency: high). | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | DCP would not affect upstream operations and therefore would not affect upstream outmigration cues. DCP north Delta intake operations would reduce Sacramento River flow into the Delta, potentially reducing through-Delta survival based on flow-survival relationships. This is limited by operating criteria. CMP-25 would offset potential increases in reverse flows at the Sacramento River-Georgiana Slough junction as a result of north Delta intakes operations (which could otherwise lead to more fish entering the relatively high-predation interior Delta migration pathway); CMP-25 would also reduce interior Delta entry when the north Delta intakes are not operating. |
| | Stranding Risk | Not anticipated to change (more seaward end of Delta); Increase (winter and spring; lethal; proportion: small to medium [Sacramento River, San Joquin River, American River, Stanislaus River], small [Clear Creek]: frequency: high [Sacramento River, Clear Creek, San Joaquin River, American River, Stanislaus River] ); decrease (summer and fall; beneficial; proportion: small to medium [Sacramento River, American River, Stanislaus River]; frequency: high [Sacramento River, American River, Stanislaus River] | Minimize/compensate: Sacramento River: Minimum Instream Flows; Ramping Rates. Clear Creek: Minimum Instream Flows; Ramping Rates. American River: Minimum Instream Flows; Ramping Rates. Stanislaus River: Stepped Release Plan. | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: not anticipated to change. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan | DCP construction has the potential to strand juveniles within cofferdams but there would be limited temporal overlap with construction because of AMM-14 work window; AMM-25 would provide fish rescue. DCP would not affect upstream operations and therefore would not affect areas of concern noted in Chapter 7. Within the Delta, stranding on inundated riparian or wetland benches would not be anticipated given bench design (slope). |
| | Refuge Habitat | Not anticipated to change (more seaward end of Delta); Increase (winter and spring; sublethal; proportion: large [Clear Creek, American River, Stanislaus River], small to medium [Sacramento River/more landward end of the Delta, San Joaquin River]; frequency: high [San Joaquin River], medium [Sacramento River/more landward end of the Delta, Clear Creek, American River, Stanislaus River]; decrease (summer and fall: beneficial; proportion: large [rearing: American River, Stanislaus River], small [outmigration: American River, Stanislaus River]; frequency: medium [American River, Stanislaus River] | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (sub-lethal; proportion: small; frequency: high) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, mitigated by CMP-26. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | |
| | Food Availability and Quality | Not anticipated to change (more seaward end of Delta); increase (entire year; sublethal; proportion: small to medium [San Joaquin River]; frequency: high [San Joaquin River]; winter and spring; sublethal; proportion: large [Sacramento River, Clear Creek, American River, Stanislaus River]; frequency: medium [Sacramento River, Clear Creek], low to medium [American River, Stanislaus River]); decrease (summer and fall; beneficial; proportion: large [rearing: Sacramento River, Clear Creek, American River], small to medium [outmigration: Sacramento River, Clear Creek, American River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources); North Delta intakes operating criteria | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production; larger food items (e.g., fish) would be prevented from entrainment by the north Delta intake fish screens. |
| | Entrainment Risk | Increase (lethal; proportion: small [focused on Delta]; frequency: high. | Minimize/compensate: Delta Cross Channel Gate Closure; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Steelhead Weekly Thresholds; Winter and Spring and Delta Outflows; Salvage Facilities<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Drought Actions. | Construction: not anticipated to change. Operations and maintenance: increase (lethal; proportion: high; frequency: high). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | North Delta intakes' 1.75-mm cylindrical screens would exclude juveniles from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. Operating criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment; see discussion of Outmigration Cues for CMP-25, which would offset potential for greater entrainment at the south Delta export facilities caused by greater interior Delta entry via Georgiana Slough. |
| | Other construction-related stressors (acoustic effects; direct physical injury) | — | — | Increase (sub-lethal to lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance. |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation.

**Table 7A-6. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Central Valley Steelhead Critical Habitat**

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Freshwater Spawning Sites | Spawning Habitat | No adverse effects anticipated | Minimize/compensate: Sacramento River: Minimum Instream Flow. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan. | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Water Temperature | Adverse | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan. | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Redd Stranding and Dewatering | Adverse [Sacramento River, American River, Stanislaus River]; No adverse effects anticipated [Clear Creek] | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management; Redd Dewatering Adjustment. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill and Redd Maintenance. | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| Freshwater Rearing Sites | Water Temperature | Adverse (winter-spring [Stanislaus River, American River]); No adverse effects anticipated (summer-fall [Stanislaus River, American River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management. Clear Creek; Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All Basins: Drought Action. | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Adverse (winter-spring [Stanislaus River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management. Clear Creek; Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders | No adverse effects anticipated | — | DCP would not affect upstream operations. |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All Basins: Drought Action. | | | |
| | Stranding | Adverse (winter-spring [Sacramento River, Clear Creek, Stanislaus River, American River]); No adverse effects anticipated (summer-fall [Sacramento River, Clear Creek, Stanislaus River, American River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Ramping Rates. Clear Creek: Minimum Instream Flows; Ramping Rates. American River: Minimum Instream Flows; Ramping Rates. Stanislaus River: Stepped Release Plan. | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Food Availability and Quality | Adverse (winter-spring [Sacramento River, Clear Creek, Stanislaus River, American River]); No adverse effects anticipated (summer-fall [Sacramento River, Clear Creek, American River, Stanislaus River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Refuge Habitat | Adverse (winter-spring [Sacramento River, Clear Creek, American River, Stanislaus River]); No adverse effects anticipated (summer-fall [Sacramento River, Clear Creek, Stanislaus River, American River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| Freshwater Migration Corridors/Estuarine Areas** | Water Temperature | Adverse (winter-spring adult migration and holding [Sacramento River, Clear Creek, American River, Stanislaus River]; fall adult migration and holding [Stanislaus River]); No adverse effects anticipated (summer-fall adult migration and holding [Sacramento River, Clear Creek, American River]; entire year [San Joaquin River, Delta]); | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management; Adult Migration and Holding Water Temperature Objectives. Clear Creek: Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River:<br>SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All streams: Drought Action | No adverse effects anticipated | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Dissolved Oxygen | Adverse (winter-spring outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; fall | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management. | No adverse effects anticipated | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on | DCP removal of trees at construction sites would have minimal effects on temperature (channel margin habitat |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | outmigration [Stanislaus River]); No adverse effects anticipated (summer-fall outmigration [Sacramento River, Clear Creek, American River]) | Clear Creek; Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All Basins: Drought Action. | | Habitat for Fish and Aquatic Resources) | restoration would be undertaken to replace lost habitat) and therefore possibly dissolved oxygen; DCP would not affect upstream operations; no DCP operations effect on dissolved oxygen (DCP FEIR chapter 9). |
| | Pathogens and Disease, Juveniles | Adverse (winter-spring outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; fall outmigration [Stanislaus River]; entire year outmigration [San Joaquin River]; No adverse effects anticipated (summer-fall outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; fall outmigration [Stanislaus]) | Minimize/compensate: Sacramento Adult Migration and Holding Water Objectives. Clear Creek; Water Temperature Management. American Water Temperature Management. Stanislaus River: Stepped Release Plan. | Construction: no adverse effects anticipated. Operations and maintenance: adverse. | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL), noted as key driver of pathogens/disease (Chapter 5); small potential for injury leading to disease from contacting north Delta intake screens, minimized by screen design (smooth screen face; cleaning system) and operating criteria (e.g., approach velocity) |
| | Pathogens and Disease, Adults | Adverse (winter-spring migration and holding [Sacramento River, Clear Creek, American River, Stanislaus River]; fall migration and holding [Stanislaus River]); No adverse effects anticipated (summer-fall migration and holding [Sacramento River, Clear Creek, American River]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan. | No adverse effects anticipated. | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL), noted as key driver of pathogens/disease (Chapter 5); adults not likely to contact north Delta intake screens. |
| | Stranding | Adverse (winter-spring outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; fall outmigration [Stanislaus River]; entire year outmigration [San Joaquin River]); No adverse effects anticipated (fall outmigration [Sacramento River, Clear Creek, American River]; entire year [Delta]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Ramping Rates. Clear Creek: Minimum Instream Flows; Ramping Rates. American River: Minimum Instream Flows; Ramping Rates. Stanislaus River: Stepped Release Plan. | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: not anticipated to change. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan | DCP construction has the potential to strand juveniles within cofferdams but there would be limited temporal overlap with construction because of AMM-14 work window; AMM-25 would provide fish rescue. DCP would not affect upstream operations and therefore would not affect areas of concern noted in Chapter 7. Within the Delta, stranding on inundated riparian or wetland benches would not be anticipated given bench design (slope). |
| | Refuge Habitat | Adverse (winter-spring outmigration [Sacramento River, Clear Creek, Stanislaus River, American River, Stanislaus]; fall outmigration [Stanislaus River]; entire year outmigration [San Joaquin River]); No adverse effects anticipated (summer outmigration [Sacramento River, | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (sub-lethal; proportion: small; | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 and CMP-24 mitigate for reduced habitat extent. DCP north Delta intake operations would reduce inundation of riparian/wetland bench rearing habitat, |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | Clear Creek, American River, Stanislaus River]; fall outmigration [Sacramento River, Clear Creek, American River]; entire year [Delta]) | | frequency: high) | Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | mitigated by CMP-26. |
| | Food Availability and Quality | Adverse (winter-spring outmigration [Sacramento River, Clear Creek, Stanislaus River, American River]); No adverse effects anticipated (summer outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; entire year [Delta]) | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | Construction: adverse. Operations and maintenance: no adverse effects anticipated. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources); North Delta intakes operating criteria | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production; larger food items (e.g., fish) would be prevented from entrainment by the north Delta intake fish screens. |
| | Entrainment Risk | Adverse | Minimize/compensate: Delta Cross Channel Gate Closure; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Steelhead Weekly Thresholds; Winter and Spring and Delta Outflows; Salvage Facilities<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Drought Actions. | Construction: no adverse effects anticipated. Operations and maintenance: adverse. | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | North Delta intakes' 1.75-mm cylindrical screens would exclude juveniles from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. Operating criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment; see discussion of Outmigration Cues for CMP-25, which would offset potential for greater entrainment at the south Delta export facilities caused by greater interior Delta entry via Georgiana Slough. |
| | Other construction-related stressors | — | — | Increase (sub-lethal to lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance. |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation. **Effects noted for the Delta are representative of Estuarine Areas; such effects would not be likely to occur at the more seaward end of the Delta.

## 7A.3.4 Green Sturgeon

Chapter 8 discusses the status of the southern distinct population segment of North American green sturgeon, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. Summaries of the effects analysis for effects on the species and its critical habitat are provided in Tables GS1 and GS2. A qualitative analysis was conducted to provide a programmatic summary of the effects of the DCP for the species life stages, critical habitat physical and biological features, and stressors discussed for the Proposed Action (Tables GS1 and GS2)[4]. The analysis of the DCP was based on information in the draft DCP BA and FEIR, which includes consideration of various quantitative and qualitative analyses.

As illustrated in Tables GS1 and GS2, the principal potential effects of the DCP in addition to the Proposed Action would be from construction-related effects, which would be compensated or minimized with various conservation measures. Operations effects would be limited, although there is some uncertainty related to the effect of reduced flow on juveniles (see discussion below related to life cycle analyses). The DCP north Delta intakes include cylindrical fish screens meeting fish agency standards for factors such as screen opening size and approach velocity to minimize risk from entrainment and impingement.

Life cycle analyses were conducted using statistical relationships of white sturgeon year class strength and Delta outflow. Hypotheses exist that the mechanisms behind positive statistical correlations between Delta outflow and white sturgeon year class may also apply to green sturgeon, although statistical relationships have not yet been established for green sturgeon. Quantitative modeling between white sturgeon year class strength and either April-May or March-July Delta outflow suggests the potential for negative effects of DCP based on lower summer outflow resulting from less outflow being needed to meet Delta salinity requirements with operations of the north Delta intakes. It is highly uncertain that there would be significant increase to this stressor because the statistical relationships are based on a surrogate species and may be related to upstream flow or Delta inflow as opposed to Delta outflow; changes are limited to differences within water year type, as opposed to hydrological condition–scale differences; the prediction intervals of the statistical relationship range over several orders of magnitude; and there is little difference in estimates based on one (April–May) of the averaging periods examined. For the Proposed Action, the analysis showed similar white sturgeon year class strength estimates under the Proposed Action phases as the No Action Alternative.

As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of the DCP would be avoided, minimized, and offset. Guiding principles relevant to green sturgeon include:

- Operate projects consistent with existing and/or future regulatory requirements in the Delta.
- Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.
- Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
- Monitor and mitigate effects of diversions on migrating anadromous species and their habitat

[4] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.

- Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations.
- Implement project operations and maintenance consistent with the proposed project description, as an integrated component of the SWP.
    - Future consultation on Delta Conveyance Project Operations and Maintenance is envisioned to update and align elements of project description with conditions (e.g. regulatory, climate, status of species) in advance of operations of the north Delta diversions.

As described in Chapter 3, DCP has an adaptive management program which would integrate with the adaptive management program for the Proposed Action and includes a number of general principles such as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

**Table 7A-7. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Green Sturgeon**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Adult Migration, River Spawning, and Holding | Barriers | Not anticipated to change | — | Construction: increase (sub-lethal to lethal; proportion: small; frequency: low). Operations and maintenance: not anticipated to change. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction would result in noise and disturbance, as well as potential for injury from pile driving and barge operations; adults would likely move away from such effects and these potential effects would be minimized by AMM-14, AMM-26, and AMM-27. DCP operations do not include installation of any barriers to migration or change in operations of existing barriers. |
| | Food | Increase or decrease (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: not anticipated to change. | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources). | DCP construction may affect food availability through disturbance, water quality effects, or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. Water operations are not the proximate cause of changes in green sturgeon prey in the Bay-Delta (Appendix D). |
| | Harvest | Not anticipated to change | — | Not anticipated to change | — | DCP does not include any activities that would influence harvest. |
| | Migration and Foraging Habitat | Not anticipated to change | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: not anticipated to change. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | CMP-23 and CMP-24 mitigate for reduced habitat extent from construction footprint; AMMs minimize other potential impacts. Adult foraging areas are not influenced by water operations (Appendix D). |
| | Predation Risk | Not anticipated to change | — | Not anticipated to change | — | Pinnipeds are noted as predators of green sturgeon in Chapter 8. DCP construction and operations/maintenance would have less-than-significant impacts on California sea lions (DCP FEIR chapter 12), so predation risk from pinnipeds to adult green sturgeon would not be anticipated to change as a result of DCP. |
| | Spawning habitat | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Flow | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Toxicity | Increase or decrease (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants; AMMs minimize effects; DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Water Temperature | Decrease [Sacramento River]; increase or decrease [Delta] (discountable/insignificant) | — | Construction: increase (discountable/insignificant). Operations and maintenance: not anticipated to change. | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Salinity | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Adults are tolerant of a broad range of salinity (Appendix D); any operations effects of DCP on salinity would be limited in relation to this broad range. |
| Egg Incubation | Flow | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Predation Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Water Temperature | Decrease (beneficial; proportion: likely large; frequency: likely medium) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| Larvae | Entrainment Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Rearing Habitat | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Predation Risk | Not anticipated to change | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Flow | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Toxicity | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Food | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations. |
| | Water | Decrease (beneficial; | — | Not anticipated to change | — | DCP would not affect upstream operations. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Temperature | proportion: likely large; likely medium) | | | | |
| Juveniles | Rearing habitat | Not anticipated to change | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: not anticipated to change. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | CMP-23 and CMP-24 mitigate for reduced habitat extent from construction footprint; AMMs minimize other potential impacts. Juveniles occupy a broad range of habitat (Appendix D) and so would not be anticipated to be affected by DCP operations. |
| | Predation Risk | Not anticipated to change | | Increase (discountable/insignificant) | — | By the time they reach the Delta, juveniles would be around the size (200 mm) at which predation risk diminishes to zero (see Appendix D), therefore should there be any increases in predators at the north Delta intakes during construction or operation, this would pose very little risk to juveniles. |
| | Flow | Increase or decrease (discountable/insignificant) | — | Increase (discountable/insignificant) | — | See in-text discussion of life cycle analyses related to Delta outflow. |
| | Water Temperature | Increase or decrease (discountable/insignificant) | — | Construction: increase (discountable/insignificant). Operations and maintenance: not anticipated to change. | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Salinity | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Juveniles are tolerant of a broad range of salinity and are strong enough swimmers to move to acceptable habitat (Chapter 8); any operations effects of DCP on salinity would be limited in relation to this broad range. |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP would not affect upstream operations; no DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants; AMMs minimize effects; DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Food | Increase or decrease (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: not | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill | DCP construction may affect food availability through disturbance, water quality effects, or reduced habitat, which would be small in extent, |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | anticipated to change. | Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources). | limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. Water operations are not the proximate cause of changes in green sturgeon prey in the Bay-Delta (Appendix D), and juvenile diet richness is greater at juvenile size within the Delta (Chapter 8). |
| | Entrainment Risk | Increase (lethal or sublethal; proportion: low [Delta]; frequency: high [Delta]) | Minimize/compensate: Delta Cross Channel Gate Closure; First Flush and Start of OMR Management; January 1 and Start of OMR Management; End of OMR Management; Winter and Spring Delta Outflows; Drought Actions; Salvage Facilities<br>Exacerbate: SHOT Reduction in Sacramento Fall and Winter Flows; Drought Actions | Construction: not anticipated to change. Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | North Delta intakes' 1.75-mm cylindrical screens would exclude juveniles from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. |
| | Other construction-related stressors (acoustic effects; direct physical injury) | — | — | Increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-25: Develop and Implement a Fish Rescue and Salvage Plan; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction effects would be limited by AMMs minimizing effects; juveniles would be likely to move away from disturbance. |
| Estuarine Subadult and Adult Residence and Outmigration | — | Not anticipated to change | — | Not anticipated to change | — | There would not be anticipated to be any effects to subadults or adults per the above adult and juvenile life stage rationale for operations; see below for construction. |
| | Construction-related stressors | — | — | Increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and | Should any subadults or adults occur near DCP construction, construction-related effects could occur, but would be minimized or compensated for with the various conservation measures. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources). | |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation.

**Table 7A-8. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Green Sturgeon Critical Habitat**

| Location | Physical and Biological Feature/Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Freshwater Riverine Systems | Food Resources | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Substrate type or size (i.e., features of substrates) | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Water flow | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Water quality (toxicity) | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Water quality (dissolved oxygen) | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Water quality (temperature) | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Migratory corridor | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Depth | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| | Sediment quality | No adverse effects anticipated | — | No adverse effects anticipated | — | DCP would not affect upstream operations. |
| Estuarine Habitats | Food Resources | No adverse effects anticipated | — | Construction: adverse. Operations and maintenance: no adverse effects anticipated. | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and | DCP construction may affect food availability through disturbance, water quality effects, or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. Water operations are not the proximate cause of changes in green sturgeon prey in the Bay-Delta (Appendix D). |

| Location | Physical and Biological Feature/Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources). | |
| | Substrate type or size (i.e., structural features of substrates) | No adverse effects anticipated | — | No adverse effects anticipated | — | Neither DCP construction nor operations/maintenance would cause adverse effects to substrate type or size. |
| | Water flow | No adverse effects anticipated | — | Adverse | — | Hypotheses exist that the mechanisms behind positive statistical correlations between Delta outflow and white sturgeon year class may also apply to green sturgeon, statistical relationships have not yet been established. Quantitative modeling between white sturgeon year class strength and either April-May or March-July Delta outflow suggest the potential for negative effects based on lower summer outflow resulting from less outflow being needed to meet Delta salinity requirements with operations of the north Delta intakes. It is highly uncertain that there would be significant increase to this stressor because the statistical relationships are based on a surrogate species and may be related to upstream flow or Delta inflow as opposed to Delta outflow; changes are limited to differences within water year type, as opposed to hydrological condition–scale differences; the prediction intervals of the statistical relationship range over several orders of magnitude; and there is little difference in estimates based on one (April–May) of the averaging periods examined. |
| | Water quality (toxicity) | No adverse effects anticipated | — | Construction: adverse<br>Operations and maintenance: no adverse effects anticipated | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants; AMMs minimize effects; DCP would not affect upstream operations; minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9). |
| | Water quality (dissolved oxygen) | No adverse effects anticipated | — | No adverse effects anticipated | — | No DCP operations effect on Delta water temperature (DSM2-QUAL) and would not affect dissolved oxygen (DCP FEIR chapter 9). |
| | Water quality (temperature) | No adverse effects anticipated | — | No adverse effects anticipated | Minimize/compensate: Mitigation Measure CMP (CMP-24: Channel Margin Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP removal of trees at construction sites would have minimal effects (channel margin habitat restoration would be undertaken to replace lost habitat); no DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Water quality (salinity) | No adverse effects anticipated | — | No adverse effects anticipated | — | Adults are tolerant of a broad range of salinity (Appendix D); juveniles are tolerant of a broad range of salinity and are strong enough swimmers to move to acceptable habitat (Chapter 8); any operations effects of DCP on salinity would be limited in relation to this broad range. |
| | Migratory corridor (barriers) | No adverse effects anticipated | — | Construction: adverse<br>Operations and maintenance: no adverse effects anticipated | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction would result in noise and disturbance, as well as potential for injury from pile driving and barge operations; sturgeon would likely move away from such effects and these potential effects would be minimized by AMM-14, AMM-26, and AMM-27. DCP operations do not include installation of any barriers to migration or change in operations of existing barriers. |
| | Depth | No adverse effects | — | No adverse effects anticipated | — | Any changes in water depth as a result of DCP operations at the north Delta intakes would be marginal in relation to available habitat. |

| Location | Physical and Biological Feature/Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | anticipated | | | | |
| | Sediment quality | No adverse effects anticipated | — | Construction: adverse<br>Operations and maintenance: no adverse effects anticipated | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects to sediment could occur from sediment disturbance and construction contaminants; AMMs minimize effects. Operations and maintenance would not be anticipated to affect sediment quality. |
| Nearshore Coastal Marine Areas | Migratory Corridor | No adverse effects anticipated | — | No adverse effects anticipated | — | There would be no DCP effect on nearshore coastal marine areas because this is outside the action area. |
| | Water quality | No adverse effects anticipated | — | No adverse effects anticipated | — | There would be no DCP effect on nearshore coastal marine areas because this is outside the action area. |
| | Food resources | No adverse effects anticipated | — | No adverse effects anticipated | — | There would be no DCP effect on nearshore coastal marine areas because this is outside the action area. |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation.

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## 7A.3.5 Delta Smelt

Chapter 9 discusses the status of delta smelt, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. Summaries of the effects analysis for effects on the species and its critical habitat are provided in Tables DS1 and DS2. A qualitative analysis was conducted to provide a programmatic summary of the effects of the DCP on the species life stages, critical habitat physical and biological features, and stressors discussed for the Proposed Action (Tables DS1 and DS2)[5]. The analysis of the DCP was based on information in the draft DCP BA and FEIR, which includes consideration of various quantitative and qualitative analyses.

As illustrated in Tables DS1 and DS2, potential effects of the DCP in addition to the Proposed Action would primarily be from operations effects related to lower Delta outflow, to be mitigated with compensatory tidal habitat restoration. Effects such as larval entrainment or impingement of older life stages would be limited because of the location of the north Delta intakes upstream of the main delta smelt distribution and inclusion of cylindrical fish screens meeting fish agency standards for factors such as screen opening size and approach velocity to minimize risk from entrainment and impingement. Consistent with the qualitative analysis summarized in Table 7A-9, life cycle modeling for delta smelt with the Life Cycle Model with Entrainment (LCME) suggested potential negative effects from DCP primarily as a result of lower summer Delta outflow, to be mitigated with compensatory tidal habitat restoration. Overall, LCME modeling described in Chapter 9 showed the Proposed Action phases to have similar population growth rate to the No Action Alternative; a similar overall pattern was observed with the Maunder and Deriso model for delta smelt that is also summarized in Chapter 9.

As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of the DCP would be avoided, minimized, and offset. Guiding principles relevant to delta smelt include:

- Operate projects consistent with existing and/or future regulatory requirements in the Delta.
- Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to improve productivity of those fish populations.
- Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP with habitat restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.
- Implement project operations and maintenance consistent with the proposed project description, as an integrated component of the SWP.
    - Future consultation on Delta Conveyance Project Operations and Maintenance is envisioned to update and align elements of project description with conditions (e.g. regulatory, climate, status of species) in advance of operations of the north Delta diversions.
- Cooperate with the fisheries resource agencies to monitor effects of diversions to DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions.

As described in Chapter 3, DCP has an adaptive management program which would integrate with the

[5] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

adaptive management program for the Proposed Action and includes a number of general principles such as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

**Table 7A-9. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Delta Smelt**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Adult Migration and Spawning | Toxicity | Decrease (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other AMMs minimize effects); minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9), including selenium as modeled for delta smelt (DCP FEIR chapter 12). |
| | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | No DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Food Visibility | Decrease (discountable/insignificant) | — | Not anticipated to change | — | DCP north Delta intakes sediment entrainment during migration/spawning period is not likely to immediately affect turbidity of water. |
| | Predation | Increase (discountable/insignificant) | — | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: increase (lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction has the potential to disturb adults and make them more susceptible to predation (however, there would be limited temporal overlap with construction because of AMM-14 work window; other AMMs minimize effects); presence of cofferdams during construction period provides potential predator habitat but is small in extent relative to the area of habitat in the Delta. Predation associated with DCP operations could occur at the north Delta intakes if predators aggregate there but existing literature suggests such effects would be minimal and there is limited spatial overlap with delta smelt distribution; uncertainty to be addressed with fisheries studies and adaptive management. At broad scale, predation effects from operations not likely because there would not be major changes to water temperature, turbidity (suspended sediment), or predators (FEIR chapter 12). |
| | Food Availability | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely high) | Minimize/compensate: Minimum Instream Flows; Delta Smelt Supplementation<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. |
| | Entrainment | Increase (lethal; proportion: variable; frequency: medium) | Minimize/compensate: First Flush and Start of OMR Management; January 1 and Start of OMR Management; Adult Delta | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal to lethal; | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | DCP north Delta intakes' 1.75-mm cylindrical screens would exclude adults from entrainment, with screen design and |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Smelt Entrainment Protection Action (Turbidity Bridge)<br>Exacerbate: Drought Actions | proportion: small; frequency: high). | | operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. |
| | Other construction-related stressors (acoustic effects; direct physical injury; habitat extent) | — | — | Increase (sub-lethal to lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; fish likely to move away from disturbance; CMP-23 mitigates for reduced habitat extent. Cofferdam presence could impede or delay access to upstream spawning habitat but 2D modeling indicates suitably low velocity habitat would be present even at relatively high river flows. |
| Eggs and Larvae | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | No DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Food Visibility | Increase (discountable/insignificant) | — | Not anticipated to change | — | DCP north Delta intakes sediment entrainment during larval period is not likely to immediately affect turbidity of water. |
| | Predation | Increase (discountable/insignificant) | — | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: Increase (lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction has the potential to disturb larvae and make them more susceptible to predation (however, there would be limited temporal overlap with construction because of AMM-14 work window; other AMMs minimize effects). Increased predation associated with DCP operations could occur as a result of increased silverside abundance related to lower spring south Delta exports, although this is uncertain. |
| | Food Availability | Increase (sub-lethal to lethal; proportion: likely medium; frequency: high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (sub-lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-27: Tidal Habitat Restoration for Operations Impacts on Delta Smelt) | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. Less spring Delta outflow (higher X2) could result in small (0-3%) reductions in spring zooplankton prey (*Eurytemora affinis*), mitigated by CMP-27. |
| | Entrainment | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: First Flush and Start of OMR Management; January 1 and Start of OMR Management; Larval and Juvenile Delta Smelt Protection Action; Spring Delta Outflow; Barker Slough Pumping Plant, Maximum Spring Diversions, Larval Delta Smelt; Delta Smelt Supplementation | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal to lethal; proportion: small; frequency: low to medium). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | DCP north Delta intakes may entrain larval delta smelt but the proportion of the population would be low based on spatial distribution and the frequency would be limited because of relatively little spring diversion, with hydrodynamic effects ("bow wave") at tee screens potentially also reducing effects. Delta smelt eggs could also be |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Drought Actions | | | entrained if adhered to resuspended sediment, but there is uncertainty because no information exists regarding survival following resuspension; the proportion of the population affected would in any case be low. |
| | Other construction-related stressors (acoustic effects; direct physical injury; habitat extent) | — | — | Increase (sub-lethal to lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; CMP-23 mitigates for reduced habitat extent. |
| Juveniles | Toxicity from Harmful Algal Blooms | Increase or decrease (discountable/insignificant) | — | Construction: not anticipated to change. Operations and maintenance: not anticipated to change. | — | DCP operations would not have a significant effect on harmful algal blooms in the Delta (DCP FEIR chapter 9). |
| | Water Temperature | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | No DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Predation | Increase (discountable/insignificant) | — | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: increase (lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-15: Sediment Monitoring, Modeling, and Reintroduction Adaptive Management; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction has the potential to disturb juveniles and make them more susceptible to predation (however, there would be limited temporal overlap with construction because of AMM-14 work window; other AMMs minimize effects); presence of cofferdams during construction period provides potential predator habitat but is small in extent relative to the area of habitat in the Delta. Predation associated with DCP operations could occur at the north Delta intakes if predators aggregate there but existing literature suggests such effects would be minimal and there is limited spatial overlap with delta smelt distribution; uncertainty to be addressed with fisheries studies and adaptive management. At broad scale, predation effects from operations not likely because there would not be major changes to water temperature, turbidity (suspended sediment), or predators (FEIR chapter 12). AMM-15 would address uncertainty in sediment/turbidity effects. |
| | Food Availability and Quality | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely medium to high) | Minimize/compensate: Minimum Instream Flows; Delta Smelt Supplementation<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (sub-lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-27: Tidal Habitat Restoration for Operations Impacts on Delta Smelt) | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. Less June-October Delta outflow because of less outflow needed meeting Delta salinity requirements could result in less zooplankton |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | prey (*Pseudodiaptomus forbesi*), but there is uncertainty associated with factors such as QWEST flow being similar to baseline; effects to be mitigated by CMP-27. |
| | Entrainment | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: January 1 and Start of OMR Management; Larval and Juvenile Delta Smelt Protection Action; Spring Delta Outflow; End of OMR Management; Barker Slough Pumping Plant, Maximum Spring Diversions, Larval Delta Smelt; Delta Smelt Supplementation<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal to lethal; proportion: small; frequency: high). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | DCP north Delta intakes' 1.75-mm cylindrical screens would exclude juveniles from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. Most if not all juvenile delta smelt would not be present near the north Delta intakes. |
| | Size and Location of the Low Salinity Zone | Increase (sub-lethal; proportion: likely medium to large; frequency: likely medium to high) | Minimize/compensate: Spring Delta Outflow; Summer Suisun Marsh Salinity Control Gate Operation; Fall X2<br>Exacerbate: Drought Actions | Construction: not anticipated to change. Operations and maintenance: Increase (sub-lethal; proportion: medium to large; frequency: low to medium) | Minimize/compensate: Mitigation Measure CMP (CMP-27: Tidal Habitat Restoration for Operations Impacts on Delta Smelt) | DCP operations would have minor reductions in Delta outflow caused by less outflow needed to meet Delta salinity requirements; mitigated by CMP-27. |
| | Other construction-related stressors (acoustic effects; direct physical injury; habitat extent) | — | — | Increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; CMP-23 mitigates for reduced habitat extent. |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation.

**Table 7A-10. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Delta Smelt Critical Habitat**

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Physical Habitat | Habitat extent | — | — | Construction: Adverse. Operations and maintenance: No adverse effects anticipated. | Minimize/compensate: Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources); AMM-15: Sediment Monitoring, Modeling, and Reintroduction Adaptive Management | Physical habitat would be reduced within construction footprint, to be mitigated by CMP-23. The limited percentage of sediment estimated to be entrained is not anticipated to affect habitat extent (e.g., sand for spawning), but AMM-15 addresses uncertainty. |
| Water Quality | Water Temperature | No adverse effects anticipated | — | No adverse effects anticipated | — | No DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Food Visibility | No adverse effects anticipated | — | No adverse effects anticipated | AMM-15: Sediment Monitoring, Modeling, and Reintroduction Adaptive Management | The limited percentage of sediment estimated to be entrained by DCP operations would not be anticipated to affect food visibility; AMM-15 would address uncertainty in sediment/turbidity effects. |
| | Predation | No adverse effects anticipated | — | Construction: Adverse. Operations and maintenance: | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and | DCP construction has the potential to disturb delta smelt and make them more susceptible to predation (however, there would be limited temporal overlap with |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | DCP Effect on Critical Habitat* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | Adverse. | Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | construction because of AMM-14 work window; other AMMs minimize effects); presence of cofferdams during construction period provides potential predator habitat but is small in extent relative to the area of habitat in the Delta. Predation associated with DCP operations could occur at the north Delta intakes if predators aggregate there but existing literature suggests such effects would be minimal and there is limited spatial overlap with delta smelt distribution; uncertainty to be addressed with fisheries studies and adaptive management. At broad scale, predation effects from operations not likely because there would not be major changes to water temperature, turbidity (suspended sediment), or predators (FEIR chapter 12). |
| | Food Availability | Adverse | Minimize/compensate: Minimum Instream Flows; Delta Smelt Supplementation; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: Adverse. Operations and maintenance: Adverse. | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-27: Tidal Habitat Restoration for Operations Impacts on Delta Smelt) | DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. Less Delta outflow could result in small reductions in zooplankton prey (*Eurytemora affinis*), mitigated by CMP-27. |
| River Flow | Entrainment | Adverse | Minimize/compensate: First Flush and Start of OMR Management; January 1 and Start of OMR Management; Adult Delta Smelt Entrainment Protection Action (Turbidity Bridge); Larval and Juvenile Delta Smelt Protection Action; Spring Delta Outflow; End of OMR Management; Barker Slough Pumping Plant, Maximum Spring Diversions, Larval Delta Smelt; Delta Smelt Supplementation<br>Exacerbate: Drought Actions; SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows | Construction: No adverse effects anticipated. Operations and maintenance: Adverse. | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | DCP north Delta intakes' 1.75-mm cylindrical screens would exclude juveniles and adults from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. The north Delta intakes may entrain larval delta smelt but the proportion of the population would be low based on spatial distribution and the frequency would be limited because of relatively little spring diversion, with hydrodynamic effects at tee screens potentially also reducing. Delta smelt eggs could also be entrained if adhered to resuspended sediment, but there is uncertainty because no information exists regarding survival following resuspension; the proportion of the population affected would in any case be low. |
| Salinity | Size and Location of the Low Salinity Zone | Adverse | Minimize/compensate: Spring Delta Outflow; Summer Suisun Marsh Salinity Control Gate Operation; Fall X2<br>Exacerbate: Drought Actions | Construction: No adverse effects anticipated. Operations and maintenance: Adverse. | Minimize/compensate: Mitigation Measure CMP (CMP-27: Tidal Habitat Restoration for Operations Impacts on Delta Smelt) | DCP operations would have minor reductions in Delta outflow caused by less outflow needed to meet Delta salinity requirements; mitigated by CMP-27. |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation.

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## 7A.3.6 Longfin Smelt

Chapter 10 discusses the status of longfin smelt, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. A summary of the effects analysis for effects on the species is provided in Table 7A-11. A qualitative analysis was conducted to provide a programmatic summary of the effects of the DCP for the species life stages and stressors discussed for the Proposed Action (Table 7A-11)[6]. The analysis of the DCP was based on information in the draft DCP ITP Application and FEIR, which includes consideration of various quantitative and qualitative analyses.

As illustrated in Table 7A-11, potential effects of the DCP in addition to the Proposed Action would primarily be from operations effects related to lower Delta outflow, to be mitigated with compensatory tidal habitat restoration. Effects such as larval entrainment or impingement of older life stages would be limited because of the location of the north Delta intakes well upstream of the main longfin smelt distribution and inclusion of cylindrical fish screens meeting fish agency standards for factors such as screen opening size and approach velocity to minimize risk from entrainment and impingement.

As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of the DCP would be avoided, minimized, and offset. Guiding principles relevant to longfin smelt include:

- Operate projects consistent with existing and/or future regulatory requirements in the Delta.
- Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to improve productivity of those fish populations.
- Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP with habitat restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.
- Implement project operations and maintenance consistent with the proposed project description, as an integrated component of the SWP.
    - Future consultation on Delta Conveyance Project Operations and Maintenance is envisioned to update and align elements of project description with conditions (e.g. regulatory, climate, status of species) in advance of operations of the north Delta diversions.
- Cooperate with the fisheries resource agencies to monitor effects of diversions to DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions.

As described in Chapter 3, DCP has an adaptive management program which would integrate with the adaptive management program for the Proposed Action and includes a number of general principles such as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

[6] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

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**Table 7A-11. Qualitative Summary of DCP Combined with Proposed Action (PA) Effects on Longfin Smelt**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Juveniles Rearing and Migration | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | No DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Toxicity | Increase (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other AMMs minimize effects; most longfin smelt would be well downstream); minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9), including selenium as modeled for delta smelt (DCP FEIR chapter 12). |
| | Predation | Increase (discountable/insignificant) | — | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: increase (lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction has the potential to disturb juveniles and make them more susceptible to predation (however, there would be limited temporal overlap with construction because of AMM-14 work window; other AMMs minimize effects); presence of cofferdams during construction period provides potential predator habitat but is small in extent relative to the area of habitat in the Delta. Predation associated with DCP operations could occur at the north Delta intakes if predators aggregate there but existing literature suggests such effects would be minimal and there is very limited spatial overlap with longfin smelt distribution; uncertainty to be addressed with fisheries studies and adaptive management. At broad scale, predation effects from operations not likely because there would not be major changes to water temperature, turbidity (suspended sediment), or predators (FEIR chapter 12). |
| | Entrainment | Increase (lethal; proportion: likely small; frequency: medium) | Minimize/compensate: January 1 and Start of OMR Management; Larval and Juvenile Longfin Smelt Protection Action; Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal to lethal; proportion: low; frequency: low). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | Longfin smelt distribution is generally well downstream of the north Delta intakes, limiting the potential for negative effects. DCP north Delta intakes' 1.75-mm cylindrical screens would exclude juveniles from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. |
| | Freshwater Flow | Increase (sub-lethal to lethal; proportion: likely small; frequency: likely medium to high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal to lethal; proportion: medium; frequency: medium to high) | Minimize/compensate: Mitigation Measure CMP (CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt) | DCP operations have the potential for an uncertain negative effect on population abundance index caused by less winter/spring Delta outflow, mitigated by |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | | | tidal habitat restoration (CMP-28). |
| | Food Availability | Increase (sub-lethal to lethal; proportion: medium; frequency: likely high) | Minimize/compensate: Minimum Instream Flows; Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (sub-lethal to lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt). | Longfin smelt distribution is generally well downstream of the north Delta intakes, limiting the potential for negative effects from construction. DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. Less Delta outflow could affect zooplankton abundance (see summary for delta smelt); effects to be mitigated by CMP-28. |
| | Other construction-related stressors (acoustic effects; direct physical injury; habitat extent) | — | — | Increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; CMP-23 mitigates for reduced habitat extent. |
| Adult Holding and Spawning | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | No DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Toxicity | Increase (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other AMMs minimize effects; most longfin smelt would be well downstream); minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9), including selenium as modeled for delta smelt (DCP FEIR chapter 12). |
| | Predation | Increase (discountable/insignificant) | — | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: increase (lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction has the potential to disturb adults and make them more susceptible to predation (however, there would be limited temporal overlap with construction because of AMM-14 work window; other AMMs minimize effects); presence of cofferdams during construction period provides potential predator habitat but is small in extent relative to the area of habitat in the Delta. Predation associated with DCP operations could occur at the north Delta intakes if predators aggregate there but existing literature suggests such effects would be minimal and there is very limited spatial overlap with longfin smelt distribution; |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | uncertainty to be addressed with fisheries studies and adaptive management. At broad scale, predation effects from operations not likely because there would not be major changes to water temperature, turbidity (suspended sediment), or predators (FEIR chapter 12). |
| | Entrainment | Increase (lethal; proportion: small; frequency: likely medium) | Minimize/compensate: First Flush and Start of OMR Management; January 1 and Start of OMR Management; Adult Longfin Smelt Entrainment Protection Action<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal to lethal; proportion: low; frequency: low). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | Longfin smelt distribution is generally well downstream of the north Delta intakes, limiting the potential for negative effects. DCP north Delta intakes' 1.75-mm cylindrical screens would exclude adults from entrainment, with screen design and operating criteria (e.g., approach velocity) minimizing the potential for negative near-field effects such as impingement. |
| | Freshwater Flow | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely low) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal to lethal; proportion: medium; frequency: medium to high) | Minimize/compensate: Mitigation Measure CMP (CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt) | DCP operations have the potential for an uncertain negative effect on population abundance index caused by less winter/spring Delta outflow, mitigated by tidal habitat restoration (CMP-28). |
| | Food Availability | Increase (sub-lethal to lethal; proportion: medium; frequency: likely high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (sub-lethal to lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources; CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt). | Longfin smelt distribution is generally well downstream of the north Delta intakes, limiting the potential for negative effects from construction. DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. Less Delta outflow could affect zooplankton abundance (see summary for delta smelt); effects to be mitigated by CMP-28. |
| | Other construction-related stressors (acoustic effects; direct physical injury; habitat extent) | — | — | Increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; CMP-23 mitigates for reduced habitat extent. |
| Eggs and Larvae | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | No DCP operations effect on Delta water temperature (DSM2-QUAL). |
| | Toxicity | Increase (discountable/insignificant) | — | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (discountable/insignificant). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: | DCP construction effects from sediment disturbance and construction contaminants (limited temporal overlap because of AMM-14 work window; other |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM -27: Develop and Implement a Barge Operations Plan | AMMs minimize effects; most longfin smelt would be well downstream); minimal operations effect on modeled contaminants in the Delta (DCP FEIR chapter 9), including selenium as modeled for delta smelt (DCP FEIR chapter 12). |
| | Predation | Increase (discountable/insignificant) | — | Construction: increase (lethal; proportion: small; frequency: low). Operations and maintenance: Increase (lethal; proportion: small; frequency: high). | Minimize/compensate: AMM-2: Develop and Implement Hazardous Materials Management Plans; AMM-3: Develop and Implement Spill Prevention, Control, and Countermeasure Plans; AMM-4a: Develop and Implement Erosion and Sediment Control Plans and AMM-4b: Develop and Implement Stormwater Pollution Prevention Plans; AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan | DCP construction has the potential to disturb larvae and make them more susceptible to predation (however, there would be limited temporal overlap with construction because of AMM-14 work window; other AMMs minimize effects; and there is limited spatial overlap of longfin smelt with the north Delta intakes). Increased predation associated with DCP operations could occur as a result of increased silverside abundance related to lower spring south Delta exports, although this is uncertain, particularly because this mechanism has only been studied for delta smelt and not longfin smelt. |
| | Entrainment | Increase (lethal; proportion: likely small; frequency: medium to high) | Minimize/compensate: January 1 and Start of OMR Management; Larval and Juvenile Longfin Smelt Protection Action; Spring Delta Outflow; Barker Slough Pumping Plant, Maximum Spring Diversions, Larval Longfin Smelt<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal to lethal; proportion: low; frequency: low). | Minimize/compensate: North Delta intakes cylindrical tee fish screens and operating criteria | DCP north Delta intakes may entrain larval longfin smelt but the proportion of the population would be low based on spatial distribution and the frequency would be limited, with hydrodynamic effects ("bow wave") at tee screens potentially also reducing effects. Longfin smelt eggs could also be entrained if adhered to resuspended sediment, but there is uncertainty because no information exists regarding survival following resuspension; the proportion of the population affected would in any case be low. |
| | Freshwater Flow | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely medium to high) | Minimize/compensate: Minimum Instream Flows; Spring Delta Outflow<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: not anticipated to change. Operations and maintenance: increase (sub-lethal to lethal; proportion: medium; frequency: medium to high) | Minimize/compensate: Mitigation Measure CMP (CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt) | DCP operations have the potential for an uncertain negative effect on population abundance index caused by less winter/spring Delta outflow, mitigated by tidal habitat restoration (CMP-28). |
| | Food Availability | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Construction: increase (sub-lethal; proportion: small; frequency: low). Operations and maintenance: increase (sub-lethal to lethal; proportion: small; frequency: high). | Minimize/compensate: Mitigation Measure CMP (CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt) | Longfin smelt distribution is generally well downstream of the north Delta intakes, limiting the potential for negative effects from construction. DCP construction may affect food availability through disturbance or reduced habitat, which would be small in extent, limited in temporal overlap because of AMM-14 work window, and minimized or compensated for by conservation measures. Less Delta outflow could affect |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor* | DCP Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | zooplankton abundance (see summary for delta smelt); effects to be mitigated by CMP-28. |
| | Other construction-related stressors (acoustic effects; direct physical injury; habitat extent) | — | — | Increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: AMM-14: Construction Best Management Practices for Biological Resources; AMM-26: Develop and Implement an Underwater Sound Control and Abatement Plan; AMM-27: Develop and Implement a Barge Operations Plan; Mitigation Measure CMP (CMP-23: Tidal Perennial Habitat Restoration for Construction Impacts on Habitat for Fish and Aquatic Resources) | DCP construction effects would be limited in temporal overlap because of AMM-14 work window; other AMMs minimize effects; CMP-23 mitigates for reduced habitat extent. |

Notes: *Table includes consideration of DCP construction effects and conservation measures; these are addressed in a separate consultation.

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### 7A.3.7 Southern Resident Killer Whale

As described in Chapter 11, the Proposed Action is not anticipated to change the stressors Pollutants and Contaminants, Vessel Effects, Oil Spill, or Acoustic. The Proposed Action may increase the Prey Availability stressor to a discountable or insignificant level, with effects limited by the Proposed Action not impacting hatchery operations, and hatchery release strategies limiting the potential for operational effects to outmigration of hatchery-origin fish. Hatchery-origin Chinook salmon are likely to contribute far more to the killer whale diet than natural-origin Chinook salmon, with only 10.5% of the diet estimated to be of natural-origin Central Valley Chinook salmon (see Chapter 11). As shown in Sections 7A.3.1 and 7A.3.2, effects of the DCP on listed Chinook salmon would be limited; additional analyses in the draft DCP BA and FEIR show this would also be the case for unlisted fall-/late fall-run Chinook salmon. Therefore any increase in the Prey Availability stressor as a result of the DCP would be discountable/insignificant for killer whale.

## 7A.4 Sites Combined with Proposed Action Qualitative Effects Analysis

### 7A.4.1 Sacramento River Winter-Run Chinook Salmon

Chapter 5 discusses the status of Sacramento River winter-run Chinook Salmon, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. Summaries of the effects analysis for effects on the species and its critical habitat are provided in Tables WR1_Sites and WR2_Sites. A qualitative analysis was conducted to provide a programmatic summary of the effects of Sites for the species life stages, critical habitat physical and biological features, and stressors discussed for the Proposed Action (Tables WR1_Sites and WR2_Sites)[7]. The analysis of Sites was based on information in the administrative draft Sites BA and FEIR/S, which includes consideration of various quantitative and qualitative analyses.

As illustrated in Tables WR1_Sites and WR2_Sites, the principal potential effects of Sites in addition to the Proposed Action would be reduction in early life stage water temperature stressors through coordination of operations with CVP, in addition to potential increases in stressors such as outmigration cues and refuge habitat because of diversions to Sites Reservoir during winter/spring. Life cycle modeling undertaken for Sites indicated overall slightly positive effects on winter-run Chinook Salmon adult abundance based on all three models run (IOS, OBAN, and the Winter-Run Chinook Salmon Life Cycle Model). Life cycle modeling described in Chapter 5 for the Proposed Action with the CVPIA winter-run Chinook salmon life cycle model suggested generally similar adult spawner abundance population change for Proposed Action phases to the No Action Alternative, and similar to or higher than Run of the River (EXP1) and Minimum Releases (EXP3) scenarios.

As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of Sites would be avoided, minimized, and offset. Guiding principles relevant to winter-run Chinook salmon include:

- Upper Sacramento River

[7] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

- Utilize the additional water supply provided by the Sites Project to address adverse effects of the CVP on salmonid and sturgeon habitat in the Sacramento River above the Red Bluff Pumping Plant by:
  - Optimizing the use of Reclamation's storage to facilitate the following:
    - Enhancing conservation of the cold-water pool in Shasta Lake for use in managing temperatures in salmonid spawning habitat downstream of Keswick Dam particularly in dry water year types;
    - Enhancing pulse flows envisioned in the biological assessment at appropriate times, particularly in years when natural pulse events are minimal, to stimulate migration of juvenile salmon downstream toward the Delta; and
    - Stabilizing flow to minimize or preclude losses of salmon redds due to flow fluctuations associated with management of Shasta Lake for fall storage.
  - Implementing additional mitigation actions as necessary and appropriate to maintain and/or improve spawning and rearing habitat for anadromous fish in the Upper Sacramento River.
  - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions.

- Sacramento River from Red Bluff Pumping Plant to Knights Landing
  - Implement actions necessary to minimize potential impacts to listed species exposed to diversion facilities.
  - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions.
  - Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
  - Find opportunities to develop and/or restore additional side channel habitat and/or salmonid rearing habitat to offset adverse effects to salmonid migratory and rearing habitat associated with diversions of flow to Sites Reservoir.
- Below Knights Landing and in the Delta
  - Operate projects consistent with existing and/or future regulatory requirements in the Delta.
  - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.
  - Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
  - Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to maintain and/or improve productivity of those fish populations.
  - Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of

Fish and Wildlife (CDFW) to maintain and/or improve productivity of those fish populations.

- Cooperate in the monitoring of the Fremont Weir Big Notch Project to assess what effect, if any, diversions of flow to Sites Reservoir have on the effectiveness of the Big Notch Project's ability to achieve its juvenile entrainment and adult passage performance goals for salmonids in the Sacramento River. If necessary, implement operational measures to avoid diminishing the performance of the Big Notch Project.

As described in Chapter 3, Sites has an adaptive management program which would integrate with the adaptive management program for the Proposed Action and includes a number of general principles such as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

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**Table 7A-12. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Sacramento River Winter-Run Chinook Salmon**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Adult Migration | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river flows from Sites operations that suggest in-river fishing or poaching would change. |
| | Stranding Risk | Not anticipated to change | — | Increase (discountable/insignificant) | — | Quantitative modeling showed limited effects of Sites diversion operations on number of days meeting adult upstream passage criteria at Fremont Weir and Colusa Weir. |
| | Dissolved Oxygen | Not anticipated to change | — | Not anticipated to change | — | Assumed similar to water temperature. |
| | Toxicity from Contaminants | Increase (discountable/insignificant) | — | Not anticipated to change | — | Adult migration does not overlap main period of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | No biologically meaningful effects of Sites based on quantitative modeling (HEC-5Q). |
| | Pathogens and Disease | Increase (discountable/insignificant) | — | Not anticipated to change | — | Assumed similar to water temperature. |
| Adult Holding and Spawning | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river flows from Sites operations that suggest in-river fishing or poaching would change. |
| | Stranding Risk | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river flows from Sites operations that suggest stranding risk would change. |
| | Competition, Introgression, and Broodstock Removal | Not anticipated to change | — | Not anticipated to change | — | There is no mechanism to Sites operations that suggests a change would occur in the influence of hatchery-origin fish on natural-origin fish. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Adult holding and spawning is upstream of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Dissolved Oxygen | Decrease (discountable/insignificant) | — | Decrease (discountable/insignificant) | — | Assumed similar to water temperature. |
| | Spawning Habitat | Increase (lethal; proportion: likely small/medium; frequency: low) | Minimize/compensate: Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; Drought Actions<br>Exacerbate: SRSC Diversion Spring Delays and Shifting; Shasta Operations Team (SHOT) Water Transfer Timing Approvals | Increase or decrease (discountable/insignificant) | — | Weighted usable area quantitative analyses show limited effects of Sites operations, with minor increases to the stressor tending to occur in April-June and minor decreases to the stressor tending to occur in July. |
| | Water Temperature | Decrease (beneficial; proportion: likely large; frequency: high); increase (sublethal; proportion: small; frequency: low) | Minimize/compensate: Adult Migration and Holding Water Temperature Objectives<br>Exacerbate: Drought Tool Kit Warmwater Bypass; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows | Decrease (discountable/insignificant) | — | Few biologically meaningful effects of Sites based on quantitative modeling (HEC-5Q). |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Pathogens and Disease | Decrease (beneficial; proportion: likely large; frequency: high); increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: Adult Migration and Holding Water Temperature Objectives | Decrease (discountable/insignificant) | — | Assumed similar to water temperature. |
| Egg Incubation and Fry Emergence | In-River Fishery or Trampling | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to flow as a result of Sites operations that would be expected to result in changes to the in-river fishery or trampling. |
| | Predation Risk | Not anticipated to change | — | Decrease (discountable/insignificant) | — | Water temperature would decrease as a result of Sites operations in coordination with CVP (see discussion for Water Temperature below), which could result in a decrease in predation risk given general decrease in predator metabolic demand with decreasing temperature; assumed such changes would be to a lesser degree because of a lack of specific information. |
| | Toxicity from Contaminants | Decrease (discountable/insignificant) | — | Not anticipated to change | — | Egg incubation and fry emergence is upstream of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Dissolved Oxygen | Decrease (discountable/insignificant) | — | Decrease (discountable/insignificant) | — | Assumed similar trend to water temperature but to lesser degree because of lack of specific information. |
| | Pathogens and Disease | Decrease (discountable/insignificant) | — | Decrease (discountable/insignificant) | — | Assumed similar trend to water temperature but to lesser degree because of lack of specific information. |
| | Sedimentation and Gravel Quantity | Decrease (discountable/insignificant) | — | Decrease (discountable/insignificant) | — | Increased flow associated with lower temperature (see discussion below for Water Temperature) in critically dry years could decrease sedimentation but there is no quantitative analysis available to inform the extent; Sites does not include any gravel augmentation and there are limited effects on spawning habitat (see above discussion of Spawning Habitat for Adult Holding and Spawning). |
| | Redd Stranding and Dewatering | Increase (lethal; proportion: likely small; frequency: high) | Minimize/compensate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance<br>Exacerbate: SHOT Water Transfer Timing Approvals | Decrease (beneficial; proportion: medium; frequency: medium) | Minimize/compensate: Coordination with CVP | Quantitative modeling shows Sites reducing redd dewatering during most water year types in June-September and July-October. |
| | Redd Quality | Decrease (beneficial; proportion: likely large; frequency: likely high) | Minimize/compensate: SHOT Water Transfer Timing Approvals<br>Exacerbate: Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; SRSC Diversion Spring Delays and Shifting; Minimum Refuge Summer Deliveries North of Delta; Drought Actions | Decrease (beneficial; proportion: medium; frequency: medium) | Minimize/compensate: Coordination with CVP | Assumed in consideration of other stressors (in particular water temperature) and quantitative modeling showing no anticipated change to redd scour/entombment as a result of Sites. |
| | Water | Decrease (beneficial; proportion: | Minimize/compensate: Shasta Reservoir | Decrease (beneficial; proportion: large; | Minimize/compensate: | Quantitative modeling (HEC-5Q; Anderson and |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Temperature | likely large; frequency: medium); increase (lethal; proportion: likely small; frequency: medium) | Water Temperature and Storage Management; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; SRSC Diversion Spring Delays and Shifting; Drought Actions<br>Exacerbate: Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Adult Migration and Holding Water Temperature Objectives; SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool); SHOT Water Transfer Timing Approvals (Denials that precludes water transfers) | frequency: medium) | Coordination with CVP | Martin models) shows reduction in water temperature and egg mortality in critically dry years as a result of Sites operations in coordination with CVP, benefiting egg incubation/fry in August/September/October. |
| Juvenile Rearing and Outmigration | Pathogens and Disease | Increase or decrease (discountable/insignificant) | — | Not anticipated to change (Delta); increase or decrease (Sacramento River; sub-lethal or beneficial; proportion: small; frequency: medium) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; coordination with CVP. | Operations-related effects on water temperature in the Delta are minimal, with water temperature noted as a key driver of pathogens/disease (Chapter 5). There is small potential for injury leading to disease from juveniles contacting the Red Bluff and Hamilton City fish screens, minimized by screen design (smooth screen face; cleaning system) and operating criteria (e.g., approach velocity). At the broad scale, beneficial effects could occur as a result of lower water temperature (see discussion of Water Temperature stressor below). |
| | Toxicity from Contaminants | Increase (discountable/insignificant) | — | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2, although juvenile rearing and outmigration generally would be outside the main period of reservoir releases. |
| | Predation and Competition | Increase (discountable/insignificant) | — | Increase (discountable/insignificant) | — | Available studies suggest there would be limited effects of Sites diversions on predation risk at the Red Bluff and Hamilton City intakes; uncertainty would be addressed with technical studies of predator density and distribution. |
| | Stranding Risk | Increase (lethal; proportion: small; frequency: high) | Minimize/compensate: Minimum Instream Flows; Ramping Rates | Decrease (beneficial; proportion: small; frequency: medium) | Minimize/compensate: Coordination with CVP | Quantitative modeling shows a potential beneficial effect of Sites in reducing the stranding risk stressor during July-October of some water year types. |
| | Outmigration Cues | Increase (lethal; proportion: large; frequency: low) | Minimize/compensate: Minimum Instream Flows; SRSC Diversion Spring Delays and Shifting<br>Exacerbate: Fall and Winter Base Flows for | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: Diversion criteria | Sites diversions would reduce outmigration flows for juveniles in the Sacramento River and the Delta, to be minimized with diversion criteria (Bend Bridge Pulse Protection and Minimum |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Shasta Reservoir Refill and Redd Maintenance; Shasta Reservoir Water Temperature and Storage Management; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; Drought Actions; SHOT Water Transfer Timing Approvals | | | Bypass Flows in the Sacramento River at Wilkins Slough); quantitative modeling (e.g., STARS spreadsheet; river migration flow-survival analysis) suggests effects would be limited. Adaptive management would be utilized to assess and if necessary refine operations and diversion criteria based on biological monitoring. |
| | Entrainment Risk | Increase (lethal; proportion: small/medium; frequency: high) | Minimize/compensate: SRSC Transfer Delays; Delta Cross Channel Gate Closure; Winter-Run Chinook Salmon Early Season Salvage Threshold; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Winter-Run 50% Annual Loss Threshold; Winter-Run 75% Annual Loss Threshold; Winter-Run Weekly Loss Thresholds; Winter and Spring Delta Outflows; Salvage Facilities<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; SHOT Water Transfer Timing Approvals; Reduced Wilkins Slough Minimum Flows; Drought Actions | Not anticipated to change (Delta); increase (Sacramento River; sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; diversion criteria | South Delta exports during the main period of juvenile entrainment risk would not be changed as a result of Sites operations, as indicated by quantitative modeling (salvage-density method). Diversion criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment. Entrainment risk at the Red Bluff and Hamilton City intakes would not change because juveniles small enough to be entrained would not temporally overlap the Sites diversion period. There is the potential for other near-field negative effects such as impingement, which would be minimized by the fish screens meeting agency criteria, with monitoring in addition to long-term hydraulic evaluations of screen performance. |
| | Refuge Habitat | Not anticipated to change (more seaward end of Delta); increase (Sacramento River and more landward end of Delta; sub-lethal; proportion: large; frequency: medium) | Minimize/compensate: Minimum Instream Flows; SRSC Transfer Delays<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Reduced Wilkins Slough Minimum Flows; SHOT Water Transfer Timing Approvals; Drought Actions | Not anticipated to change (more seaward end of Delta); increase (more landward end of the Delta; proportion: medium; frequency: medium); increase or decrease (Sacramento River/floodplains; sub-lethal or beneficial; proportion: small; frequency: medium) | Minimize/compensate: Diversion criteria | Quantitative modeling indicates that Sites diversions would increase or reduce (depending on location/timing; increases are more likely for fry than juveniles) flow-inundated habitat in the Sacramento River, floodplains, and more landward end of the Delta, which would be limited by diversion criteria. |
| | Food Availability and Quality | Not anticipated to change (more seaward end of Delta); increase (Sacramento River and more landward end of Delta; sub-lethal; proportion: large; frequency: low) | Minimize/compensate: Minimum Instream Flows; SRSC Transfer Delays<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Reduced Wilkins Slough Minimum Flows; SHOT Water Transfer Timing Approvals; Drought Actions | Not anticipated to change (more seaward end of Delta); increase (more landward end of the Delta; proportion: medium; frequency: medium); increase or decrease (Sacramento River/floodplains; sub-lethal or beneficial; proportion: small; frequency: medium) | Minimize/compensate: Diversion criteria | Sites diversions could affect food, assuming similar effects as to decreases in refuge habitat. |
| | Water Temperature and Dissolved Oxygen | Not anticipated to change (Delta); decrease or increase (Sacramento River; beneficial or sub-lethal/lethal; proportion: medium to large; frequency: high) | Minimize/compensate: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management (preserve cold water)<br>Exacerbate: SHOT Water Transfer Timing Approvals (denial of water transfers); SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool) | Not anticipated to change (Delta); decrease (Sacramento River; beneficial; proportion: large; frequency: medium) | Minimize/compensate: Coordination with CVP | Operations-related effects on water temperature in the Delta are minimal. Quantitative modeling (HEC-5Q) shows reduction in Sacramento River water temperature in critically dry years as a result of Sites operations in coordination with CVP, benefiting juveniles in September/October. |

**Table 7A-13. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Sacramento River Winter-Run Chinook Salmon Critical Habitat**

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Access from the Pacific Ocean to Appropriate Spawning Areas | In-River Fishery and Poaching | No adverse effects anticipated | — | No adverse effects anticipated | — | There are no major changes to river flows from Sites operations that suggest in-river fishing or poaching would change. |
| | Stranding Risk | No adverse effects anticipated | — | No adverse effects anticipated | — | Quantitative modeling showed limited effects of Sites diversion operations on number of days meeting adult upstream passage criteria at Fremont Weir and Colusa Weir. |
| | Dissolved Oxygen | No adverse effects anticipated | — | No adverse effects anticipated | — | Assumed similar to water temperature. |
| | Toxicity from Contaminants | No adverse effects anticipated | — | No adverse effects anticipated | — | Adult migration does not overlap main period of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Water Temperature | No adverse effects anticipated | — | No adverse effects anticipated | — | No biologically meaningful effects of Sites based on quantitative modeling (HEC-5Q). |
| Clean Gravel for Spawning Substrate | Spawning Habitat | Adverse | Minimize/compensate: Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; Drought Actions<br>Exacerbate: SRSC Diversion Spring Delays and Shifting; Shasta Operations Team (SHOT) Water Transfer Timing Approvals | No adverse effects anticipated | — | Weighted usable area quantitative analyses show limited effects of Sites operations, with minor increases to the stressor tending to occur in April-June and minor decreases to the stressor tending to occur in July. |
| River Flows for Spawning, Incubation, Fry Development and Emergence, and Downstream Transport of Juveniles | Spawning Habitat | Adverse | Minimize/compensate: Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; Drought Actions<br>Exacerbate: SRSC Diversion Spring Delays and Shifting; Shasta Operations Team (SHOT) Water Transfer Timing Approvals | No adverse effects anticipated | — | Weighted usable area quantitative analyses show limited effects of Sites operations, with minor increases to the stressor tending to occur in April-June and minor decreases to the stressor tending to occur in July. |
| | Redd Quality | No adverse effects anticipated | Minimize/compensate: SHOT Water Transfer Timing Approvals<br>Exacerbate: Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; SRSC Diversion Spring Delays and Shifting; Minimum Refuge Summer Deliveries North of Delta; Drought Actions | No adverse effects anticipated | Minimize/compensate: Coordination with CVP | Assumed in consideration of other stressors (in particular water temperature) and quantitative modeling showing no anticipated change to redd scour/entombment as a result of Sites. |
| | Redd Stranding and Dewatering | Adverse | Minimize/compensate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance<br>Exacerbate: SHOT Water Transfer Timing Approvals | No adverse effects anticipated | Minimize/compensate: Coordination with CVP | Quantitative modeling shows Sites reducing redd dewatering during most water year types in June-September and July-October. |
| | Stranding Risk | Adverse | Minimize/compensate: Minimum Instream Flows; | No adverse effects | Minimize/compensate: Coordination with | Quantitative modeling shows a potential beneficial effect of |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Ramping Rates | anticipated | CVP | Sites in reducing the stranding risk stressor during July-October of some water year types. |
| | Outmigration Cues | Adverse | Minimize/compensate: Minimum Instream Flows; SRSC Diversion Spring Delays and Shifting<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Shasta Reservoir Water Temperature and Storage Management; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; Drought Actions; SHOT Water Transfer Timing Approvals | Adverse | Minimize/compensate: Diversion criteria | Sites diversions would reduce outmigration flows for juveniles in the Sacramento River and the Delta, to be minimized with diversion criteria (Bend Bridge Pulse Protection and Minimum Bypass Flows in the Sacramento River at Wilkins Slough); quantitative modeling (e.g., STARS spreadsheet; river migration flow-survival analysis) suggests effects would be limited. Adaptive management would be utilized to assess and if necessary refine operations and diversion criteria based on biological monitoring. |
| | Entrainment Risk | Adverse | Minimize/compensate: SRSC Transfer Delays; Delta Cross Channel Gate Closure; Winter-Run Chinook Salmon Early Season Salvage Threshold; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Winter-Run 50% Annual Loss Threshold; Winter-Run 75% Annual Loss Threshold; Winter-Run Weekly Loss Thresholds; Winter and Spring Delta Outflows; Salvage Facilities<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; SHOT Water Transfer Timing Approvals; Reduced Wilkins Slough Minimum Flows; Drought Actions | No adverse effects anticipated (Delta); adverse (Sacramento River) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; diversion criteria | South Delta exports during the main period of juvenile entrainment risk would not be changed as a result of Sites operations, as indicated by quantitative modeling (salvage-density method). Diversion criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment. Entrainment risk at the Red Bluff and Hamilton City intakes would not change because juveniles small enough to be entrained would not temporally overlap the Sites diversion period. There is the potential for other near-field negative effects such as impingement, which would be minimized by the fish screens meeting agency criteria, with monitoring in addition to long-term hydraulic evaluations of screen performance. |
| Water Temperatures between 42.5 and 57.5°F for Spawning, Incubation, and Fry Development | Water Temperature | Primarily no adverse effects anticipated | Minimize/compensate: Shasta Reservoir Water Temperature and Storage Management; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; SRSC Diversion Spring Delays and Shifting; Drought Actions<br>Exacerbate: Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Adult Migration and Holding Water Temperature Objectives; SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool); SHOT Water Transfer Timing Approvals (Denials that precludes water transfers) | No adverse effects anticipated | Minimize/compensate: Coordination with CVP | Few biologically meaningful effects of Sites based on quantitative modeling (HEC-5Q) for spawning adults. Quantitative modeling (HEC-5Q; Anderson and Martin models) shows reduction in water temperature and egg mortality in critically dry years as a result of Sites operations in coordination with CVP, benefiting egg incubation/fry in August/September/October. |
| Habitat and Adequate Prey that are not Contaminated | Toxicity from Contaminants | No adverse effects anticipated | — | Adverse | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2, although juvenile rearing and outmigration generally would be outside the main period of reservoir releases; other life stages would be upstream of potential reservoir release influence or not |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Yolo Bypass | temporally overlapping main period of reservoir releases. |
| Riparian Habitat for Juvenile Development and Survival | Refuge Habitat | No adverse effects anticipated (more seaward end of Delta); adverse (Sacramento River and more landward end of Delta) | Minimize/compensate: Minimum Instream Flows; SRSC Transfer Delays<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Reduced Wilkins Slough Minimum Flows; SHOT Water Transfer Timing Approvals; Drought Actions | No adverse effects anticipated (more seaward end of Delta); adverse (Sacramento River and more landward end of Delta) | Minimize/compensate: Diversion criteria | Sites diversions would reduce flow-inundated habitat in the Sacramento River and more landward end of the Delta, which would be limited by diversion criteria. |
| | Food Availability and Quality | No adverse effects anticipated (more seaward end of Delta); adverse (Sacramento River and more landward end of Delta) | Minimize/compensate: Minimum Instream Flows; SRSC Transfer Delays<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Reduced Wilkins Slough Minimum Flows; SHOT Water Transfer Timing Approvals; Drought Actions | No adverse effects anticipated (more seaward end of Delta); adverse (Sacramento River and more landward end of Delta) | Minimize/compensate: Diversion criteria | Sites diversions could reduce food, assuming similar effects as to decreases in refuge habitat. |
| Access Downstream for Juvenile Migration to San Francisco Bay and the Pacific Ocean | Entrainment Risk | Adverse | Minimize/compensate: SRSC Transfer Delays; Delta Cross Channel Gate Closure; Winter-Run Chinook Salmon Early Season Salvage Threshold; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Winter-Run 50% Annual Loss Threshold; Winter-Run 75% Annual Loss Threshold; Winter-Run Weekly Loss Thresholds; Winter and Spring Delta Outflows; Salvage Facilities<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; SHOT Water Transfer Timing Approvals; Reduced Wilkins Slough Minimum Flows; Drought Actions | No adverse effects anticipated (Delta); adverse (Sacramento River) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria | South Delta exports during the main period of juvenile entrainment risk would not be changed as a result of Sites operations, as indicated by quantitative modeling (salvage-density method). Entrainment risk at the Red Bluff and Hamilton City intakes would not change because juveniles small enough to be entrained would not temporally overlap the Sites diversion period. There is the potential for other near-field negative effects such as impingement, which would be minimized by the fish screens meeting agency criteria, with monitoring in addition to long-term hydraulic evaluations of screen performance. |

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## 7A.4.2 Central Valley Spring-Run Chinook Salmon

Chapter 6 discusses the status of Central Valley spring-run Chinook Salmon, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. Summaries of the effects analysis for effects on the species and its critical habitat are provided in Tables SR1_Sites and SR2_Sites. A qualitative analysis was conducted to provide a programmatic summary of the effects of Sites for the species life stages, critical habitat physical and biological features, and stressors discussed for the Proposed Action (Tables SR1_Sites and SR2_Sites)[8]. The analysis of Sites was based on information in the administrative draft Sites BA and FEIR/S, which includes consideration of various quantitative and qualitative analyses.

As illustrated in Tables SR1_Sites and SR2_Sites, the principal potential effects of Sites in addition to the Proposed Action would be reduction in early life stage water temperature stressors through coordination of operations with CVP, in addition to potential increases in stressors such as outmigration cues and refuge habitat because of diversions to Sites Reservoir during winter/spring. Life cycle modeling described in Chapter 6 for the Proposed Action with the CVPIA spring-run Chinook salmon life cycle model suggested generally similar adult spawner abundance population change for Proposed Action phases compared to the No Action Alternative. Spring-run Chinook salmon life cycle modeling has not been undertaken for Sites, although the relatively limited nature of effects (Table 7A-14) and available life cycle modeling for winter-run Chinook salmon (see Section 7A.4.1) suggests that there would be little effect of Sites evident from such modeling.

As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of Sites would be avoided, minimized, and offset. Guiding principles relevant to spring-run Chinook salmon include:

- Upper Sacramento River
  - Utilize the additional water supply provided by the Sites Project to address adverse effects of the CVP on salmonid and sturgeon habitat in the Sacramento River above the Red Bluff Pumping Plant by:
    - Optimizing the use of Reclamation's storage to facilitate the following:
      - Enhancing conservation of the cold-water pool in Shasta Lake for use in managing temperatures in salmonid spawning habitat downstream of Keswick Dam particularly in dry water year types;
      - Enhancing pulse flows envisioned in the biological assessment at appropriate times, particularly in years when natural pulse events are minimal, to stimulate migration of juvenile salmon downstream toward the Delta; and
      - Stabilizing flow to minimize or preclude losses of salmon redds due to flow fluctuations associated with management of Shasta Lake for fall storage.
    - Implementing additional mitigation actions as necessary and appropriate to,maintain and/or improve spawning and rearing habitat for anadromous fish in the Upper Sacramento River.
    - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions.

[8] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

- Sacramento River from Red Bluff Pumping Plant to Knights Landing
  - Implement actions necessary to minimize potential impacts to listed species exposed to diversion facilities.
  - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions.
  - Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
  - Find opportunities to develop and/or restore additional side channel habitat and/or salmonid rearing habitat to offset adverse effects to salmonid migratory and rearing habitat associated with diversions of flow to Sites Reservoir.
- Below Knights Landing and in the Delta
  - Operate projects consistent with existing and/or future regulatory requirements in the Delta.
  - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.
  - Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
  - Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to maintain and/or improve productivity of those fish populations.
  - Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to maintain and/or improve productivity of those fish populations.
  - Cooperate in the monitoring of the Fremont Weir Big Notch Project to assess what effect, if any, diversions of flow to Sites Reservoir have on the effectiveness of the Big Notch Project's ability to achieve its juvenile entrainment and adult passage performance goals for salmonids in the Sacramento River If necessary, implement operational measures to avoid diminishing the performance of the Big Notch Project.

As described in Chapter 3, Sites has an adaptive management program which would integrate with the adaptive management program for the Proposed Action and includes a number of general principles such as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

**Table 7A-14. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Central Valley Spring-Run Chinook Salmon**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Adult Migration | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river flows from Sites operations that suggest in-river fishing or poaching would change. |
| | Stranding Risk | Not anticipated to change | — | Increase (discountable/insignificant) | — | Quantitative modeling showed limited effects of Sites diversion operations on number of days meeting adult upstream passage criteria at Fremont Weir and Colusa Weir. |
| | Dissolved Oxygen | Decrease (discountable/insignificant) | — | Not anticipated to change | — | Assumed similar to water temperature. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Adult migration does not overlap main period of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Water Temperature | Decrease (discountable/insignificant) | — | Not anticipated to change | — | No biologically meaningful effects of Sites based on quantitative modeling (HEC-5Q; Reclamation Temperature Model). |
| | Pathogens and Disease | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Assumed similar to water temperature. |
| Adult Holding and Spawning | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river flows from Sites operations that suggest in-river fishing or poaching would change. |
| | Competition, Introgression, and Broodstock Removal | Not anticipated to change | — | Not anticipated to change | — | There is no mechanism to Sites operations that suggests a change would occur in the influence of hatchery-origin fish on natural-origin fish. |
| | Toxicity from Contaminants | Decrease (discountable/insignificant) | — | Not anticipated to change | — | Adult holding and spawning is upstream of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Dissolved Oxygen | Decrease (discountable/insignificant) | — | Decrease (Sacramento River; discountable/insignificant); not anticipated to change (Feather River) | — | Assumed similar trend to water temperature but to lesser degree because of lack of specific information. |
| | Spawning Habitat | Increase (lethal; proportion: low) | Minimize/compensate: Sacramento River: Minimum Instream Flow; Fall and Winter Base Flows for Redd | Increase or decrease (discountable/insignificant) | — | Weighted usable area quantitative analyses show |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Maintenance; SRSC Rice Decomposition Smoothing. Clear Creek: Minimum Instream Flows, Segregation Weir. Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill. | | | limited effects of Sites operations. |
| | Water Temperature | Decrease (beneficial; proportion: likely large; frequency: high); increase (sublethal; proportion: small; frequency: low) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives; Shasta Reservoir Water Temperature and Storage Management. Clear Creek: Water Temperature Management. Exacerbate: Drought Tool Kit Warmwater Bypass; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; SHOT Determination on Temperature Shoulders (requiring too cold releases too early and exhausting the coldwater pool). | Decrease (Sacramento River; beneficial; proportion: small; frequency: medium); not anticipated to change (Feather River) | Minimize/compensate: Coordination with CVP | Quantitative modeling (HEC-5Q) shows reduction in biologically meaningful effects in the Sacramento River with Sites coordination with CVP; no changes in the Feather River (Reclamation Temperature Model). |
| | Pathogens and Disease | Decrease (beneficial; proportion: large; frequency: high); increase (sub-lethal; proportion: small; frequency: low) | Minimize/compensate: Adult Migration and Holding Water Temperature Objectives | Decrease (Sacramento River; discountable/insignificant); not anticipated to change (Feather River) | — | Assumed similar trend to water temperature but to lesser degree because of lack of specific information. |
| Egg Incubation and Fry Emergence | In-River Fishery or Trampling | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to flow as a result of Sites operations that would be expected to result in changes to the in-river fishery or trampling. |
| | Predation Risk | Not anticipated to change | — | Decrease (Sacramento River; discountable/insignificant); not anticipated to change (Feather River) | — | Water temperature in the Sacramento River would decrease as a result of Sites operations in coordination with CVP (see discussion for Water Temperature below), which could result in a decrease in predation risk given general decrease in predator metabolic demand with decreasing temperature; assumed such changes would be to a lesser degree because of a lack of specific information. |
| | Toxicity from Contaminants | Decrease (discountable/insignificant) | — | Not anticipated to change | — | Egg incubation and fry emergence is upstream of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Dissolved Oxygen | Decrease (discountable/insignificant) | — | Decrease (Sacramento River; discountable/insignificant); not anticipated to change (Feather River) | — | Assumed similar trend to water temperature but to lesser degree because of lack of specific information. |
| | Pathogens and Disease | Increase or Decrease (discountable/insignificant) | — | Decrease (Sacramento River; discountable/insignificant); not anticipated to change | — | Assumed similar trend to water temperature but to lesser degree because of lack |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | (Feather River) | | of specific information. |
| | Sedimentation and Gravel Quantity | Decrease (discountable/insignificant) | — | Decrease (Sacramento River; discountable/insignificant); not anticipated to change (Feather River) | — | Increased flow associated with lower temperature (see discussion below for Water Temperature) could decrease sedimentation but there is no quantitative analysis available to inform the extent; Sites does not include any gravel augmentation and there are limited effects on spawning habitat (see above discussion of Spawning Habitat for Adult Holding and Spawning). |
| | Redd Stranding and Dewatering | Increase (lethal; proportion: likely small; frequency: high) | Minimize/compensate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Minimum Instream Flows. Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill; SRSC Transfer Delays | Decrease or increase (Sacramento River; discountable/insignificant); not anticipated to change (Feather River) | — | Quantitative modeling shows Sites increasing or reducing redd dewatering in the Sacramento to a minor extent. |
| | Redd Quality | Decrease (beneficial; proportion: medium; frequency: large) | Minimize/compensate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; SRSC Transfer Delayed Timing. Clear Creek: Minimum Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill; SHOT Water Transfer Timing Approvals | Decrease (Sacramento River; beneficial; proportion: small; frequency: medium); not anticipated to change (Feather River) | Minimize/compensate: Coordination with CVP | Assumed in consideration of other stressors (in particular water temperature) and quantitative modeling showing no anticipated change to redd scour/entombment as a result of Sites. |
| | Water Temperature | Decrease (beneficial; proportion: medium; frequency: medium to high); increase (lethal; proportion: medium; frequency: low) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Water Temperature Management<br>Exacerbate: Sacramento River:<br>SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool); Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows | Decrease (Sacramento River; beneficial; proportion: small; frequency: medium); not anticipated to change (Feather River) | Minimize/compensate: Coordination with CVP | Quantitative modeling (HEC-5Q) shows reduction in biologically meaningful effects in the Sacramento River with Sites coordination with CVP; no changes in the Feather River (Reclamation Temperature Model). |
| Juvenile Rearing and Outmigration | Pathogens and Disease | Increase (discountable/insignificant) | — | Not anticipated to change (Delta; Feather River); increase or decrease (Sacramento River; sub-lethal or beneficial; proportion: small; frequency: medium) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; coordination with CVP. | Operations-related effects on water temperature in the Delta are minimal, with water temperature noted as a key driver of pathogens/disease (Chapter 6). There are no temperature-related differences in the Feather River that would suggest an increase or decrease in this stressor. There is small potential for injury leading to disease from juveniles contacting the Red Bluff and Hamilton City fish screens, |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | minimized by screen design (smooth screen face; cleaning system) and operating criteria (e.g., approach velocity). At the broad scale, beneficial effects could occur as a result of lower water temperature (see discussion of Water Temperature stressor below). |
| | Toxicity from Contaminants | Increase (discountable/insignificant) | — | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2, although juvenile rearing and outmigration generally would be outside the main period of reservoir releases. |
| | Predation and Competition | Increase (discountable/insignificant) | — | Increase (discountable/insignificant) | — | Available studies suggest there would be limited effects of Sites diversions on predation risk at the Red Bluff and Hamilton City intakes; uncertainty would be addressed with technical studies of predator density and distribution. |
| | Stranding Risk | Increase (lethal; proportion: medium [Sacramento River], low [Clear Creek]; frequency: high [Sacramento River], low [Clear Creek]) | Minimize/compensate: Minimum Instream Flows; Ramping Rates | Increase or decrease (discountable/insignificant) | — | Quantitative modeling suggests small increases in juvenile stranding risk in the Sacramento River at Keswick and Clear Creek, with small reductions at Battle Creek; substantial effects would not occur. |
| | Outmigration Cues | Increase (lethal; proportion: large [Sacramento River], medium [Clear Creek]; frequency: low [Sacramento River and Clear Creek]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Ramping Rates; Clear Creek: Minimum Instream Flows; Spring Pulse Flows; Ramping Rates<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: Diversion criteria | Sites diversions would reduce outmigration flows for juveniles in the Sacramento River and the Delta, to be minimized with diversion criteria (Bend Bridge Pulse Protection and Minimum Bypass Flows in the Sacramento River at Wilkins Slough); quantitative modeling (e.g., STARS spreadsheet; river migration |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | flow-survival analysis) suggests effects would be limited. Adaptive management would be utilized to assess and if necessary, refine diversion criteria and/or operations based on biological monitoring. |
| | Entrainment Risk | Not anticipated to change (Clear Creek); increase (Delta; lethal; proportion: small; frequency: high) | Minimize/compensate: Delta Cross Channel Gate Closure; Winter-Run Chinook Salmon Early Season Salvage Threshold; January 1 and Start of OMR Management; Spring-run Chinook Salamon and Surrogate Thresholds; Winter-Run Weekly Loss Thresholds; Winter and Spring Delta Outflows; Salvage Facilities | Not anticipated to change (Delta); increase (Sacramento River; sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; diversion criteria | South Delta exports during the main period of juvenile entrainment risk would not be changed as a result of Sites operations, as indicated by quantitative modeling (salvage-density method). Diversion criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment. Entrainment risk at the Red Bluff and Hamilton City intakes would not appreciably change because juveniles small enough to be entrained would only have little temporal overlap with the Sites diversion period. There is the potential for other near-field negative effects such as impingement, which would be minimized by the fish screens meeting agency criteria, with monitoring in addition to long-term hydraulic evaluations of screen performance. |
| | Refuge Habitat | Not anticipated to change (more seaward end of Delta); increase (Sacramento River, Clear Creek, and more landward end of Delta; sub-lethal; proportion: large; frequency: low [Sacramento River and more landward end of Delta], medium [Clear Creek]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Not anticipated to change (more seaward end of Delta); increase (Sacramento River downstream of Sites intakes, Yolo Bypass, more landward end of the Delta; proportion: medium; frequency: medium); decrease (Sacramento River upstream of Sites intakes; beneficial; proportion: small; frequency: medium) | Minimize/compensate: Diversion criteria; coordination with CVP. | Quantitative modeling indicates that Sites diversions would increase or reduce flow-inundated habitat in the Sacramento River, Yolo Bypass, and more landward end of the Delta, which would be limited by diversion criteria. |
| | Food Availability and Quality | Not anticipated to change (more seaward end of Delta); increase (Sacramento River, Clear Creek, and more landward end of Delta; sub-lethal; proportion: large; frequency: low [Sacramento River and more | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows | Not anticipated to change (more seaward end of Delta); increase (Sacramento River downstream of Sites intakes, | Minimize/compensate: Diversion criteria; coordination with CVP. | Sites diversions could affect food, assuming similar effects as to changes in refuge habitat. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | landward end of Delta], medium [Clear Creek]) | Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Yolo Bypass, more landward end of the Delta; proportion: medium; frequency: medium); decrease (Sacramento River upstream of Sites intakes; beneficial; proportion: small; frequency: medium) | | |
| | Water Temperature and Dissolved Oxygen | Not anticipated to change (Delta); decrease or increase (Sacramento River and Clear Creek; beneficial or sub-lethal/lethal; proportion: medium to large; frequency: high) | Minimize/compensate: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management (preserve cold water)<br>Exacerbate: SHOT Water Transfer Timing Approvals (denial of water transfers); SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool) | Decrease (Sacramento River; beneficial; proportion: small; frequency: medium); not anticipated to change (Feather River and Delta) | Minimize/compensate: Coordination with CVP | Quantitative modeling (HEC-5Q) shows reduction in biologically meaningful temperature effects in the Sacramento River with Sites coordination with CVP; no changes in the Feather River (Reclamation Temperature Model). Operations-related effects on water temperature in the Delta are minimal. Dissolved oxygen effects may be less than temperature effects. |
| Yearling Rearing | Pathogens and Disease | Decrease (discountable/insignificant) | — | Not anticipated to change | — | Sites would not affect operations in yearling natal tributaries where rearing occurs. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Sites would not affect operations in yearling natal tributaries where rearing occurs. |
| | Predation and Competition | Increase (discountable/insignificant) | — | Not anticipated to change | — | Sites would not affect operations in yearling natal tributaries where rearing occurs. |
| | Stranding Risk | Decrease (beneficial; proportion: small; frequency: low) | Minimize/compensate: Sacramento River and Clear Creek: Minimum Instream Flows; Ramping Rates | Not anticipated to change | — | Sites would not affect operations in yearling natal tributaries where rearing occurs. |
| | Refuge Habitat | Increase (sub-lethal; proportion: small; frequency: medium) or decrease (beneficial) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; SRSC Diversion Spring Delays and Shifting; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta | Not anticipated to change | — | Sites would not affect operations in yearling natal tributaries where rearing occurs. |
| | Food Availability and Quality | Increase (sub-lethal; proportion: small; frequency: medium) or decrease (beneficial) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Minimum Instream Flows | Not anticipated to change | — | Sites would not affect operations in yearling natal |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; SRSC Diversion Spring Delays and Shifting; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta | | | tributaries where rearing occurs. |
| | Water Temperature and Dissolved Oxygen | Decrease (beneficial; proportion: low; frequency: high) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winer Base Flows for Shasta Reservoir Redd Maintenance; Shasta Reservoir Water Temperature and Storage Management; Clear Creek: Minimum Instream Flow; Water Temperature Management<br>Exacerbate: Sacramento River: Shasta Reservoir Water Temperature Storage Management | Not anticipated to change | — | Sites would not affect operations in yearling natal tributaries where rearing occurs. |
| Yearling Outmigration | Pathogens and Disease | Increase or decrease (discountable/insignificant) | — | Not anticipated to change (Delta); increase or decrease (Sacramento River; sub-lethal or beneficial; proportion: small; frequency: medium) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; coordination with CVP. | Operations-related effects on water temperature in the Delta are minimal, with water temperature noted as a key driver of pathogens/disease (Chapter 6). There is small potential for injury leading to disease from yearlings contacting the Red Bluff and Hamilton City fish screens, minimized by screen design (smooth screen face; cleaning system) and operating criteria (e.g., approach velocity). At the broad scale, beneficial effects could occur as a result of lower water temperature (see discussion of Water Temperature stressor below). |
| | Toxicity from Contaminants | Increase (discountable/insignificant) | — | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2, although yearling outmigration generally would be outside the main period of reservoir releases. |
| | Predation and Competition | Increase (discountable/insignificant) | — | Increase (discountable/insignificant) | — | Available studies suggest there would be limited effects of Sites diversions on predation risk at the Red Bluff |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | and Hamilton City intakes; uncertainty would be addressed with technical studies of predator density and distribution. |
| | Stranding Risk | Not anticipated to change (Delta); increase (Sacramento River; lethal; proportion: small; frequency: high) | Minimize/compensate: Sacramento River and Clear Creek: Minimum Instream Flows; Ramping Rates | Not anticipated to change | — | Yearlings are unlikely to be stranded given small differences noted for juveniles (see discussion for Juvenile Rearing and Outmigration above). |
| | Outmigration Cues | Increase (lethal; proportion: large; frequency: low) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: Diversion criteria | Sites diversions would reduce outmigration flows for juveniles in the Sacramento River and the Delta, to be minimized with diversion criteria (Bend Bridge Pulse Protection and Minimum Bypass Flows in the Sacramento River at Wilkins Slough); quantitative modeling (e.g., STARS spreadsheet; river migration flow-survival analysis) suggests effects would be limited. Adaptive management would be utilized to assess and if necessary refine diversion criteria and/or operations based on biological monitoring. |
| | Entrainment Risk | Increase (lethal; proportion: small; frequency: high) | Minimize/compensate: Delta Cross Channel Gate Closure; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Spring-run Chinook Salamon and Surrogate Thresholds; Winter and Spring Delta Outflows; Salvage Facilities<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Drought Actions | Not anticipated to change (Delta); increase (Sacramento River; sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; diversion criteria | Yearling outmigration through the Delta would not overlap the period of increase south Delta exports of Sites Reservoir water. Diversion criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment. Entrainment risk at the Red Bluff and Hamilton City intakes would not change because yearlings would be screened. There is the potential for other near-field negative effects such as impingement, which would be minimized by the fish screens meeting agency criteria, with monitoring in addition to |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | long-term hydraulic evaluations of screen performance. |
| | Refuge Habitat | Increase (Sacramento River; sub-lethal; proportion: large; frequency: low); not anticipated to change (Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Not anticipated to change (more seaward end of Delta); increase (more landward end of Delta and Sacramento River/Yolo Bypass; proportion: low; frequency: medium) | Minimize/compensate: Diversion criteria | General decrease in flow because of Sites diversions, quantitative modeling shows decrease in Yolo Bypass habitat area. |
| | Food Availability and Quality | Increase (Sacramento River and more landward end of the Delta; sub-lethal; proportion: large; frequency: low [Sacramento River], high [Delta]); not anticipated to change (more seaward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Not anticipated to change (more seaward end of Delta); increase (more landward end of Delta and Sacramento River/Yolo Bypass; proportion: low; frequency: medium) | Minimize/compensate: Diversion criteria | Sites diversions could affect food, assuming similar effects as to changes in refuge habitat. |
| | Water Temperature and Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change (Delta); decrease (Sacramento River; proportion: low; frequency: medium) | Minimize/compensate: Coordination with CVP | Operations-related effects on water temperature in the Delta are minimal. Quantitative modeling (HEC-5Q) shows reduction in Sacramento River water temperature in critically dry years as a result of Sites operations in coordination with CVP. Dissolved oxygen assumed to follow similar pattern to temperature. |

**Table 7A-15. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Central Valley Spring-Run Chinook Salmon Critical Habitat**

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Freshwater Spawning Sites | Spawning Habitat | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flow; Fall and Winter Base Flows for Redd Maintenance; SRSC Rice Decomposition Smoothing. Clear Creek: Minimum Instream Flows, Segregation Weir. Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill. | No adverse effects anticipated | — | Weighted usable area quantitative analyses show limited effects of Sites operations. |
| | Redd Quality (clean spawning gravel) | Decrease (beneficial; proportion: medium; frequency: large) | Minimize/compensate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; SRSC Transfer Delayed Timing. Clear Creek: Minimum Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill; SHOT Water Transfer Timing Approvals | No adverse effects anticipated | Minimize/compensate: Coordination with CVP | Assumed in consideration of other stressors (in particular water temperature) and quantitative modeling showing no anticipated change to redd scour/entombment as a result of Sites. |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Redd Stranding and Dewatering | Increase (lethal; proportion: likely small; frequency: high) | Minimize/compensate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Minimum Instream Flows. Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill; SRSC Transfer Delays | No adverse effects anticipated | — | Quantitative modeling shows Sites increasing or reducing redd dewatering in the Sacramento to a minor extent. |
| | Water Temperature | No adverse effects anticipated | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Water Temperature Management<br>Exacerbate: Sacramento River:<br>SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool); Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows | No adverse effects anticipated | Minimize/compensate: Coordination with CVP | Quantitative modeling (HEC-5Q) shows reduction in biologically meaningful effects in the Sacramento River with Sites coordination with CVP; no changes in the Feather River (Reclamation Temperature Model). |
| Freshwater Rearing Sites | Refuge habitat (juvenile) | No adverse effects anticipated (more seaward end of the Delta); adverse (Sacramento River, Clear Creek, and more landward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Adverse (Sacramento River downstream of Sites intakes; Yolo Bypass; more landward end of the Delta); no adverse effects anticipated (Sacramento River upstream of Sites diversions; more seaward end of the Delta) | Minimize/compensate: Diversion criteria; coordination with CVP | Quantitative modeling indicates that Sites diversions would increase or reduce flow-inundated habitat in the Sacramento River, Yolo Bypass, or more landward end of the Delta, which would be limited by diversion criteria and coordination with CVP. |
| | Refuge habitat (yearling) | Adverse or no adverse effects anticipated | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; SRSC Diversion Spring Delays and Shifting; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta | No adverse effects anticipated | — | Sites would not affect operations in yearling natal tributaries where rearing occurs. |
| | Food Availability and Quality (juvenile) | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Adverse (Sacramento River downstream of Sites intakes; Yolo Bypass; more landward end of the Delta); no adverse effects anticipated (Sacramento River upstream of Sites diversions; more seaward end of the Delta) | Minimize/compensate: Diversion criteria; coordination with CVP | Sites diversions could affect food, assuming similar effects as to decreases in refuge habitat. |
| | Food Availability and Quality (yearling) | Adverse or no adverse effects anticipated | Minimize/compensate: Sacramento River: Minimum Instream Flows; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; SRSC Diversion Spring Delays and Shifting; Allocation Reductions for Shasta Reservoir End of September Storage; | No adverse effects anticipated | — | Sites would not affect operations in yearling natal tributaries where rearing occurs. |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta | | | |
| | Stranding Risk (juvenile) | No adverse effects anticipated | — | No adverse effects anticipated | — | Quantitative modeling suggests small increases in juvenile stranding risk in the Sacramento at Keswick and Clear Creek, with small reductions at Battle Creek; substantial effects would not occur. |
| | Stranding Risk (yearling) | No adverse effects anticipated | — | No adverse effects anticipated | — | Sites would not affect operations in yearling natal tributaries where rearing occurs. |
| | Water Temperature and Dissolved Oxygen (juvenile) | Adverse or no adverse effects anticipated | Minimize/compensate: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management (preserve cold water)<br>Exacerbate: SHOT Water Transfer Timing Approvals (denial of water transfers); SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool) | No adverse effects anticipated | Minimize/compensate: Coordination with CVP | Quantitative modeling (HEC-5Q) shows reduction in biologically meaningful temperature effects in the Sacramento River with Sites coordination with CVP; no changes in the Feather River (Reclamation Temperature Model). Operations-related effects on water temperature in the Delta are minimal. Dissolved oxygen effects may be less than temperature effects. |
| | Water Temperature and Dissolved Oxygen (yearling) | No adverse effects anticipated | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winer Base Flows for Shasta Reservoir Redd Maintenance; Shasta Reservoir Water Temperature and Storage Management; Clear Creek: Minimum Instream Flow; Water Temperature Management<br>Exacerbate: Sacramento River: Shasta Reservoir Water Temperature Storage Management | No adverse effects anticipated | — | Sites would not affect operations in yearling natal tributaries where rearing occurs. |
| Freshwater Migration Corridors | Outmigration Cues (juvenile) | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Adverse | Minimize/compensate: Diversion criteria | Sites diversions would reduce outmigration flows for juveniles in the Sacramento River and the Delta, to be minimized with diversion criteria (Bend Bridge Pulse Protection and Minimum Bypass Flows in the Sacramento River at Wilkins Slough); quantitative modeling (e.g., STARS spreadsheet; river migration flow-survival analysis) suggests effects would be limited. Adaptive management would be utilized to assess and if necessary refine diversion criteria and/or operations based on biological monitoring. |
| | Outmigration Cues (yearling) | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Adverse | Minimize/compensate: Diversion criteria | Sites diversions would reduce outmigration flows for juveniles in the Sacramento River and the Delta, to be minimized with diversion criteria (Bend Bridge Pulse Protection and Minimum Bypass Flows in the Sacramento River at Wilkins Slough); quantitative modeling (e.g., STARS spreadsheet; river migration flow-survival analysis) suggests effects would be limited. Adaptive management would be utilized to assess and if necessary refine diversion criteria and/or operations based on biological monitoring. |
| | Refuge Habitat (juvenile) | Adverse (Sacramento River and more landward end of the Delta); no adverse effects anticipated (more seaward end | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows | No adverse effects anticipated (more seaward end of Delta); adverse (more landward end of Delta and Sacramento River/Yolo | Minimize/compensate: Diversion criteria; coordination with CVP. | Quantitative modeling indicates that Sites diversions would increase or reduce flow-inundated habitat in the Sacramento River, Yolo Bypass, and more landward end of the Delta, which would be limited by diversion |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | of the Delta) | Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Bypass) | | criteria. |
| | Refuge Habitat (yearling) | Adverse (Sacramento River); no adverse effects anticipated (Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | No adverse effects anticipated (more seaward end of Delta); adverse (more landward end of Delta and Sacramento River/Yolo Bypass) | Minimize/compensate: Diversion criteria | General decrease in flow because of Sites diversions, quantitative modeling shows decrease in Yolo Bypass habitat area. |
| | Food Availability and Quality (juvenile) | Adverse (Sacramento River and more landward end of the Delta); no adverse effects anticipated (more seaward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | No adverse effects anticipated (more seaward end of Delta); adverse (more landward end of Delta and Sacramento River/Yolo Bypass) | Minimize/compensate: Diversion criteria; coordination with CVP. | Sites diversions could affect food, assuming similar effects as to decreases in refuge habitat. |
| | Food Availability and Quality (yearling) | Adverse (Sacramento River and more landward end of the Delta); no adverse effects anticipated (more seaward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | No adverse effects anticipated (more seaward end of Delta); adverse (more landward end of Delta and Sacramento River/Yolo Bypass) | Minimize/compensate: Diversion criteria | Sites diversions could affect food, assuming similar effects as to decreases in refuge habitat. |
| | Entrainment Risk (juvenile) | Adverse | Minimize/compensate: Delta Cross Channel Gate Closure; Winter-Run Chinook Salmon Early Season Salvage Threshold; January 1 and Start of OMR Management; Spring-run Chinook Salamon and Surrogate Thresholds; Winter-Run Weekly Loss Thresholds; Winter and Spring Delta Outflows; Salvage Facilities | No adverse effects anticipated (Delta); adverse (Sacramento River) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; diversion criteria | South Delta exports during the main period of juvenile entrainment risk would not be changed as a result of Sites operations, as indicated by quantitative modeling (salvage-density method). Diversion criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment. Entrainment risk at the Red Bluff and Hamilton City intakes would not appreciably change because juveniles small enough to be entrained would only have little temporal overlap with the Sites diversion period. There is the potential for other near-field negative effects such as impingement, which would be minimized by the fish screens meeting agency criteria, with monitoring in addition to long-term hydraulic evaluations of screen performance. |
| | Entrainment Risk (yearling) | Adverse | Minimize/compensate: Delta Cross Channel Gate Closure; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Spring-run Chinook Salamon and Surrogate Thresholds; Winter and Spring Delta Outflows; Salvage Facilities<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Drought Actions | No adverse effects anticipated (Delta); adverse (Sacramento River) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; diversion criteria | Yearling outmigration through the Delta would not overlap the period of increase south Delta exports of Sites Reservoir water. Diversion criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment. Entrainment risk at the Red Bluff and Hamilton City intakes would not change because yearlings would be screened. There |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | is the potential for other near-field negative effects such as impingement, which would be minimized by the fish screens meeting agency criteria, with monitoring in addition to long-term hydraulic evaluations of screen performance. |
| Estuarine Areas | Outmigration Cues (juvenile) | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Adverse | Minimize/compensate: Diversion criteria | Sites diversions would reduce outmigration flows for juveniles in the Sacramento River and the Delta, to be minimized with diversion criteria (Bend Bridge Pulse Protection and Minimum Bypass Flows in the Sacramento River at Wilkins Slough); quantitative modeling (e.g., STARS spreadsheet) suggests effects would be limited. Adaptive management would be utilized to assess and if necessary refine diversion criteria and/or operations based on biological monitoring. |
| | Outmigration Cues (yearling) | Adverse | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Adverse | Minimize/compensate: Diversion criteria | Sites diversions would reduce outmigration flows for juveniles in the Sacramento River and the Delta, to be minimized with diversion criteria (Bend Bridge Pulse Protection and Minimum Bypass Flows in the Sacramento River at Wilkins Slough); quantitative modeling (e.g., STARS spreadsheet) suggests effects would be limited. Adaptive management would be utilized to assess and if necessary refine diversion criteria and/or operations based on biological monitoring. |
| | Refuge Habitat (juvenile) | No adverse effects anticipated (more seaward end of Delta); adverse (more landward end of Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | No adverse effects anticipated (more seaward end of Delta); adverse (more landward end of Delta) | Minimize/compensate: Diversion criteria. | Quantitative modeling indicates that Sites diversions reduce flow-inundated habitat in the more landward end of the Delta, which would be limited by diversion criteria. |
| | Refuge Habitat (yearling) | No adverse effects anticipated (Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | No adverse effects anticipated (more seaward end of Delta); adverse (more landward end of Delta) | Minimize/compensate: Diversion criteria | General decrease in flow because of Sites diversions. |
| | Food Availability and Quality (juvenile) | Adverse (more landward end of the Delta); no adverse effects anticipated (more seaward end of the Delta) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | No adverse effects anticipated (more seaward end of Delta); adverse (more landward end of Delta) | Minimize/compensate: Diversion criteria; coordination with CVP. | Sites diversions could affect food, assuming similar effects as to decreases in refuge habitat. |
| | Food Availability | Adverse (more landward end | Minimize/compensate: Sacramento River: Minimum | No adverse effects anticipated | Minimize/compensate: | Sites diversions could affect food, assuming similar |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | and Quality (yearling) | of the Delta); no adverse effects anticipated (more seaward end of the Delta) | Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | (more seaward end of Delta); adverse (more landward end of Delta) | Diversion criteria | effects as to decreases in refuge habitat. |
| Nearshore Marine Areas | — | No adverse effects anticipated | — | No adverse effects anticipated | — | There would be no Sites effect on nearshore marine areas because this is outside the action area. |
| Offshore Marine Areas | — | No adverse effects anticipated | — | No adverse effects anticipated | — | There would be no Sites effect on offshore marine areas because this is outside the action area. |

### 7A.4.3 California Central Valley Steelhead

Chapter 7 discusses the status of Central Valley steelhead, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. Summaries of the effects analysis for effects on the species and its critical habitat are provided in Tables SH1_Sites and SH2_Sites. A qualitative analysis was conducted to provide a programmatic summary of the effects of Sites for the species life stages, critical habitat physical and biological features, and stressors discussed for the Proposed Action (Tables SH1_Sites and SH2_Sites)[9]. The analysis of Sites was based on information in the administrative draft Sites BA and FEIR/S, which includes consideration of various quantitative and qualitative analyses.

As illustrated in Tables SH1_Sites and SH2_Sites, the principal potential effects of Sites would be potential increases in stressors such as juvenile outmigration cues and refuge habitat because of diversions to Sites Reservoir during winter/spring. As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of Sites would be avoided, minimized, and offset. Guiding principles relevant to steelhead include:

- Upper Sacramento River
  - Utilize the additional water supply provided by the Sites Project to address adverse effects of the CVP on salmonid and sturgeon habitat in the Sacramento River above the Red Bluff Pumping Plant by:
    - Optimizing the use of Reclamation's storage to facilitate the following:
      - Enhancing conservation of the cold-water pool in Shasta Lake for use in managing temperatures in salmonid spawning habitat downstream of Keswick Dam particularly in dry water year types;
      - Enhancing pulse flows envisioned in the biological assessment at appropriate times, particularly in years when natural pulse events are minimal, to stimulate migration of juvenile salmon downstream toward the Delta; and
      - Stabilizing flow to minimize or preclude losses of salmon redds due to flow fluctuations associated with management of Shasta Lake for fall storage.
    - Implementing additional mitigation actions as necessary and appropriate to maintain and/or improve spawning and rearing habitat for anadromous fish in the Upper Sacramento River.
    - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions.
- Sacramento River from Red Bluff Pumping Plant to Knights Landing
  - Implement actions necessary to minimize potential impacts to listed species exposed to diversion facilities.
  - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions.
  - Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.

[9] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

  - Find opportunities to develop and/or restore additional side channel habitat and/or salmonid rearing habitat to offset adverse effects to salmonid migratory and rearing habitat associated with diversions of flow to Sites Reservoir.

- Below Knights Landing and in the Delta
  - Operate projects consistent with existing and/or future regulatory requirements in the Delta.
  - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.
  - Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
  - Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to maintain and/or improve productivity of those fish populations.
  - Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to maintain and/or improve productivity of those fish populations.
  - Cooperate in the monitoring of the Fremont Weir Big Notch Project to assess what effect, if any, diversions of flow to Sites Reservoir have on the effectiveness of the Big Notch Project's ability to achieve its juvenile entrainment and adult passage performance goals for salmonids in the Sacramento River. i. If necessary, implement operational measures to avoid diminishing the performance of the Big Notch Project.

As described in Chapter 3, Sites has an adaptive management program which would integrate with the adaptive management program for the Proposed Action and includes a number of general principles such as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

**Table 7A-16. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Central Valley Steelhead**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Adult Migration and Holding | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river flows from Sites operations that suggest in-river fishing or poaching would change. |
| | Stranding Risk | Not anticipated to change | — | Increase (discountable/insignificant) | — | Quantitative modeling showed limited effects of Sites diversion operations on number of days meeting adult salmon upstream passage criteria at Fremont Weir and Colusa Weir; assumed similar for steelhead. |
| | Competition, Introgression, and Broodstock Removal | Not anticipated to change | | Not anticipated to change | — | There is no mechanism to Sites operations that suggests a change would occur in the influence of hatchery-origin fish on natural-origin fish. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2. |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Decrease (Sacramento River; discountable/insignificant); not anticipated to change (Feather River; American River; Delta) | — | Assumed similar to water temperature. |
| | Water Temperature | Decrease (insignificant [Sacramento River, Clear Creek, San Joaquin River, Delta], beneficial; proportion: small [American River, Stanislaus River], frequency: medium [American River], low [Stanislaus River] | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All streams: Drought Action | Decrease (Sacramento River; discountable/insignificant); not anticipated to change (Feather River; American River; Delta) | — | Quantitative modeling (HEC-5Q) shows minor reduction in biologically meaningful effects in the Sacramento River with Sites coordination with CVP; no changes in the Feather River (Reclamation Temperature Model) or American River (HEC-5Q). Operations-related effects on water temperature in the Delta are minimal. |
| | Pathogens and Disease | Decrease (beneficial; proportion: large [Sacramento River], small [Clear Creek, Stanislaus River], medium [American River]; frequency: medium [Sacramento River, Clear | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: | Decrease (Sacramento River; discountable/insignificant); not anticipated to change (Feather River; American River; Delta) | — | Assumed similar trend to water temperature but to lesser degree because of lack of specific information. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | Creek], high [American River, Stanislaus River] | Water Temperature Management.<br>Stanislaus River: Stepped Release Plan. | | | |
| Adult Spawning | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river flows from Sites operations that suggest in-river fishing or poaching would change. |
| | Stranding Risk | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river flows from Sites operations that suggest stranding risk would change. |
| | Competition, Introgression, and Broodstock Removal | Not anticipated to change | — | Not anticipated to change | — | There is no mechanism to Sites operations that suggests a change would occur in the influence of hatchery-origin fish on natural-origin fish. |
| | Toxicity from Contaminants | Increase (discountable/insignificant) | — | Not anticipated to change | — | Adult holding and spawning is upstream of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Dissolved Oxygen | Increase (discountable/insignificant) | — | Not anticipated to change | — | Assumed similar to water temperature. |
| | Food Availability and Quality | Increase (discountable/insignificant) | | Not anticipated to change | — | Any changes in food availability or quality as a result of Sites would have limited effects on adults because most are fasting (Chapter 7). |
| | Water Temperature | Increase (sublethal; proportion: small [Sacramento River, Clear Creek, American River], medium [Stanislaus River]; frequency: high [Sacramento River, American River, Stanislaus River], low [Clear Creek]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Water Temperature Management.<br>Exacerbate: Sacramento River: Drought Tool Kit Warmwater Bypass | Not anticipated to change | — | No biologically meaningful effects of Sites based on quantitative modeling (HEC-5Q; Reclamation Temperature Model). |
| | Pathogens and Disease | Increase (sublethal; proportion: small [Sacramento River]; frequency: medium [Sacramento River]; insignificant [Clear Creek, American River, Stanislaus River]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan | Not anticipated to change | — | Assumed similar to water temperature. |
| | Spawning Habitat | Decrease (discountable [Sacramento River]; beneficial; proportion: high [Clear Creek, American River, Stanislaus]; frequency: medium [Clear Creek, American River], high [Stanislaus River]) | Minimize/compensate: Sacramento River: Minimum Instream Flow. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan. | Increase (Sacramento River; proportion: low; frequency: medium); not anticipated to change (Feather River and American River) | — | Weighted usable area quantitative analyses show minor increases in the stressor in the Sacramento River as a result Sites operations, and little change in the Feather River and American River. |
| Kelt Emigration | In-River Fishery and Poaching | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river flows from Sites operations that suggest in-river fishing or poaching would change. |
| | Stranding Risk | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | flows from Sites operations that suggest stranding risk would change. |
| | Competition, Introgression, and Broodstock Removal | Not anticipated to change | — | Not anticipated to change | — | There is no mechanism to Sites operations that suggests a change would occur in the influence of hatchery-origin fish on natural-origin fish. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2. Effects would likely be limited by low temporal overlap with main period of reservoir releases (see emigration timing in Appendix C). |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Assumed similar to water temperature. |
| | Food Availability and Quality | Increase or decrease (discountable/insignificant) | — | Increase or decrease (discountable/insignificant) | — | If kelt emigration occurs in winter/spring, there could be potential for increase of the stressor as a result of less inundated habitat caused by Sites diversions (see discussion for juveniles), although such effects would likely be limited given relatively fast movement of most kelts to the ocean. The stressor could decrease if emigration occurs during reservoir releases, although this is less likely (Appendix C). |
| | Water Temperature | Increase or decrease (insignificant [Sacramento River, Clear Creek, San Joquin River, Delta]; spring; sublethal; proportion: small [American River]; frequency: low [American River]; summer; beneficial; proportion: small [Stanislaus River]; frequency: medium [American River], small [Stanislaus River] | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives; Water Temperature Management. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan. Exacerbate: Sacramento River: Drought Tool Kit Warmwater Bypass | Not anticipated to change | — | No biologically meaningful effects of Sites based on quantitative modeling (HEC-5Q; Reclamation Temperature Model). |
| | Pathogens and Disease | Increase (insignificant [Clear Creek, San Joaquin River, Delta]; sublethal; proportion: medium [Sacramento River, American River], low [Clear Creek, Stanislaus River]; frequency: high [American River], medium [Sacramento River, Stanislaus River], low [Clear Creek] | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives; Clear Creek: Water Temperature Management; American River: Water Temperature Management; Stanislaus River: Stepped Release Plan | Not anticipated to change | — | Assumed similar to water temperature. |
| Egg Incubation and Fry Emergence | Predation Risk | Not anticipated to change | — | Not anticipated to change | — | The lack of change in the water temperature stressor (see discussion for Water Temperature below) suggests there would not be any change in temperature-driven predation risk. |
| | In-River Fishery | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to flow as a result of Sites operations that would |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | and Trampling | | | | | be expected to result in changes to the in-river fishery or trampling. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Egg incubation and fry emergence is upstream of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Assumed similar to water temperature. |
| | Sedimentation and Gravel Quantity | Increase (discountable/insignificant) | — | Increase (Sacramento River; discountable/insignificant); not anticipated to change (Feather River and American River) | — | Potential for small negative effects given less spawning habitat (see discussion of Spawning Habitat for Adult Spawning life stages), but effects likely limited and Sites does not include gravel augmentation. |
| | Redd Quality | Increase or decrease (discountable/insignificant) | — | Increase (Sacramento River; discountable/insignificant); not anticipated to change (Feather River and American River) | — | Assumed in consideration of other stressors (in particular water temperature and quantitative results from redd scour/entombment analyses). |
| | Food Availability and Quality | Increase or decrease (discountable/insignificant | — | Not anticipated to change | — | Not anticipated to change based on limited effects to other stressors. |
| | Water Temperature | Increase (sublethal; proportion: small [Clear Creek]; frequency: high [Clear Creek]; lethal; proportion: small [Sacramento River], medium [American River, Stanislaus River]; frequency: high [Sacramento River, American River], medium [Stanislaus River]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan. | Not anticipated to change | — | No biologically meaningful effects of Sites based on quantitative modeling (HEC-5Q; Reclamation Temperature Model). |
| | Pathogens and Disease | Increase (insignificant; [Clear Creek]; sublethal; proportion: small [Sacramento River, Stanislaus River], medium [American River]; frequency: medium [Sacramento River, American River], low [Stanislaus River]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan. | Not anticipated to change | — | Assumed similar to water temperature. |
| | Redd Stranding and Dewatering | Increase or decrease (beneficial; proportion: small to medium [Clear Creek]; frequency: high [Clear Creek]); (lethal; proportion: small [Sacramento River] small to medium [American River, Stanislaus River]; frequency: high [Sacramento River, American River, Stanislaus River]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management; Redd Dewatering Adjustment. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill and Redd Maintenance. | Increase (Sacramento River; discountable/insignificant); not anticipated to change (Feather River and American River) | — | Quantitative analyses show potential for minor increases in the stressor in the Sacramento River; only small differences in the Feather River and American River. |
| Juvenile Rearing and Outmigration | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Yolo Bypass | |
| | Predation and Competition | Increase (discountable/insignificant) | — | Increase (discountable/insignificant) | — | Available studies suggest there would be limited effects of Sites diversions on predation risk at the Red Bluff and Hamilton City intakes; uncertainty would be addressed with technical studies of predator density and distribution. |
| | Dissolved Oxygen | Increase or decrease (insignificant; [Sacramento River, American River, Clear Creek, Delta]; sublethal; proportion: high [rearing: Stanislaus River], medium [outmigration: San Joaquin River, Stanislaus River], low [San Joaquin – rearing]; frequency: high [rearing: Stanislaus River], medium [rearing: San Joaquin River, outmigration: Stanislaus River], low [outmigration: San Joaquin River] | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management. Clear Creek; Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All Basins: Drought Action. | Not anticipated to change | — | Assumed similar to water temperature. |
| | Water Temperature | Increase or decrease (summer; beneficial; proportion: large [American River]; frequency: medium [American River]; sublethal; proportion: large [Stanislaus River]; frequency: low [Stanislaus River] | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management. Clear Creek; Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All Basins: Drought Action. | Not anticipated to change | — | Quantitative modeling (HEC-5Q) shows few differences in biologically meaningful effects in the Sacramento River; no changes in the Feather River (Reclamation Temperature Model) or American River (HEC-5Q). Operations-related effects on water temperature in the Delta are minimal. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Pathogens and Disease | Increase or decrease (spring; sublethal; proportion: large [rearing: American River, Stanislaus River], medium [rearing: Sacramento River, Clear Creek], low [outmigration: Sacramento River, Clear Creek, American River, Stanislaus River], frequency: high [rearing: American River, Stanislaus], medium [rearing: Sacramento River, Clear Creek, outmigration: Sacramento River, American River], low [outmigration: Clear Creek, Stanislaus River] | Minimize/compensate: Sacramento Adult Migration and Holding Water Objectives. Clear Creek; Water Temperature Management. American Water Temperature Management. Stanislaus River: Stepped Release Plan. | Not anticipated to change (Delta; Feather River; American River); increase (Sacramento River; sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria. | Operations-related effects on water temperature in the Delta are minimal. There are no temperature-related differences in the Feather River or American River that would suggest an increase or decrease in this stressor. There is small potential for injury leading to disease from juveniles contacting the Red Bluff and Hamilton City fish screens, minimized by screen design (smooth screen face; cleaning system) and operating criteria (e.g., approach velocity). |
| | Outmigration Cues | Increase (insignificant [San Joaquin River, Delta]; sublethal; proportion; large [Sacramento River, American River, Stanislaus River], small [Clear Creek]; frequency: low to high [Sacramento River], high [Clear Creek, American River, Stanislaus River] | Minimize/compensate: Sacramento River: Minimum Instream Flows; Spring Pulse Flows. Clear Creek: Minimum Instream Flows; Spring Pulse Flows; American River: Minimum Instream Flows; Spring Pulse Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance. American River: Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage. All Basins: Drought Action. | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: Diversion criteria | Sites diversions would reduce outmigration flows for juveniles in the Sacramento River and the Delta, to be minimized with diversion criteria (Bend Bridge Pulse Protection and Minimum Bypass Flows in the Sacramento River at Wilkins Slough); quantitative modeling (e.g., STARS spreadsheet; river migration flow-survival analysis) suggests effects would be limited. Adaptive management would be utilized to assess and if necessary refine diversion criteria and/or operations based on biological monitoring. |
| | Stranding Risk | Not anticipated to change (more seaward end of Delta); Increase (winter and spring; lethal; proportion: small to medium [Sacramento River, San Joquin River, American River, Stanislaus River], small [Clear Creek]: frequency: high [Sacramento River, Clear Creek, San Joaquin River, American River, Stanislaus River] ); decrease (summer and fall; beneficial; proportion: small to medium [Sacramento River, American River, Stanislaus River]; frequency: high [Sacramento River, American River, Stanislaus River] | Minimize/compensate: Sacramento River: Minimum Instream Flows; Ramping Rates. Clear Creek: Minimum Instream Flows; Ramping Rates. American River: Minimum Instream Flows; Ramping Rates. Stanislaus River: Stepped Release Plan. | Increase (discountable/insignificant) | — | Quantitative modeling suggests small increases in juvenile stranding risk in the Sacramento River at Keswick and Clear Creek, with small reductions at Battle Creek; substantial effects would not occur. |
| | Refuge Habitat | Not anticipated to change (more seaward end of Delta); Increase (winter and spring; sublethal; proportion: large [Clear Creek, American River, Stanislaus River], small to medium [Sacramento River/more landward end of the Delta, San Joaquin River]; frequency: high [San Joaquin River], medium [Sacramento River/ more landward end of the Delta, Clear Creek, American River, Stanislaus River]; decrease (summer and fall: beneficial; | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | Not anticipated to change (more seaward end of Delta); increase (Sacramento River downstream of Sites intakes, Yolo Bypass, more landward end of the Delta; proportion: medium; frequency: medium); decrease (Sacramento River upstream of Sites intakes; beneficial; proportion: small; frequency: medium) | Minimize/compensate: Diversion criteria; coordination with CVP. | Quantitative modeling indicates that Sites diversions would increase or reduce flow-inundated habitat in the Sacramento River, Yolo Bypass, and more landward end of the Delta, which would be limited by diversion criteria. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | proportion: large [rearing: American River, Stanislaus River], small [outmigration: American River, Stanislaus River]; frequency: medium [American River, Stanislaus River] | | | | |
| | Food Availability and Quality | Not anticipated to change (more seaward end of Delta); increase (entire year; sublethal; proportion: small to medium [San Joaquin River]; frequency: high [San Joaquin River]; winter and spring; sublethal; proportion: large [Sacramento River, Clear Creek, American River, Stanislaus River]; frequency: medium [Sacramento River, Clear Creek], low to medium [American River, Stanislaus River]); decrease (summer and fall; beneficial; proportion: large [rearing: Sacramento River, Clear Creek, American River], small to medium [outmigration: Sacramento River, Clear Creek, American River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | Not anticipated to change (more seaward end of Delta); increase (Sacramento River downstream of Sites intakes, Yolo Bypass, more landward end of the Delta; proportion: medium; frequency: medium); decrease (Sacramento River upstream of Sites intakes; beneficial; proportion: small; frequency: medium) | Minimize/compensate: Diversion criteria; coordination with CVP. | Sites diversions could affect food, assuming similar effects as to changes in refuge habitat. |
| | Entrainment Risk | Increase (lethal; proportion: small [focused on Delta]; frequency: high. | Minimize/compensate: Delta Cross Channel Gate Closure; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Steelhead Weekly Thresholds; Winter and Spring and Delta Outflows; Salvage Facilities<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Drought Actions. | Not anticipated to change (Delta); increase (Sacramento River; sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; diversion criteria | South Delta exports during the main period of juvenile entrainment risk would not be changed as a result of Sites operations, as indicated by quantitative modeling (salvage-density method). Diversion criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment. Entrainment risk at the Red Bluff and Hamilton City intakes would not appreciably change because only a small proportion of juveniles small enough to be entrained would temporally overlap the Sites diversion period; most individuals migrate at larger sizes. There is the potential for other near-field negative effects such as impingement, which would be minimized by the fish screens meeting agency criteria, with monitoring in addition to long-term hydraulic evaluations of screen performance. |

**Table 7A-17. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Central Valley Steelhead Critical Habitat**

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Freshwater Spawning Sites | Spawning Habitat | No adverse effects anticipated | Minimize/compensate: Sacramento River: Minimum Instream Flow. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan. | Adverse; no adverse effects anticipated (Feather River and American River) | — | Weighted usable area quantitative analyses show minor increases in the stressor in the Sacramento River as a result Sites operations, and little change in the Feather River and American River. |
| | Water Temperature | Adverse | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan. | No adverse effects anticipated | — | No biologically meaningful effects of Sites based on quantitative modeling (HEC-5Q; Reclamation Temperature Model). |
| | Redd Stranding and Dewatering | Adverse [Sacramento River, American River, Stanislaus River]; No adverse effects anticipated [Clear Creek] | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management; Redd Dewatering Adjustment. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Refill and Redd Maintenance. | No adverse effects anticipated | — | Quantitative analyses show potential for minor increases in the stressor in the Sacramento River; only small differences in the Feather River and American River. |
| Freshwater Rearing Sites | Water Temperature | Adverse (winter-spring [Stanislaus River, American River]); No adverse effects anticipated (summer-fall [Stanislaus River, American River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management. Clear Creek; Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All Basins: Drought Action. | No adverse effects anticipated | — | Quantitative modeling (HEC-5Q) shows few differences in biologically meaningful effects in the Sacramento River; no changes in the Feather River (Reclamation Temperature Model) or American River (HEC-5Q). Operations-related effects on water temperature in the Delta are minimal. |
| | Dissolved Oxygen | Adverse (winter-spring [Stanislaus River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management. Clear Creek; Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of | No adverse effects anticipated | — | Assumed similar to water temperature. |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | September Storage. All Basins: Drought Action. | | | |
| | Stranding Risk | Adverse (winter-spring [Sacramento River, Clear Creek, Stanislaus River, American River]); No adverse effects anticipated (summer-fall [Sacramento River, Clear Creek, Stanislaus River, American River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Ramping Rates. Clear Creek: Minimum Instream Flows; Ramping Rates. American River: Minimum Instream Flows; Ramping Rates. Stanislaus River: Stepped Release Plan. | No adverse effects anticipated | — | Quantitative modeling suggests small increases in juvenile stranding risk in the Sacramento River at Keswick and Clear Creek, with small reductions at Battle Creek; substantial effects would not occur. |
| | Food Availability and Quality | Adverse (winter-spring [Sacramento River, Clear Creek, Stanislaus River, American River]); No adverse effects anticipated (summer-fall [Sacramento River, Clear Creek, American River, Stanislaus River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | No adverse effects anticipated (more seaward end of Delta and Sacramento River upstream of Sites intakes); adverse (Sacramento River downstream of Sites intakes, Yolo Bypass, more landward end of the Delta) | Minimize/compensate: Diversion criteria; coordination with CVP. | Sites diversions could affect food, assuming similar effects as to changes in refuge habitat. |
| | Refuge Habitat | Adverse (winter-spring [Sacramento River, Clear Creek, American River, Stanislaus River]); No adverse effects anticipated (summer-fall [Sacramento River, Clear Creek, Stanislaus River, American River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | No adverse effects anticipated (more seaward end of Delta and Sacramento River upstream of Sites intakes); adverse (Sacramento River downstream of Sites intakes, Yolo Bypass, more landward end of the Delta) | Minimize/compensate: Diversion criteria; coordination with CVP. | Quantitative modeling indicates that Sites diversions would increase or reduce flow-inundated habitat in the Sacramento River, Yolo Bypass, and more landward end of the Delta, which would be limited by diversion criteria. |
| Freshwater Migration Corridors/Estuarine Areas* | Water Temperature | Adverse (winter-spring adult migration and holding [Sacramento River, Clear Creek, American River, Stanislaus River]; fall adult migration and holding [Stanislaus River]); No adverse effects anticipated (summer-fall adult migration and holding [Sacramento River, Clear Creek, American River]; entire year [San Joaquin River, Delta]); | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management; Adult Migration and Holding Water Temperature Objectives. Clear Creek: Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River:<br>SHOT Determination on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All streams: Drought Action | No adverse effects anticipated | — | Quantitative modeling (HEC-5Q; Reclamation Temperature Model) shows few changes in biologically meaningful effects (Reclamation Temperature Model) or American River (HEC-5Q). Operations-related effects on water temperature in the Delta are minimal. |
| | Dissolved Oxygen | Adverse (winter-spring outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; fall outmigration [Stanislaus River]); No adverse effects anticipated (summer-fall outmigration [Sacramento River, Clear Creek, American River]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Shasta Reservoir Water Temperature and Storage Management. Clear Creek; Minimum Instream Flows; Water Temperature Management. American River: Minimum Instream Flows; Water Temperature Management. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Sacramento River: SHOT Determination | No adverse effects anticipated | — | Assumed similar to water temperature. |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | on Temperature Shoulders (requiring releases too cold too early and exhausting coldwater pool). American River: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage. All Basins: Drought Action. | | | |
| | Pathogens and Disease, Juveniles | Adverse (winter-spring outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; fall outmigration [Stanislaus River]; entire year outmigration [San Joaquin River]; No adverse effects anticipated (summer-fall outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; fall outmigration [Stanislaus]) | Minimize/compensate: Sacramento Adult Migration and Holding Water Objectives. Clear Creek; Water Temperature Management. American Water Temperature Management. Stanislaus River: Stepped Release Plan. | No adverse effects anticipated | — | Assumed similar to water temperature. |
| | Pathogens and Disease, Adults | Adverse (winter-spring migration and holding [Sacramento River, Clear Creek, American River, Stanislaus River]; fall migration and holding [Stanislaus River]); No adverse effects anticipated (summer-fall migration and holding [Sacramento River, Clear Creek, American River]) | Minimize/compensate: Sacramento River: Adult Migration and Holding Water Temperature Objectives. Clear Creek: Water Temperature Management. American River: Water Temperature Management. Stanislaus River: Stepped Release Plan. | No adverse effects anticipated | — | Assumed similar to water temperature. |
| | Stranding Risk | Adverse (winter-spring outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; fall outmigration [Stanislaus River]; entire year outmigration [San Joaquin River]); No adverse effects anticipated (fall outmigration [Sacramento River, Clear Creek, American River]; entire year [Delta]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Ramping Rates. Clear Creek: Minimum Instream Flows; Ramping Rates. American River: Minimum Instream Flows; Ramping Rates. Stanislaus River: Stepped Release Plan. | No adverse effects anticipated | — | For adults, quantitative modeling showed limited effects of Sites diversion operations on number of days meeting adult salmon upstream passage criteria at Fremont Weir and Colusa Weir; assumed similar for steelhead. Quantitative modeling suggests small increases in juvenile stranding risk in the Sacramento River at Keswick and Clear Creek, with small reductions at Battle Creek; substantial effects would not occur. |
| | Refuge Habitat | Adverse (winter-spring outmigration [Sacramento River, Clear Creek, Stanislaus River, American River, Stanislaus]; fall outmigration [Stanislaus River]; entire year outmigration [San Joaquin River); No adverse effects anticipated (summer outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; fall outmigration [Sacramento River, Clear Creek, American River]; entire year [Delta]) | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | No adverse effects anticipated (more seaward end of Delta and Sacramento River upstream of Sites intakes); adverse (Sacramento River downstream of Sites intakes, Yolo Bypass, more landward end of the Delta) | Minimize/compensate: Diversion criteria; coordination with CVP. | Quantitative modeling indicates that Sites diversions would increase or reduce flow-inundated habitat in the Sacramento River, Yolo Bypass, and more landward end of the Delta, which would be limited by diversion criteria. |
| | Food Availability and Quality | Adverse (winter-spring outmigration [Sacramento River, Clear Creek, Stanislaus River, American River]); No adverse effects anticipated (summer outmigration [Sacramento River, Clear Creek, American River, Stanislaus River]; entire year | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | No adverse effects anticipated (more seaward end of Delta and Sacramento River upstream of Sites intakes); adverse (Sacramento River downstream of Sites intakes, | Minimize/compensate: Diversion criteria; coordination with CVP. | Sites diversions could affect food, assuming similar effects as to changes in refuge habitat. |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | [Delta]) | | Yolo Bypass, more landward end of the Delta) | | |
| | Entrainment Risk | Adverse | Minimize/compensate: Delta Cross Channel Gate Closure; First Flush and Start of OMR Management; January 1 and Start of OMR Management; Steelhead Weekly Thresholds; Winter and Spring and Delta Outflows; Salvage Facilities<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Drought Actions. | No adverse effects anticipated (Delta); adverse (Sacramento River) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria; diversion criteria | South Delta exports during the main period of juvenile entrainment risk would not be changed as a result of Sites operations, as indicated by quantitative modeling (salvage-density method). Diversion criteria such as pulse protection would limit potential for entry into interior Delta and risk of south Delta entrainment. Entrainment risk at the Red Bluff and Hamilton City intakes would not appreciably change because only a small proportion of juveniles small enough to be entrained would temporally overlap the Sites diversion period; most individuals migrate at larger sizes. There is the potential for other near-field negative effects such as impingement, which would be minimized by the fish screens meeting agency criteria, with monitoring in addition to long-term hydraulic evaluations of screen performance. |

*Effects noted for the Delta are representative of Estuarine Areas; such effects would not be likely to occur at the more seaward end of the Delta.

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## 7A.4.4 Green Sturgeon

Chapter 8 discusses the status of the southern distinct population segment of North American green sturgeon, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. Summaries of the effects analysis for effects on the species and its critical habitat are provided in Tables GS1_Sites and GS2_Sites. A qualitative analysis was conducted to provide a programmatic summary of the effects of Sites for the species life stages, critical habitat physical and biological features, and stressors discussed for the Proposed Action (Tables GS1_Sites and GS2_Sites)[10]. The analysis of Sites was based on information in the administrative draft Sites BA and FEIR, which includes consideration of various quantitative and qualitative analyses.

As illustrated in Tables GS1_Sites and GS2_Sites, the principal potential effects of Sites in addition to the Proposed Action would be from diversions (e.g., entrainment/impingement of larvae at the Red Bluff and Hamilton City intakes) or reservoir releases (resulting in potential water quality effects). These effects would be limited by various conservation measures, such as fish screens meeting fish agency standards for factors such as screen opening size and approach velocity to minimize risk from entrainment and impingement.

Life cycle analyses were conducted using statistical relationships of white sturgeon year class strength and Delta outflow. Hypotheses exist that the mechanisms behind positive statistical correlations between Delta outflow and white sturgeon year class may also apply to green sturgeon, although statistical relationships have not yet been established for green sturgeon. Quantitative modeling between white sturgeon year class strength and either April-May or March-July Delta outflow suggests the potential for negative effects of Sites based on lower Delta outflow but this was not concluded to be a significant effect because the statistical relationships are based on a surrogate species and may be related to upstream flow or Delta inflow as opposed to Delta outflow; changes are limited to differences within water year type, as opposed to hydrological condition–scale differences; the prediction intervals of the statistical relationship range over several orders of magnitude; and there is little difference in estimates based on one (April–May) of the averaging periods examined. For the Proposed Action, the analysis showed similar white sturgeon year class strength estimates under the Proposed Action phases as the No Action Alternative.

As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of Sites would be avoided, minimized, and offset. Guiding principles relevant to green sturgeon include:

- Upper Sacramento River
  - Utilize the additional water supply provided by the Sites Project to address adverse effects of the CVP on sturgeon habitat in the Sacramento River above the Red Bluff Pumping Plant by:
    - Implementing additional mitigation actions as necessary and appropriate to maintain and/or improve spawning and rearing habitat for anadromous fish in the Upper Sacramento River.
    - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions.
- Sacramento River from Red Bluff Pumping Plant to Knights Landing

[10] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

  - Implement actions necessary to minimize potential impacts to listed species exposed to diversion facilities.
  - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions.
  - Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
- Below Knights Landing and in the Delta
  - Operate projects consistent with existing and/or future regulatory requirements in the Delta.
  - Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.
  - Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
  - Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to maintain and/or improve productivity of those fish populations.
  - Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to maintain and/or improve productivity of those fish populations.
  - Cooperate in the monitoring of the Fremont Weir Big Notch Project to assess what effect, if any, diversions of flow to Sites Reservoir have on the effectiveness of the Big Notch Project's ability to achieve its juvenile entrainment and adult passage performance goals for salmonids in the Sacramento River. in. If necessary, implement operational measures to avoid diminishing the performance of the Big Notch Project.

**Table 7A-18. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Green Sturgeon**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Adult Migration, River Spawning, and Holding | Barriers | Not anticipated to change | — | Not anticipated to change | — | Quantitative modeling shows generally similar number of days meeting passage criteria at Fremont Weir and Sutter Bypass weirs under Sites as existing conditions. |
| | Food | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Recent assessments have suggested no potential effects on food resources from Sacramento River operations of the type included in Sites. |
| | Harvest | Not anticipated to change | — | Not anticipated to change | — | There are no major changes to river flows from Sites operations that suggest harvest would change; as noted above, fish passage at Fremont Weir and Sutter Bypass weirs is not anticipated to change, so illegal harvest at these locations also would not be anticipated to change. |
| | Migration and Foraging Habitat | Not anticipated to change | — | Not anticipated to change | — | Adult foraging areas are not influenced by water operations (Appendix D). |
| | Predation Risk | Not anticipated to change | — | Not anticipated to change | — | Pinnipeds are noted as predators of green sturgeon in Chapter 8. Sites operations would not be anticipated to affect California sea lions, so predation risk from pinnipeds to adult green sturgeon would not be anticipated to change as a result of Sites. |
| | Spawning habitat | Not anticipated to change | — | Not anticipated to change | — | Quantitative modeling (weighted usable area analysis) indicates no effect on spawning habitat in the Sacramento River. |
| | Flow | Increase or decrease (discountable/insignificant) | — | Increase or decrease (discountable/insignificant) | — | Quantitative modeling (CalSim) indicates generally similar flows in the Sacramento River during February through December migration, spawning, and holding, with some reductions in spring and increases in summer and fall. See also in-text discussion of life cycle analyses related to Delta outflow. |
| | Dissolved Oxygen | Not anticipated to change | — | Not anticipated to change (Sacramento River); increase (discountable/insignificant) [Delta] | Minimize/compensate: Mitigation Measure FISH-8.1: Prevent Detrimental Dissolved Oxygen and Water Temperature Effects to Fish Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass. | Assumed similar to water temperature. |
| | Toxicity | Increase or decrease (discountable/insignificant) | — | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2, although adult migration generally would be outside the main period of reservoir releases; spawning and holding would be upstream of reservoir releases and would not be affected. |
| | Water Temperature | Decrease [Sacramento River]; increase or decrease [Delta] (discountable/insignificant) | — | Not anticipated to change (Sacramento River); increase (discountable/insignificant) [Delta] | Minimize/compensate: Mitigation Measure FISH-8.1: Prevent Detrimental Dissolved Oxygen and Water Temperature Effects to Fish Associated with Moving Colusa Basin | Quantitative modeling (HEC-5Q) for Sacramento River indicated no effects to biologically meaningful criteria for Sites. For the Delta, operations-related effects on water |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Drain Water Through the Yolo Bypass. | temperature in the Delta are minimal; Mitigation Measure FISH-8.1 addresses the possibility that temperature could increase in the localized area receiving water from Sites Reservoir via the Yolo Bypass in summer/fall. |
| | Salinity | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Adults are tolerant of a broad range of salinity (Appendix D); any operations effects of Sites on salinity would be limited in relation to this broad range. |
| Egg Incubation | Flow | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Quantitative modeling (weighted usable area analysis) indicates no effect on spawning habitat in the Sacramento River, reflecting limited differences in flow. |
| | Predation Risk | Not anticipated to change | — | Increase (discountable/insignificant) | — | Quantitative modeling (HEC-5Q) for Sacramento River water temperature indicated few effects to biologically meaningful criteria for Sites, which indicates any increase in predation risk given general decrease in predator metabolic demand with decreasing temperature would also be very limited. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Egg incubation is upstream of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Assumed similar to water temperature. |
| | Water Temperature | Decrease (beneficial; proportion: likely large; frequency: likely medium) | — | Increase (discountable/insignificant) | — | Quantitative modeling (HEC-5Q) for Sacramento River indicated few effects to biologically meaningful criteria for Sites. |
| Larvae | Entrainment Risk | Not anticipated to change | — | Increase (sub-lethal to lethal; proportion: small; frequency: small) or decrease (beneficial; proportion; small; frequency: small) | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria | The Red Bluff and Hamilton City intakes' fish screens would be expected to exclude most larvae from entrainment based on size, with approach velocity limiting risk of impingement; relative to existing conditions, Sites may increase or decrease the stressor at different times. Uncertainty in effects would be addressed with monitoring and adaptive management if necessary. |
| | Rearing Habitat | Not anticipated to change | — | Not anticipated to change | — | There is uncertainty about rearing habitat characteristics and availability for larvae (Appendix D). Sites operations would not be anticipated to change riverbed substrate. |
| | Predation Risk | Not anticipated to change | — | Not anticipated to change | — | Quantitative modeling (HEC-5Q) for Sacramento River water temperature indicated no effects to biologically meaningful criteria for Sites, which indicates an increase in predation risk given general decrease in predator metabolic demand with decreasing temperature would not be anticipated. |
| | Flow | Increase or decrease (discountable/insignificant) | — | Increase or decrease (discountable/insignificant) | — | Quantitative modeling (CalSim) indicates generally limited effects of Sites, with some relatively minor increases or decreases to the |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | stressor at times. |
| | Toxicity | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Larvae are upstream of Sites reservoir releases that could result in increase in toxicity from contaminants. |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Assumed similar to water temperature. |
| | Food | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Recent assessments have suggested no potential effects on food resources from Sacramento River operations of the type included in Sites. |
| | Water Temperature | Decrease (beneficial; proportion: likely large; likely medium) | — | Not anticipated to change | — | Quantitative modeling (HEC-5Q) for Sacramento River indicated no effect to biologically meaningful criteria for Sites. |
| Juveniles | Rearing habitat | Not anticipated to change | — | Not anticipated to change | — | Juveniles occupy a broad range of habitat (Appendix D) and so would not be anticipated to be affected by Sites operations. |
| | Predation risk | Not anticipated to change | — | Not anticipated to change | — | Quantitative modeling (HEC-5Q) for Sacramento River water temperature indicated no effects to biologically meaningful criteria for Sites, which indicates an increase in predation risk given general decrease in predator metabolic demand with decreasing temperature would not be anticipated. |
| | Flow | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Quantitative modeling (CalSim) indicates Sites would be similar to existing conditions. See also in-text discussion of life cycle analyses related to Delta outflow. |
| | Water Temperature | Increase or decrease (discountable/insignificant) | — | Not anticipated to change (Sacramento River); increase (discountable/insignificant) | Minimize/compensate: Mitigation Measure FISH-8.1: Prevent Detrimental Dissolved Oxygen and Water Temperature Effects to Fish Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass. | Quantitative modeling (HEC-5Q) for Sacramento River indicated no effect to biologically meaningful criteria for Sites. For the Delta, operations-related effects on water temperature in the Delta are minimal. Mitigation Measure FISH-8.1 addresses the possibility that temperature could increase in the localized area receiving water from Sites Reservoir via the Yolo Bypass in summer/fall. |
| | Salinity | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Juveniles are tolerant of a broad range of salinity and are strong enough swimmers to move to acceptable habitat (Chapter 8); any operations effects of Sites on salinity would be limited in relation to this broad range. |
| | Dissolved Oxygen | Increase or decrease (discountable/insignificant) | — | Not anticipated to change (Sacramento River); increase (discountable/insignificant) | Minimize/compensate: Mitigation Measure FISH-8.1: Prevent Detrimental Dissolved Oxygen and Water Temperature Effects to Fish Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass. | Assumed similar to water temperature. |
| | Toxicity from Contaminants | Increase or decrease (discountable/insignificant) | — | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass. | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Food | Increase or decrease (discountable/insignificant) | — | Not anticipated to change | — | Recent assessments have suggested no potential effects on food resources from Sacramento River operations of the type included in Sites. |
| | Entrainment Risk | Increase (lethal or sublethal; proportion: low [Delta]; frequency: high [Delta]) | Minimize/compensate: Delta Cross Channel Gate Closure; First Flush and Start of OMR Management; January 1 and Start of OMR Management; End of OMR Management; Winter and Spring Delta Outflows; Drought Actions; Salvage Facilities<br>Exacerbate: SHOT Reduction in Sacramento Fall and Winter Flows; Drought Actions | Not anticipated to change | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria | The Red Bluff and Hamilton City intakes' fish screens would exclude juveniles from entrainment based on size and approach velocity would prevent impingement. Quantitative modeling (salvage-density method) indicates that south Delta entrainment would remain at low levels. |
| Estuarine Subadult and Adult Residence and Outmigration | — | Not anticipated to change | — | Not anticipated to change | — | There would not be anticipated to be any effects to subadults or adults per the above adult and juvenile life stage rationale for operations. |

**Table 7A-19. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Green Sturgeon Critical Habitat**

| Location | Physical and Biological Feature/Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Freshwater Riverine Systems | Food Resources | No adverse effects anticipated | — | No adverse effects anticipated | — | Recent assessments have suggested no potential effects on food resources from Sacramento River operations of the type included in Sites. |
| | Substrate type or size (i.e., structural features of substrates) | No adverse effects anticipated | — | No adverse effects anticipated | — | Sites operations would not be anticipated to change riverbed substrate. |
| | Water flow | No adverse effects anticipated | — | No adverse effects anticipated | — | Quantitative modeling (CalSim) indicates Sites would be similar to existing conditions. See also in-text discussion of life cycle analyses related to Delta outflow. |
| | Water quality (toxicity) | No adverse effects anticipated | — | Adverse | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2. |
| | Water quality (dissolved oxygen) | No adverse effects anticipated | — | No adverse effects anticipated | — | Assumed similar to water temperature. |
| | Water quality (temperature) | No adverse effects anticipated | — | No adverse effects anticipated | — | Quantitative modeling (HEC-5Q) for Sacramento River indicated little to no effect to biologically meaningful criteria for Sites. |
| | Migratory corridor (barriers, entrainment risk) | No adverse effects anticipated | — | Adverse | Minimize/compensate: Red Bluff and Hamilton City fish screens and operating criteria | Quantitative modeling shows generally similar number of days meeting passage criteria at Fremont Weir and Sutter Bypass weirs under Sites as existing conditions, which would not be an adverse effect. Red Bluff and Hamilton City intakes' fish |

| Location | Physical and Biological Feature/Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | screens would be expected to exclude most larvae from entrainment based on size, with approach velocity limiting risk of impingement; relative to existing conditions, Sites may increase or decrease the stressor at different times. Uncertainty in effects would be addressed with monitoring and adaptive management if necessary. |
| | Depth | No adverse effects anticipated | — | No adverse effects anticipated | — | Any changes in water depth as a result of Sites operations would be marginal in relation to available habitat. |
| | Sediment quality | No adverse effects anticipated | — | Adverse | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2. |
| Estuarine Habitats | Food Resources | No adverse effects anticipated | — | No adverse effects anticipated | — | Recent assessments have suggested no potential effects on food resources from Sacramento River operations of the type included in Sites. |
| | Substrate type or size (i.e., structural features of substrates) | No adverse effects anticipated | — | No adverse effects anticipated | — | Sites operations would not be anticipated to change riverbed substrate. |
| | Water flow | No adverse effects anticipated | — | No adverse effects anticipated | — | Quantitative modeling (CalSim) indicates Sites similar to existing conditions. See also in-text discussion of life cycle analyses related to Delta outflow. |
| | Water quality (toxicity) | No adverse effects anticipated | — | Adverse | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2. |
| | Water quality (dissolved oxygen) | No adverse effects anticipated | — | No adverse effects anticipated | Minimize/compensate: Mitigation Measure FISH-8.1: Prevent Detrimental Dissolved Oxygen and Water Temperature Effects to Fish Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass. | Assumed similar to water temperature. |
| | Water quality (temperature) | No adverse effects anticipated | — | No adverse effects anticipated | Minimize/compensate: Mitigation Measure FISH-8.1: Prevent Detrimental Dissolved Oxygen and Water Temperature Effects to Fish Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass. | For the Delta, operations-related effects on water temperature in the Delta are minimal. Mitigation Measure FISH-8.1 addresses the possibility that temperature could increase in the localized area receiving water from Sites Reservoir via the Yolo Bypass in summer/fall. |
| | Water quality (salinity) | No adverse effects anticipated | — | No adverse effects anticipated | — | Adults are tolerant of a broad range of |

| Location | Physical and Biological Feature/Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | | | | salinity (Appendix D); juveniles are tolerant of a broad range of salinity and are strong enough swimmers to move to acceptable habitat (Chapter 8); any operations effects of DCP on salinity would be limited in relation to this broad range. |
| | Migratory corridor (barriers) | No adverse effects anticipated | — | No adverse effects anticipated | — | Sites operations do not include installation of any barriers to migration or change in operations of existing barriers. |
| | Depth | No adverse effects anticipated | — | No adverse effects anticipated | — | Any changes in water depth as a result of Sites operations would be marginal in relation to available habitat. |
| | Sediment quality | No adverse effects anticipated | — | Adverse | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2. |
| Nearshore Coastal Marine Areas | Migratory Corridor | No adverse effects anticipated | — | No adverse effects anticipated | — | There would be no Sites effect on nearshore coastal marine areas because this is outside the action area. |
| | Water quality | No adverse effects anticipated | — | No adverse effects anticipated | — | There would be no Sites effect on nearshore coastal marine areas because this is outside the action area. |
| | Food resources | No adverse effects anticipated | — | No adverse effects anticipated | — | There would be no Sites effect on nearshore coastal marine areas because this is outside the action area. |

## 7A.4.5 Delta Smelt

Chapter 9 discusses the status of delta smelt, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. Summaries of the effects analysis for effects on the species and its critical habitat are provided in Tables DS1_Sites and DS2_Sites. A qualitative analysis was conducted to provide a programmatic summary of the effects of Sites for the species life stages, critical habitat physical and biological features, and stressors discussed for the Proposed Action (Tables DS1_Sites and DS2_Sites)[11]. The analysis of Sites was based on information in the administrative draft Sites BA and FEIR/S, which include consideration of various quantitative and qualitative analyses.

As illustrated in Tables DS1 and DS2, potential effects of Sites in addition to the Proposed Action would primarily occur to larval/juvenile life stages from operations effects related to lower Delta outflow affecting food availability, in addition to potential water quality (temperature, toxicity) effects from reservoir releases through the Yolo Bypass. Water quality effects from reservoir releases would be addressed with various mitigation measures, and reservoir releases have the potential for positive effects on food availability via stimulation of the north Delta foodweb (for releases through the Yolo Bypass) or generally as a result of somewhat increased Delta outflow during the juvenile life stage. Sediment entrainment effects by the two Sites intakes are not anticipated to result in negative effects to delta smelt because of changes in turbidity but uncertainty is to be addressed with a sediment monitoring plan and adaptive management. Life cycle modeling for delta smelt with the Life Cycle Model with Entrainment (LCME) described in Chapter 9 showed the Proposed Action phases to have similar population growth rate to the No Action Alternative and lower population growth rate than the Run of the River (EXP1) and Minimum Releases (EXP3) scenarios; a similar overall pattern was observed with the Maunder and Deriso model for delta smelt that is also summarized in Chapter 9. Delta smelt life cycle modeling has not been undertaken for Sites but the Sites FEIR/S noted that the drivers of difference in the LCME model (Old and Middle River flows and June-August outflow) were little changed by Sites, with small differences in June-August Delta outflow being positive in favor of Sites.

As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of Sites would be avoided, minimized, and offset. Guiding principles relevant to delta smelt include:

- Operate projects consistent with existing and/or future regulatory requirements in the Delta.
- Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to maintain and/or improve productivity of those fish populations.
- Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites with habitat restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.
- Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions.

As described in Chapter 3, Sites has an adaptive management program which would integrate with the adaptive management program for the Proposed Action and includes a number of general principles such

[11] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

**Table 7A-20. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Delta Smelt**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Adult Migration and Spawning | Toxicity | Decrease (discountable/insignificant) | — | Not anticipated to change | — | Changes to toxicity not likely in adult migration and spawning season because Sites reservoir releases would be limited during this time (mitigation is included for potential effects during the main release season; see rationale for juveniles). |
| | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | Operations-related effects on water temperature in the Delta are minimal. |
| | Food Visibility | Decrease (discountable/insignificant) | — | Not anticipated to change | — | Sites sediment entrainment during migration/spawning period is not likely to immediately affect turbidity of water. |
| | Predation | Increase (discountable/insignificant) | — | Not anticipated to change | — | Sites operations would not result in major changes to water temperature, turbidity (suspended sediment), or predators. |
| | Food Availability | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely high) | Minimize/compensate: Minimum Instream Flows; Delta Smelt Supplementation<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Not anticipated to change | — | Potential food availability effects as a result of Sites diversions would be unlikely during adult migration and spawning; such effects are more likely during other life stages, discussed below. |
| | Entrainment | Increase (lethal; proportion: variable; frequency: medium) | Minimize/compensate: First Flush and Start of OMR Management; January 1 and Start of OMR Management; Adult Delta Smelt Entrainment Protection Action (Turbidity Bridge)<br>Exacerbate: Drought Actions | Not anticipated to change | — | South Delta diversion of Sites water does not temporally overlap this life stage's entrainment vulnerability period; modeling shows little difference in key drivers of entrainment risk (e.g., Old and Middle River flows). |
| Eggs and Larvae | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | Operations-related effects on water temperature in the Delta are minimal. |
| | Food Visibility | Increase (discountable/insignificant) | — | Not anticipated to change | — | Sites sediment entrainment during migration/spawning period is not likely to immediately affect turbidity of water. |
| | Predation | Increase (discountable/insignificant) | — | Not anticipated to change | — | Sites operations would not result in major changes to water temperature, turbidity (suspended sediment), or predators. |
| | Food Availability | Increase (sub-lethal to lethal; proportion: likely medium; frequency: high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal; proportion: small; frequency: medium) | — | Sites diversions could negatively affect zooplankton prey correlated with Delta outflow/X2 in the spring, but modeling indicates such effects would be limited. |
| | Entrainment | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: First Flush and Start of OMR Management; January 1 and Start of OMR Management; Larval and Juvenile Delta Smelt Protection Action; Spring Delta Outflow; Barker Slough Pumping Plant, Maximum Spring Diversions, Larval Delta Smelt; Delta Smelt Supplementation<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Drought Actions | Not anticipated to change | — | Modeling indicates little effect of Sites-related operations on correlates with larval entrainment risk (Old and Middle River flows; X2); criteria for limiting south Delta entrainment risk also would be in place. |
| Juveniles | Toxicity from | Increase or decrease | — | Not anticipated to change | — | Sites operations would have limited effects on |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Harmful Algal Blooms | (discountable/insignificant) | | | | drivers of harmful algal blooms (nutrients, flow, and water temperature). There would be no significant impact on harmful algal blooms based on Sites FEIR Chapter 6: Sites diversions would not affect harmful algal blooms because diversions would primarily occur during storm events in winter when conditions are less conducive to bloom formation and maintenance; Sites reservoir releases to the Yolo Bypass during August-October would not affect harmful algal blooms based on available North Delta Food Subsidy studies; any cyanobacteria present in Sites reservoir release water would not affect harmful algal blooms in the Delta because of dilution, degradation, and releases not changing conditions (water temperature and residence time) in a way that would be more conducive to harmful algal blooms. |
| | Water Temperature | Increase or decrease (discountable/insignificant) | — | Increase (sub-lethal to lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-8.1: Prevent Detrimental Dissolved Oxygen and Water Temperature Effects to Fish Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Operations-related effects on water temperature in the Delta generally are minimal. Sites reservoir releases to Yolo Bypass via Colusa Basin Drain could increase temperature in the lower Yolo Bypass, although this is uncertain and would be addressed with Mitigation Measure FISH-8.1. |
| | Predation | Increase (discountable/insignificant) | — | Increase (discountable/insignificant) | Minimize/compensate: Sediment Monitoring Plan and Adaptive Management for Sediment Diverted from the Sacramento River | Sites operations would not result in major changes to water temperature, turbidity (suspended sediment), or predators. Uncertainty in effects to turbidity in relation to resuspension of marginally less (0.3-1.5% based on modeling) sediment because of Sites intake sediment entrainment would be addressed with sediment monitoring/adaptive management. |
| | Food Availability and Quality | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely medium to high) | Minimize/compensate: Minimum Instream Flows; Delta Smelt Supplementation<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Decrease (beneficial; proportion: small to medium; frequency: medium) or increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Releases from Sites Reservoir | A decrease to the stressor could occur as a result of Sites reservoir releases because of north Delta food subsidy (releases via Yolo Bypass) or broader Delta outflow increase (correlation with zooplankton prey abundance); an increase to stressor could occur as a result of zooplankton entrainment as a result of export of Sites reservoir water from south Delta. |
| | Entrainment | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: January 1 and Start of OMR Management; Larval and Juvenile Delta Smelt Protection Action; Spring Delta Outflow; End of OMR Management; Barker Slough Pumping Plant, Maximum Spring Diversions, Larval Delta Smelt; Delta Smelt Supplementation<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Not anticipated to change | — | Modeling indicates little effect of Sites-related operations on correlates with early juvenile entrainment risk (Old and Middle River flows; X2); SWP/CVP criteria for limiting south Delta entrainment risk also would be in place. |
| | Size and Location of the Low Salinity | Increase (sub-lethal; proportion: likely medium to large; frequency: likely medium to | Minimize/compensate: Spring Delta Outflow; Summer Suisun Marsh Salinity Control Gate Operation; Fall X2 | Decrease (discountable/insignificant) | — | There is little difference in low salinity zone as a result of Sites operations, as indicated by X2 modeling generally showing less than 1 km |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Zone | high) | Exacerbate: Drought Actions | | | difference between Sites and No Action Alternative (with differences tending to be negative, i.e., not indicating less low salinity zone under Sites). |
| | Other toxicity | — | — | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2. |

**Table 7A-21. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Delta Smelt Critical Habitat**

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Physical Habitat | Habitat extent | — | — | No adverse effects anticipated | AMM-15: Sediment Monitoring, Modeling, and Reintroduction Adaptive Management | The limited percentage of sediment estimated to be entrained is not anticipated to affect habitat extent (e.g., sand for spawning), but AMM-15 addresses uncertainty. |
| Water Quality | Water Temperature | No adverse effects anticipated | — | Adverse | Minimize/compensate: Mitigation Measure FISH-8.1: Prevent Detrimental Dissolved Oxygen and Water Temperature Effects to Fish Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Operations-related effects on water temperature in the Delta generally are minimal. Sites reservoir releases to Yolo Bypass via Colusa Basin Drain could increase temperature in the lower Yolo Bypass, although this is uncertain and would be addressed with Mitigation Measure FISH-8.1. |
| | Food Visibility | No adverse effects anticipated | — | No adverse effects anticipated | — | Sites sediment entrainment during life stages with food visibility noted as a stressor is not likely to immediately affect turbidity of water. |
| | Predation | No adverse effects anticipated | — | No adverse effects anticipated | Minimize/compensate: Sediment Monitoring Plan and Adaptive Management for Sediment Diverted from the Sacramento River | Sites operations would not result in major changes to water temperature, turbidity (suspended sediment), or predators. Uncertainty in effects to turbidity in relation to resuspension of marginally less (0.3-1.5% based on modeling) sediment because of Sites intake sediment entrainment would be addressed with sediment monitoring/adaptive management. |
| | Food Availability | Adverse | Minimize/compensate: Minimum Instream Flows; Delta Smelt Supplementation; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Adverse | Minimize/compensate: Releases from Sites Reservoir | For larvae, Sites diversions could negatively affect zooplankton prey correlated with Delta outflow/X2 in the spring, but modeling indicates such effects would be limited. For juveniles, a decrease to the stressor could occur as a result of Sites reservoir releases because of north Delta food subsidy (releases via Yolo Bypass) or broader Delta outflow increase (correlation with zooplankton prey abundance); an increase to stressor could occur as a result of zooplankton entrainment as a result of export of Sites reservoir water from south Delta. |
| | Other toxicity | — | — | Adverse | Minimize/compensate: Mitigation Measure WQ-1.1: Methylmercury Management; Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass | Sites reservoir releases have minor potential for negative effects from metals and pesticides, to be mitigated with Mitigation Measures WQ-1.1 and WQ-2.2. |
| River Flow | Entrainment | Adverse | Minimize/compensate: First Flush and Start of OMR Management; January 1 and Start of OMR Management; Adult Delta Smelt Entrainment Protection Action (Turbidity | No adverse effects anticipated | — | Modeling indicates little effect of Sites-related operations on correlates with early juvenile entrainment risk (Old and Middle River flows; X2); SWP/CVP criteria for limiting south Delta |

| Physical and Biological Feature | Stressor | PA Effect on Critical Habitat | PA Conservation Measures | Sites Effect on Critical Habitat | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | | | Bridge); Larval and Juvenile Delta Smelt Protection Action; Spring Delta Outflow; End of OMR Management; Barker Slough Pumping Plant, Maximum Spring Diversions, Larval Delta Smelt; Delta Smelt Supplementation<br>Exacerbate: Drought Actions; SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows | | | entrainment risk also would be in place. |
| Salinity | Size and Location of the Low Salinity Zone | Adverse | Minimize/compensate: Spring Delta Outflow; Summer Suisun Marsh Salinity Control Gate Operation; Fall X2<br>Exacerbate: Drought Actions | No adverse effects anticipated | — | There is little difference in low salinity zone as a result of Sites operations, as indicated by X2 modeling generally showing less than 1 km difference between Sites and No Action Alternative (with differences tending to be negative, i.e., not indicating less low salinity zone under Sites). |

## 7A.4.6 Longfin Smelt

Chapter 10 discusses the status of longfin smelt, including life history and habitat requirements, stressors, and an effects analysis of the Proposed Action. A summary of the effects analysis for effects on the species is provided in Table 7A-22. A qualitative analysis was conducted to provide a programmatic summary of the effects of Sites for the species life stages and stressors discussed for the Proposed Action (Table 7A-22)[12]. The analysis of Sites was based on information in the administrative draft DCP ITP Application and FEIR, which includes consideration of various quantitative and qualitative analyses.

As illustrated in Table 7A-22, potential effects of Sites in addition to the Proposed Action would primarily be from operations effects related to lower Delta outflow, to be mitigated with compensatory tidal habitat restoration. As described further in Chapter 3, guiding principles would be applied to ensure that adverse effects of the proposed operations of Sites would be avoided, minimized, and offset. Guiding principles relevant to longfin smelt include:

- Operate projects consistent with existing and/or future regulatory requirements in the Delta.
- Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to maintain and/or improve productivity of those fish populations.
- Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites with habitat restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.
- Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions.

As described in Chapter 3, Sites has an adaptive management program which would integrate with the adaptive management program for the Proposed Action and includes a number of general principles such as cooperating with resource agencies in monitoring efforts and designing studies to test operational modifications to remedy or lessen unanticipated effects.

[12] The summary tables include broad consideration of conservation measures that may affect stressors, including those that may not be specific to the given stressor or species.

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**Table 7A-22. Qualitative Summary of Sites Combined with Proposed Action (PA) Effects on Longfin Smelt**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| Juveniles Rearing and Migration | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | Operations-related effects on water temperature in the Delta are minimal. |
| | Toxicity | Increase (discountable/insignificant) | — | Increase (discountable/insignificant) | — | Life stage could temporally overlap the main period of reservoir release, during which there may be increased toxicity, but there would be little if any spatial overlap because the species would be farther downstream. |
| | Predation | Increase (discountable/insignificant) | — | Not anticipated to change | — | Sites operations would not result in major changes to water temperature, turbidity (suspended sediment), or predators. |
| | Entrainment | Increase (lethal; proportion: likely small; frequency: medium) | Minimize/compensate: January 1 and Start of OMR Management; Larval and Juvenile Longfin Smelt Protection Action; Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Not anticipated to change | — | CalSim modeling indicates that there would be little difference in Old and Middle River flows during the spring period of entrainment vulnerability, reflecting south Delta export of Sites reservoir water occurring outside of these months; criteria for limiting south Delta entrainment risk also would be in place. |
| | Freshwater Flow | Increase (sub-lethal to lethal; proportion: likely small; frequency: likely medium to high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal to lethal; proportion: medium; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | Sites operations have the potential for an uncertain negative effect on population abundance index caused by less winter/spring Delta outflow, mitigated by tidal habitat restoration (Mitigation Measure FISH-9.1). |
| | Food Availability | Increase (sub-lethal to lethal; proportion: medium; frequency: likely high) | Minimize/compensate: Minimum Instream Flows; Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | Sites diversions could negatively affect zooplankton or mysid prey correlated with Delta outflow/X2 in the spring, but modeling indicates such effects would be limited. |
| Adult Holding and Spawning | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | Operations-related effects on water temperature in the Delta are minimal. |
| | Toxicity | Increase (discountable/insignificant) | — | Not anticipated to change | — | Life stage would not temporally overlap the main period of reservoir release during which there may be increased toxicity. |
| | Predation | Increase (discountable/insignificant) | — | Not anticipated to change | — | Sites operations would not result in major changes to water temperature, turbidity (suspended sediment), or predators. |
| | Entrainment | Increase (lethal; proportion: small; frequency: likely medium) | Minimize/compensate: First Flush and Start of OMR Management; January 1 and Start of OMR Management; Adult Longfin Smelt Entrainment Protection Action<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Not anticipated to change | — | CalSim modeling indicates that there would be little difference in Old and Middle River flows during the spring period of entrainment vulnerability, reflecting south Delta export of Sites reservoir water occurring outside of these months; criteria for limiting south Delta entrainment risk also would be in place. |
| | Freshwater Flow | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely low) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal to lethal; proportion: medium; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | Sites operations have the potential for an uncertain negative effect on population abundance index caused by less winter/spring Delta outflow, mitigated by tidal habitat restoration (Mitigation Measure FISH-9.1). |
| | Food | Increase (sub-lethal to lethal; | Minimize/compensate: Minimum Instream Flows; | Increase (sub-lethal; proportion: | Minimize/compensate: | Sites diversions could negatively affect zooplankton or |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale |
|---|---|---|---|---|---|---|
| | Availability | proportion: medium; frequency: likely high) | Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | small; frequency: medium) | Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | mysid prey correlated with Delta outflow/X2 in the spring, but modeling indicates such effects would be limited. |
| Eggs and Larvae | Water Temperature | Increase (discountable/insignificant) | — | Not anticipated to change | — | Operations-related effects on water temperature in the Delta are minimal. |
| | Toxicity | Increase (discountable/insignificant) | — | Not anticipated to change | — | Life stage would not temporally overlap the main period of reservoir release during which there may be increased toxicity. |
| | Predation | Increase (discountable/insignificant) | — | Not anticipated to change | — | Sites operations would not result in major changes to water temperature, turbidity (suspended sediment), or predators. |
| | Entrainment | Increase (lethal; proportion: likely small; frequency: medium to high) | Minimize/compensate: January 1 and Start of OMR Management; Larval and Juvenile Longfin Smelt Protection Action; Spring Delta Outflow; Barker Slough Pumping Plant, Maximum Spring Diversions, Larval Longfin Smelt<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Not anticipated to change | — | CalSim modeling indicates that there would be little difference in Old and Middle River flows or QWEST during the winter/spring period of entrainment vulnerability, reflecting south Delta export of Sites reservoir water occurring outside of these months; criteria for limiting south Delta entrainment risk also would be in place. |
| | Freshwater Flow | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely medium to high) | Minimize/compensate: Minimum Instream Flows; Spring Delta Outflow<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal to lethal; proportion: medium; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | Sites operations have the potential for an uncertain negative effect on population abundance index caused by less winter/spring Delta outflow, mitigated by tidal habitat restoration (Mitigation Measure FISH-9.1). |
| | Food Availability | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | Sites diversions could negatively affect zooplankton or mysid prey correlated with Delta outflow/X2 in the spring, but modeling indicates such effects would be limited. |

### 7A.4.7 Southern Resident Killer Whale

As described in Chapter 11, the Proposed Action is not anticipated to change the stressors Pollutants and Contaminants, Vessel Effects, Oil Spill, or Acoustic. The Proposed Action may increase the Prey Availability stressor to a discountable or insignificant level, with effects limited by the Proposed Action not impacting hatchery operations, and hatchery release strategies limiting the potential for operational effects to outmigration of hatchery-origin fish. Hatchery-origin Chinook salmon are likely to contribute far more to the killer whale diet than natural-origin Chinook salmon, with only 10.5% of the diet estimated to be of natural-origin Central Valley Chinook salmon (see Chapter 11). As shown in Sections 7A.4.1 and 7A.4.2, effects of Sites on listed Chinook salmon would be limited; additional analyses in the administrative draft Sites BA and FEIR show this would also be the case for unlisted fall-/late fall-run Chinook salmon. Therefore any increase in the Prey Availability stressor as a result of Sites would be discountable/insignificant for killer whale.

## 7A.5 Cumulative Effects of the Proposed Action, DCP, and Sites on Chinook Salmon, Central Valley Steelhead, Green Sturgeon, Delta Smelt, Longfin Smelt, and Killer Whale

Section 7A.3 includes qualitative effects analysis for DCP combined with the Proposed Action (i.e., the updated LTO). Since the DCP is a dual conveyance project, the operable LTO south Delta permits will be in effect while DCP is operating, so future consultations for the LTO would also include DCP. The LTO is discussed separately in this section because the LTO is being updated and the current LTO was modeled rather than the proposed LTO in the DCP EIR. Section 7A.4 includes qualitative effects analysis for Sites combined with the updated LTO because the current LTO was modeled in the Sites EIR. Each of these sections highlights potential impacts associated with project operations and conservation measures on listed aquatic species and their designated critical habitat. This programmatic framework is intended to identify fisheries issues associated with combined effects of the LTO Proposed Action, DCP, and Sites by addressing effects that the qualitative effects analyses in Section 7A.3 and Section 7A.4 identified as occurring for all three projects related to given stressors.

Future coordination between DWR and Reclamation will focus on shared responsibilities as contained in the LTO biological opinions. Reclamation and Sites will cooperate in the study of upstream Guiding Principles related to the reoperation of Shasta Reservoir related to Reclamation's participation in Sites. The Sites and DCP project teams will focus on the shared downstream Guiding Principles (e.g., reverse flows and outflow effects on listed species) to determine whether there is a synergy between the operation of the combined Sites and DCP project facilities that changes the nature and/or magnitude of effects of the projects in ways not already identified in the individual permit planning documents for each project.

When assessing cumulative effects of DCP, Sites, and LTO, based on analyses done to date, it is important to note that these projects are not simply additive to one another as there is a relationship between joint operations and relative water right priority that has not been modeled to date. Future development of a combined model will facilitate a better understanding of potential project interactions, and will help identify, assess, and potentially alter operations where there is "overlap" resulting in potential new or exacerbated impacts to estimated water supply and federally listed species, beyond those identified for

the independent project analyses done to date. Additionally, ongoing and future regulatory processes, including water rights petitions, will also factor into refinements of project operations and how they ultimately (cumulatively) affect species.

Each project individually, within its respective project descriptions and effects analyses, provides information on potential impacts, as well as commitments to avoid, minimize and mitigate those impacts to listed species and their designated critical habitat. This information was summarized in Sections 7A.3 and 7A.4 above and is summarized below where all three projects could combine to affect species.

DCP will add an additional point of diversion but is not seeking new water right permits. DCP is planning to submit a change in point of diversion petition application to the State Water Resources Control Board (SWRCB) in 2024. The Sites Authority has submitted an application to obtain a water right permit from the SWRCB for new diversions to Sites Reservoir. Sites Reservoir operations and the operations of the SWP and CVP as they operate the DCP and/or to the LTO, as applicable, will be subject to the terms and conditions of their respective water right permits, as well as to all applicable laws, regulations, biological opinions and incidental take permits, and any court orders in place at the time. Sites operations will require coordination with Reclamation and DWR's operation of the CVP and SWP.

The Sites Authority is working with Reclamation and DWR to develop an Operations Agreement that will describe how Sites will avoid interfering with DWR and Reclamation's compliance with D-1641 (and subsequent orders or agreements), LTO biological opinions and DWR's LTO state incidental take statement, as well as address water right priority. This coordination will ensure that while Sites is operating, water quality standards can continue to be met without negatively impacting CVP and/or SWP upstream storage and without interfering with CVP and SWP compliance with their biological opinion and state incidental take permits. For example, Reclamation, as a participant in Sites, will need to include its reoperation of Shasta Reservoir related to that participation in future LTO consultations; its participation is expected to improve cold water conditions at Shasta Reservoir for the benefit of Chinook salmon spawning and egg mortality. From a species-by-species standpoint, Section 7A.3 and Section 7A.4, for DCP and Sites respectively, evaluate environmental stressors of each project combined with LTO. The evaluation highlights potential effects from each project on each species and designated critical habitat. For DCP, Sites, and the Proposed Action, conservation measures are included (and summarized in the above tables) to limit potential effects to listed species based on changes to environmental stressors. DCP and Sites include guiding principles that would be applied to ensure that adverse effects of the proposed operations of each project would be avoided, minimized, and offset. DCP, Sites, and the Proposed Action each contain a form of adaptive management. The adaptive management processes will be used to inform additional studies and modify select operations to the extent that each project is not performing as permitted, there are unanticipated synergistic impacts resulting from concurrent operation of these projects, or the impacts of a project could be further reduced (while still meeting project objectives) and refinements are proposed as part of future permitting activities. Adaptive management allows the best available science to be incorporated into management decisions and actions, and to address uncertainties associated with those actions, as well as system responses to processes like climate change. DCP, Sites and the Proposed Action each contain compensatory mitigation measures to offset the impacts associated with operations and maintenance.

Other cumulative effects (agricultural practices; increased urbanization; recreational activities in the region; and changes in location, volume, timing and method of delivery for non-CVP/SWP diversions) are discussed in Chapter 12.

### 7A.5.1 Sacramento River Winter-Run Chinook Salmon

The effects analyses in Sections 7A.3.1 and 7A.4.1 indicate that operations of the Proposed Action, DCP, and Sites could combine to affect outmigration cues and refuge habitat in the Delta (Table 7A-23). Such effects would be limited by conservation measures including tidal habitat and channel margin restoration and north Delta intakes operating criteria under DCP and diversion criteria under Sites, in addition to various conservation measures under the Proposed Action. Several guiding principles would be applied to avoid, minimize, and offset adverse effects to winter-run Chinook salmon and winter-run Chinook salmon critical habitat (Table 7A-23).

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**Table 7A-23. Qualitative Summary of Proposed Action (PA), DCP, and Sites Effects on Sacramento River Winter-Run Chinook Salmon, for Operations-Related Stressors Affected by all Three Projects**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| Juvenile Rearing and Outmigration | Outmigration Cues (Delta) | Increase (lethal; proportion: large; frequency: low) | Minimize/compensate: Minimum Instream Flows; SRSC Diversion Spring Delays and Shifting<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Shasta Reservoir Water Temperature and Storage Management; Allocation Reductions for Shasta Reservoir End of September Storage; Rebalancing between other CVP Reservoirs for Shasta Reservoir End of September Storage; Reduced Wilkins Slough Minimum Flows for Shasta Reservoir End of September Storage; Minimum Refuge Summer Deliveries North of Delta; Drought Actions; SHOT Water Transfer Timing Approvals | Increase (lethal; proportion: large; frequency: high) | Minimize/compensate: North Delta intakes operating criteria; Mitigation Measure CMP (CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles) | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: Diversion criteria | Available quantitative modeling indicates that potential effects could be greatest in December-March (based on through-Delta survival modeling with STARS spreadsheet); however, the changes are limited (DCP: 2-4%; Sites: 0-1%; reflecting the range of month/water year type means). Operating/diversion criteria and habitat restoration would minimize/mitigate potential effects for each project, as applicable. | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.<br>• Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.<br>• Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites and DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations. |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| | Refuge Habitat (Delta) | Not anticipated to change (more seaward end of Delta); increase (more landward end of Delta; sub-lethal; proportion: large; frequency: medium) | Minimize/compensate: Minimum Instream Flows; SRSC Transfer Delays<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance; Reduced Wilkins Slough Minimum Flows; SHOT Water Transfer Timing Approvals; Drought Actions | Increase (sub-lethal; proportion: small; frequency: high) | Minimize/compensate: Mitigation Measure CMP (CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | Not anticipated to change (more seaward end of Delta); increase (Sacramento River and more landward end of Delta; sub-lethal; proportion: medium; frequency: medium) | Minimize/compensate: Diversion criteria | Primarily winter diversions by Sites and DCP could affect refuge habitat in the north Delta, but effects would be limited by North Delta intakes operating criteria and Sites diversion criteria, together with CMP-26 for DCP. | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.<br>• Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites and DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations. |

### 7A.5.2 Central Valley Spring-Run Chinook Salmon

The effects analyses in Sections 7A.3.2 and 7A.4.2 indicate that operations of the Proposed Action, DCP, and Sites could combine to affect juvenile/yearling outmigration cues and refuge habitat in the Delta (Table 7A-24). Such effects would be limited by conservation measures including tidal habitat and channel margin restoration and north Delta intakes operating criteria under DCP and diversion criteria under Sites, in addition to various conservation measures under the Proposed Action. Several guiding principles would be applied to avoid, minimize, and offset adverse effects to spring-run Chinook salmon and spring-run Chinook salmon critical habitat (Table 7A-24).

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**Table 7A-24. Qualitative Summary of Proposed Action (PA), DCP, and Sites Effects on Central Valley Spring-Run Chinook Salmon, for Operations-Related Stressors Affected by all Three Projects**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| Juvenile Rearing and Outmigration | Outmigration Cues (Delta) | Increase (lethal; proportion: large [Sacramento River], medium [Clear Creek]; frequency: low [Sacramento River and Clear Creek]) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Ramping Rates; Clear Creek: Minimum Instream Flows; Spring Pulse Flows; Ramping Rates<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Construction: not anticipated to change. Operations and maintenance: not anticipated to change (Sacramento River); increase (Delta; lethal; proportion: high; frequency: high). | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: Diversion criteria | Available quantitative modeling indicates that potential effects could be greatest in December-March (based on through-Delta survival modeling with STARS spreadsheet); however, the changes are limited (DCP: 2-4%; Sites: 0-1%; reflecting the range of month/water year type means). Operating/diversion criteria and habitat restoration would minimize/mitigate potential effects for each project, as applicable. | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.<br>• Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.<br>• Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites and DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations. |
| | Refuge | Not anticipated | Minimize/compensate: | Increase (sub- | Minimize/compensate: CMP- | Not anticipated to | Minimize/compensate: | Primarily winter diversions by | • Operate projects consistent |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| | Habitat (Delta) | to change (more seaward end of Delta); increase (more landward end of Delta; sub-lethal; proportion: large; frequency: low) | Sacramento River: Minimum Instream Flows; Voluntary Agreement Pulse Flows; Sacramento River Pulse Flows; Clear Creek: Minimum Instream Flows; Spring Pulse Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | lethal; proportion: small; frequency: high) | 26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles); North Delta intakes operating criteria | change (more seaward end of Delta); increase (Sacramento River more landward end of the Delta; proportion: medium; frequency: medium) | diversion criteria | Sites and DCP could affect refuge habitat in the north Delta, but effects would be limited by North Delta intakes operating criteria and Sites diversion criteria, together with CMP-26 for DCP. | with existing and/or future regulatory requirements in the Delta.<br>• Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.<br>• Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites and DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations. |
| Yearling Outmigration | Outmigration Cues (Delta) | Increase (lethal; proportion: large; frequency: low) | Minimize/compensate: Sacramento River: Minimum Instream Flows; Fall and Winter Base Flows for Shasta Reservoir Redd Maintenance; Clear Creek: Minimum Instream Flows<br>Exacerbate: Sacramento River: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Sacramento River and Clear Creek: Drought Actions | Increase (lethal; proportion: high; frequency: high). | Minimize/compensate: North Delta intakes operating criteria; CMP-25: Tidal Habitat Restoration to Mitigate North Delta Hydrodynamic Effects on Chinook Salmon Juveniles | Increase (lethal; proportion: small to medium; frequency: medium) | Minimize/compensate: Diversion criteria | Available quantitative modeling indicates that potential effects could be greatest in December-March, which overlaps the yearling outmigration period. The potential effects would be limited (based on through-Delta survival modeling with STARS spreadsheet, i.e., DCP: 3% or less; Sites: 0-1%; reflecting the range of month/water year type means). Operating/diversion criteria and habitat restoration would minimize/mitigate potential | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.<br>• Monitor and mitigate |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | effects for each project, as applicable. | effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites and DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations. |

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### 7A.5.3 California Central Valley Steelhead

The effects analyses in Sections 7A.3.3 and 7A.4.3 indicate that operations of the Proposed Action, DCP, and Sites could combine to affect juvenile refuge habitat in the Delta (Table 7A-25)[13]. Such effects would be limited by conservation measures including channel margin restoration and north Delta intakes operating criteria under DCP and diversion criteria under Sites, in addition to various conservation measures under the Proposed Action. Several guiding principles would be applied to avoid, minimize, and offset adverse effects to Central Valley steelhead and Central Valley steelhead critical habitat (Table 7A-25).

[13] Note that increases to the Outmigration Cues stressor occurs for both DCP and Sites, but is not included in the table because it was not a sufficiently large effect for the Proposed Action.

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**Table 7A-25. Qualitative Summary of Proposed Action (PA), DCP, and Sites Effects on Central Valley Steelhead, for Operations-Related Stressors Affected by all Three Projects**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| Juvenile Rearing and Outmigration | Refuge Habitat (Delta) | Not anticipated to change (more seaward end of Delta); Increase (more landward end of the Delta; winter and spring; sublethal; proportion: small to medium; frequency: high) | Minimize/compensate: Sacramento River: Minimum Instream Flows. Clear Creek: Minimum Instream Flows. American River: Minimum Instream Flows. Stanislaus River: Stepped Release Plan.<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill and Redd Maintenance | Increase (sub-lethal; proportion: small; frequency: high) | Minimize/compensate: CMP-26: Channel Margin Habitat Restoration for Operations Impacts on Chinook Salmon Juveniles; North Delta intakes operating criteria | Not anticipated to change (more seaward end of Delta); increase (more landward end of the Delta; proportion: medium; frequency: medium) | Minimize/compensate: Diversion criteria. | Primarily winter diversions by Sites and DCP could affect refuge habitat in the north Delta, but effects would be limited by North Delta intakes operating criteria and Sites diversion criteria, together with CMP-26 for DCP. | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.<br>• Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.<br>• Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites and DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations. |

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## 7A.5.4 Green Sturgeon

The effects analyses in Sections 7A.3.4 and 7A.4.4 suggest that operations of the Proposed Action, DCP, and Sites would not combine to appreciably affect green sturgeon stressors within the Delta. Regardless of this programmatic conclusion, several guiding principles would be applied to avoid, minimize, and offset adverse effects to green sturgeon and green sturgeon critical habitat in the Delta:

- Operate projects consistent with existing and/or future regulatory requirements in the Delta.
- Implement pulse flow criteria to provide migrating anadromous fish an opportunity to migrate past the diversion locations with minimum exposure to diversions and further minimize effects to through-Delta survival.
- Utilize best available science to establish flow levels necessary to provide migratory and rearing habitat to minimize effects to juvenile anadromous fish survival and facilitate their movement out of the river toward the delta and bays.
- Monitor and mitigate effects of diversions on migrating anadromous species and their habitat through identification of opportunities to develop additional habitat (i.e. tidal and channel margin restoration) to improve productivity of those fish populations.
- Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of Sites and DCP with habitat restoration developed in coordination with National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), and California Department of Fish and Wildlife (CDFW) to improve productivity of those fish populations.

## 7A.5.5 Delta Smelt

The effects analyses in Sections 7A.3.5 and 7A.4.5 indicate that operations of the Proposed Action, DCP, and Sites could combine to affect food availability/quality for larval and juvenile delta smelt (Table 7A-26). Such effects would be limited by conservation measures including tidal habitat restoration under DCP and reservoir releases under Sites, in addition to various conservation measures under the Proposed Action. Several guiding principles would be applied to avoid, minimize, and offset adverse effects to delta smelt and delta smelt critical habitat (Table 7A-26).

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**Table 7A-26. Qualitative Summary of Proposed Action (PA), DCP, and Sites Effects on Delta Smelt, for Operations-Related Stressors Affected by all Three Projects**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| Eggs and Larvae | Food Availability | Increase (sub-lethal to lethal; proportion: likely medium; frequency: high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal; proportion: small; frequency: high) | Minimize/compensate: Mitigation Measure CMP (CMP-27: Tidal Habitat Restoration for Operations Impacts on Delta Smelt) | Increase (sub-lethal; proportion: small; frequency: medium) | — | Less spring Delta outflow (higher X2) as a result of DCP and Sites diversions could result in small reductions in spring zooplankton prey (in particular *Eurytemora affinis*); DCP includes CMP-27 for mitigation. | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP and Sites with habitat restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.<br>• Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir and DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions. |
| Juveniles | Food Availability and Quality | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely medium to high) | Minimize/compensate: Minimum Instream Flows; Delta Smelt Supplementation<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal; proportion: small; frequency: high) | Minimize/compensate: Mitigation Measure CMP (CMP-27: Tidal Habitat Restoration for Operations Impacts on Delta Smelt) | Decrease (beneficial; proportion: small to medium; frequency: medium) or increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Releases from Sites Reservoir | DCP north Delta intake operations may entrain foodweb organisms but this is limited in extent, particularly relative to in situ production. Less June-October Delta outflow because of less outflow needed meeting Delta salinity requirements could result in less zooplankton prey (*Pseudodiaptomus forbesi*), but there is uncertainty associated with factors such as QWEST flow being similar to baseline; effects to be mitigated by CMP-27. A decrease to the stressor could occur as a result of Sites reservoir releases because of north Delta food subsidy (releases via Yolo Bypass) or broader Delta outflow increase (correlation with zooplankton prey abundance); an increase to | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP and Sites with habitat |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | stressor could occur as a result of zooplankton entrainment as a result of export of Sites reservoir water from south Delta during the juvenile life stage. | restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.<br>• Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir and DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions. |

### 7A.5.6 Longfin Smelt

The effects analyses in Sections 7A.3.6 and 7A.4.6 indicate that operations of the Proposed Action, DCP, and Sites could combine to increase freshwater flow and food availability stressors for longfin smelt (Table 7A-27). Such effects would be limited by conservation measures including tidal habitat restoration under Sites and DCP, in addition to various conservation measures under the Proposed Action. Several guiding principles would be applied to avoid, minimize, and offset adverse effects to longfin smelt (Table 7A-27).

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**Table 7A-27. Qualitative Summary of Proposed Action (PA), DCP, and Sites Effects on Longfin Smelt, for Operations-Related Stressors Affected by all Three Projects**

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| Juveniles Rearing and Migration | Freshwater Flow | Increase (sub-lethal to lethal; proportion: likely small; frequency: likely medium to high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal to lethal; proportion: medium; frequency: medium to high) | Minimize/compensate: Mitigation Measure CMP (CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt) | Increase (sub-lethal to lethal; proportion: medium; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | DCP and Sites operations have the potential for an uncertain negative effect on population abundance index caused by less winter/spring Delta outflow, mitigated by tidal habitat restoration (CMP-28 and Mitigation Measure FISH-9.1). | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP and Sites with habitat restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.<br>• Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir and DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions.<br>• |
| | Food Availability | Increase (sub-lethal to lethal; proportion: medium; frequency: likely high) | Minimize/compensate: Minimum Instream Flows; Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal to lethal; proportion: small; frequency: high). | Minimize/compensate: Mitigation Measure CMP (CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt) | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | Less Delta outflow because of DCP and Sites diversions could decrease zooplankton/mysid abundance; effects to be mitigated by CMP-28 and Mitigation Measure FISH-9.1. | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP and Sites with habitat |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.<br>• Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir and DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions.<br>• |
| Adult Holding and Spawning | Freshwater Flow | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely low) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal to lethal; proportion: medium; frequency: medium to high) | Minimize/compensate: Mitigation Measure CMP (CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt) | Increase (sub-lethal to lethal; proportion: medium; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | DCP and Sites operations have the potential for an uncertain negative effect on population abundance index caused by less winter/spring Delta outflow, mitigated by tidal habitat restoration (CMP-28 and Mitigation Measure FISH-9.1). | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP and Sites with habitat restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.<br>• Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir and DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions. |
| | Food Availability | Increase (sub-lethal to lethal; proportion: medium; frequency: likely high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta | Increase (sub-lethal to lethal; proportion: small; frequency: high). | Minimize/compensate: Mitigation Measure CMP (CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt) | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | Less Delta outflow because of DCP and Sites diversions could decrease zooplankton/mysid abundance; effects to be mitigated by CMP-28 and Mitigation Measure FISH-9.1. | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| | | | Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | | | | | | identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP and Sites with habitat restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.<br>• Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir and DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions. |
| Eggs and Larvae | Freshwater Flow | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely medium to high) | Minimize/compensate: Minimum Instream Flows; Spring Delta Outflow<br>Exacerbate: SHOT Reduction in Sacramento River Fall and Winter Flows; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal to lethal; proportion: medium; frequency: medium to high) | Minimize/compensate: Mitigation Measure CMP (CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt) | Increase (sub-lethal to lethal; proportion: medium; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | DCP and Sites operations have the potential for an uncertain negative effect on population abundance index caused by less winter/spring Delta outflow, mitigated by tidal habitat restoration (CMP-28 and Mitigation Measure FISH-9.1). | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP and Sites with habitat restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.<br>• Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir and DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities |

| Life Stage | Stressor | PA Effect on Stressor | PA Conservation Measures | DCP Effect on Stressor | DCP Conservation Measures | Sites Effect on Stressor | Sites Conservation Measures | Rationale for Combined Effects | Guiding Principles |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions. |
| | Food Availability | Increase (sub-lethal to lethal; proportion: likely medium; frequency: likely high) | Minimize/compensate: Minimum Instream Flows; Winter and Spring Delta Outflow<br>Exacerbate: Fall and Winter Base Flows for Shasta Reservoir Refill; Reduced Wilkins Slough Minimum Flows; Drought Actions | Increase (sub-lethal to lethal; proportion: small; frequency: high) | Minimize/compensate: Mitigation Measure CMP (CMP-28: Tidal Perennial Habitat Restoration for Operations Impacts on Longfin Smelt) | Increase (sub-lethal; proportion: small; frequency: medium) | Minimize/compensate: Mitigation Measure FISH-9.1: Tidal Habitat Restoration for Longfin Smelt | Less Delta outflow because of DCP and Sites diversions could decrease zooplankton/mysid abundance; effects to be mitigated by CMP-28 and Mitigation Measure FISH-9.1. | • Operate projects consistent with existing and/or future regulatory requirements in the Delta.<br>• Monitor and mitigate effects of diversions on habitat for Delta pelagic fish species through identification and implementation of opportunities to develop additional habitat (i.e. tidal habitat restoration) to improve productivity of those fish populations.<br>• Protect habitat conditions supporting listed pelagic and anadromous species, mitigate potential flow related effects of DCP and Sites with habitat restoration developed in coordination with NMFS, FWS, and CDFW to improve productivity of those fish populations.<br>• Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir and DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions. |

### 7A.5.7 Southern Resident Killer Whale

The effects analyses summaries provided in Sections 7A.3.7 and 7A.4.7 indicate that the Proposed Action, DCP, and Sites would not combine to affect prey availability for killer whale beyond a discountable/insignificant level.

## 7A.6 References Cited

National Marine Fisheries Service. 2019. Biological Opinion on the Long-Term Operation of the Central Valley Project and State Water Project. Consultation tracking number WCRO-2016-2 00069. October 21. National Marine Fisheries Service, West Coast Region.

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